SALT LAKE CITY CORPORATION

THE DEPARTMENT OF PUBLIC UTILITIES

PROJECT MANUAL FOR CONSTRUCTION OF

New WRF SW1A Influent Pump Station (IPS)

PROJECT NO. 524905396

FISCAL YEAR 2023

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City Council

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1805 W. 500 S.
SALT LAKE CITY, UTAH 84104

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Chief Engineer

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SALT LAKE CITY CORPORATION
Salt Lake City, Utah

PROJECT MANUAL

FOR

New WRF SW1A Influent Pump Station (IPS)

PROJECT NO. 524905396

PREPARED FOR

DEPARTMENT OF PUBLIC UTILITIES
ENGINEERING DIVISION
1805 W. 500 S.
SALT LAKE CITY, UTAH 84104

PREPARED BY

Project Engineer: AECOM
756 WINCHESTER STREET
SALT LAKE CITY, UTAH 84107-7560

March 22, 2023

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S E A L S P A G E

New WRF SW1 Influent Pump Station (IPS)

Project No. 524905396

PROJECT MANUAL PREPARED UNDER THE DIRECTION OF:

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Professional's Name: Grant E. Davies, PE
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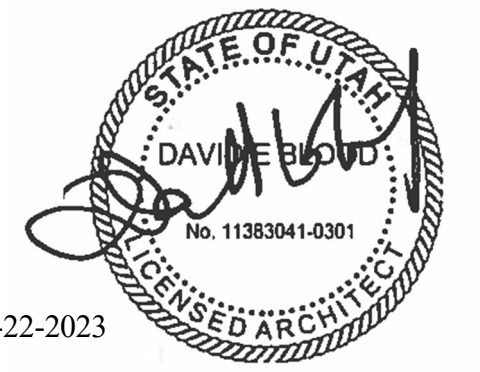
Phone Number: (801) 904-4000



3/22/2023

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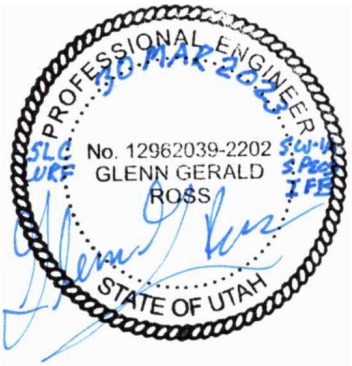
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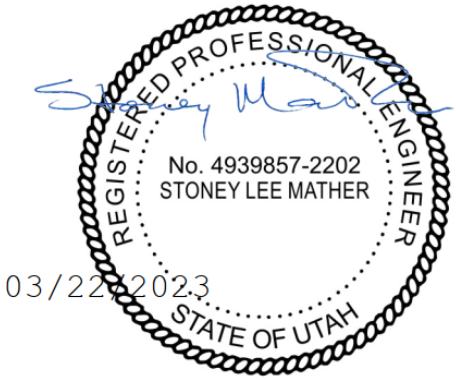
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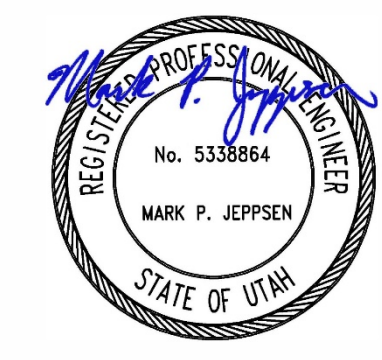
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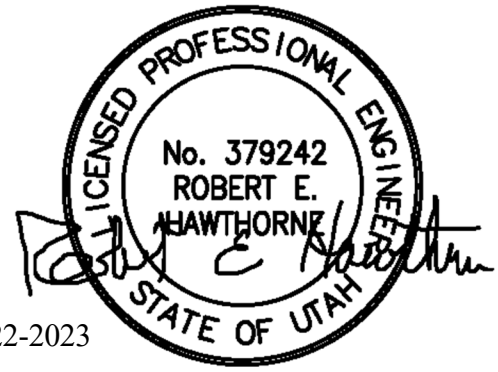
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03-22-2023

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CERT.	REG. NO.	EXPIRES
RCDD	136703	12/31/2025
RCDD/NTS	136703	12/31/2024

Kristian Zebrosky 03/22/2023

KRISTIAN ZEBROSKY

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New WRF SW1 Influent Pump Station (IPS)
Project No. 524905396

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Not Used

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Not Used

Appendices:

Appendix A: Drone Aerial Map

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DOCUMENT 00 11 16
INVITATION TO BID

PART 1 GENERAL

1.1 CONSTRUCTION CONTRACT

A. Bidders are invited to bid on the Construction Contract named and numbered as:

New WRF SW1A Influent Pump Station (IPS)

1200 Reclamation Road, Salt Lake City

Project No. 524905396

B. For information about the award of this Construction Contract, contact Jason Brown, P.E., Chief Engineer at 801-483-6888.

C. All questions about technical requirements must be submitted through U3P.

1.2 DESCRIPTION OF WORK

A. The location of the work is:

1200 Reclamation Road, Salt Lake City

B. The work to be performed consists of furnishing and installing the equipment, facilities, services, and appurtenances indicated in the Contract Documents. The Work generally includes, but is not limited to, the following:

A 105-mgd capacity wastewater IPS with future build-out to 137-mgd capacity consisting of:

1. Site preparation including demolition, clearing, grubbing, excavation, foundation preparation, backfill
2. Existing utility relocations
3. Two (2) pre-engineered metal buildings housing the IPS and electrical equipment
4. Two (2) trench style, self-cleaning wet wells side by side under same superstructure
5. Pump gallery consisting of five (5) vertical turbine solids handling pumps with space for a total of six (6) pumps, steel discharge headers, and valve pad.
6. Pre-manufactured biofilter odor control system
7. 4MW, n+1, emergency/standby power generator system , such that 4MW output is achievable even if one generator set is not operating
8. Yard utilities including fiber optic, ductbanks, potable water, non-potable water, natural gas, storm drains, influent sewer, and site drainage
9. Approximately 4,000 feet of duct bank connecting WRF site to IPS site
10. Civil site improvements including paving, grading, curb and gutter, sidewalk, chain link fencing, and landscaping for an approximate 8-acre site
11. HDPE forcemains from the valve pad header to station 2+57.46.
12. Installation of GFRP influent sewer from the influent pump station to the connection extended from MH#3.

1.3 **BIDDERS' PRE-QUALIFICATION**

A. Bidders are not required to be pre-qualified for the Work. Refer to section 00 45 14 for qualification requirements.

1.4 **BASIS OF BIDS**

A. Bids shall be on a lump sum and unit price basis. Unsealed or segregated Bids will not be accepted.

1.5 **CONTRACT TIME**

A. The Work will be Substantially Complete by **March 19, 2026**.

1.6 **EXAMINATION AND PROCUREMENT OF DOCUMENTS**

A. Complete sets of Contract Documents may be examined and obtained from the ENGINEER at 1805 West 500 South, Salt Lake City, Utah 84104 on **April 7, 2023** or downloaded from U3P at the following web address:

https://solutions.sciquest.com/apps/Router/SupplierLogin?CustOrg=StateOfUtah.

B. To ensure notification of addenda is received, BIDDERS should register as a plan holder on **U3P- Utah Public Procurement Place (formerly SciQuest)**.

1.7 **PRE-BID CONFERENCE**

A. A **mandatory** pre-bid conference will be held at **09:00 on April 18, 2023**, at 1805 West 500 South, Salt Lake City, Utah 84104 followed by a site walk located at 1200 Reclamation Road, Salt Lake City, Utah 84116. All pre-qualified contractors intending to submit a bid are required to attend to obtain relevant information concerning the project. Bidders are advised that information affecting drawings, specifications, conditions, scope of the Work, etc. may be discussed. OWNER assumes no obligation to disclose information discussed at the pre-bid conference to Bidders who do not attend. Absent Bidders assume all risk of failure to attend.

1.8 **BID SECURITY**

A. Bid security amount must equal 5 percent of the total amount of the Bid. A PDF of the Bid Security should be included in the bid documents. Bids utilizing cashier's checks or cash equivalent may not be submitted electronically. Bid Security will be returned to each unsuccessful Bidder after tabulation and award of the Construction Contract.

1.9 **BID LOCATION AND OPENING**

A. Sealed bids will be received at the **office of the Salt Lake City Department of Public Utilities** 1805 West 500 South, Salt Lake City, Utah 84104 no later than 2:00 p.m., local prevailing time, as conclusively established by the clock at the Bid opening location, on Friday **May 12, 2023**. **Bids delivered to any other location will not be accepted.** Bids received after 2:00 p.m. will not be accepted. Bids will be publicly opened and read in the same building, 1805 West 500 South, Salt Lake City, Utah 84104 at about 2:00 p.m., local prevailing time, on **May 12, 2023** by a Public Utilities representative.

B. On the outside of the envelope, Bidder shall indicate the project name, project number, and include Bidder's return mailing address.

C. Bids can also be submitted electronically no later than 2:00 PM on Friday, **May 12, 2023**, through the U3P (Utah Public Procurement Place) project site (Document 00 21 13).

D. Please join the SLCDPU for the Pre-Bid Meeting in person at 1875 W 500 S, Salt Lake City, UT 84104 SLCDPU'S West Campus.

E. Please join the SLCDPU for the Bid Opening Meeting from the convenience of your computer, tablet, or smartphone by using the link below:

SLCDPUENG Construction Open Bid(s) Meeting

https://saltlakecity.webex.com/saltlakecity/j.php?MTID=m25ef967f6e580d713fdf665060ba7f89
Friday, May 12, 2023, 2:00 AM | 1 hour | (UTC-06:00) Mountain Time (US & Canada)
Meeting number: 2491 541 4483
Password: openbid
Agenda: The following project bid(s) are to be opened and read aloud in this open-to-the-public meeting:

1) New WRF – SW1 Influent Pump Station (IPS) (524905396)

Join by video system:
Dial 24915414483@webex.com
You can also dial 173.243.2.68 and enter your meeting number.

Join by phone:
+1-408-418-9388 United States Toll
Access code: 249 154 14483

1.10 **RIGHT TO REJECT BIDS**

A. OWNER reserves the right to reject any or all bids or to waive any informality or technicality in any bid if OWNER deems it to be in its best interest.

1.11 **VALIDITY PERIOD FOR BIDS**

A. Bids shall remain valid for 60 days after the day of Bid opening. A Bidder who receives a Notice of Intent to Award and who withdraws their bid after Bid opening, but before expiration of said period, shall forfeit their bid security.

1.12 **GOVERNING LAWS AND REGULATIONS**

A. This project is being partially funded through a federal loan under the Water Infrastructure Finance and Investment Act (WIFIA) program and requires the Contractor to comply with the requirements of the WIFIA program including the payment of Davis Bacon wage rates and weekly submission of copies of Certified Payroll documents as further described in Section 01 41 13 FEDERAL REQUIREMENTS..

B. Bidders on this Work will be subject to the applicable provisions of all federal rules, laws, and regulations or orders as further described in Section 01 41 13 FEDERAL REQUIREMENTS.

C. Bidders on this Work will be subject to the Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246) located at 41 CFR § 60-4.2, as further described in Section 01 41 13 FEDERAL REQUIREMENTS.

D. This project requires compliance with American Iron and Steel (AIS) as further described in Section 01 41 13 FEDERAL REQUIREMENTS.

1.13 **AMERICANS WITH DISABILITIES (ADA)**

A. Assisted listening devices or interpreting services are available for all public meetings. Salt Lake City Corporation complies with the American Disabilities Act (ADA). For further information, contact the TDD Number 801-483-6820.

1.14 **REPRESENTATION REGARDING ETHICAL STANDARDS FOR CITY OFFICERS AND EMPLOYEES AND FORMER CITY OFFICERS AND EMPLOYEES**

A. A bid will not be accepted unless it contains the following representation.

THE BIDDER, OFFEROR OR CONTRACTOR represents that it has not:

1. **Provided an illegal gift or payoff to a City officer or employee or former City officer or employee, or its relative or business entity.**
2. **Retained any person to solicit or secure this contract upon an agreement or understanding for a commission, percentage, or brokerage or contingent fee, other than bona fide employees or bona fide commercial selling agencies for the purpose of securing business.**
3. **Knowingly breached any of the ethical standards set forth in the City's conflict of interest ordinance, Chapter 2.44, Salt Lake City Code; or**
4. **Knowingly influenced, and hereby promises that it will not knowingly influence, a City officer or employee or former City officer or employee to breach any of the ethical standards set forth in the City's conflict of interest ordinance, Chapter 2.44, Salt Lake City Code.**

1.15 **AWARD**

A. The Construction Contract will be awarded in compliance with the City's Building Improvement and Public Works Bidding Program which takes into account certain factors in the Bidder's work environment (See Salt Lake City Code Section 3.24.115).

END OF DOCUMENT

DOCUMENT 00 21 13
INSTRUCTIONS TO BIDDERS

PART 1 GENERAL

1.1 DEFINED TERMS

A. Terms used in the Bid Documents that are defined in Article 1.1 of the General Conditions will have the meanings indicated in the General Conditions.

B. General Conditions: as published in Document 00 72 00 in the current edition of the Manual of Standard Specifications by the Utah Chapter of the American Public Works Association.

1.2 COPIES OF BID DOCUMENTS

A. Complete sets of Bid Documents must be used in preparing Bids. OWNER and ENGINEER assume no responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bid Documents.

B. Bid Documents are made available to Bidder only for the purpose of obtaining Bids on the Work. No license or grant for any other use is given.

C. Bidding Document copyrights shall remain with OWNER.

D. All provisions of the current edition of the Manual of Standard Specifications and Manual of Standard Plans published by the Utah Chapter of the American Public Works Association that are applicable to the Work are made a part of the Contract Documents by reference. Those publications are available on the web at http://utah.apwa.net.

E. Salt Lake City Department of Public Utilities has a document entitled "Standard Practices for Salt Lake City Public Utilities". (March 9, 2018 edition) The document is available from 1805 West 500 South, Salt Lake City, Utah 84104

1.3 PRE-BID CONFERENCE

A. Representatives of OWNER and ENGINEER will be present at a pre-bid conference to discuss the Project. Bidders are required to attend and participate in the conference. ENGINEER will publish to U3P copies of the Bid Documents Addenda as ENGINEER/OWNER considers necessary in response to questions arising at the conference. The location and time of the conference are identified in the Invitation to Bid (Document 00 11 16).

1.4 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. **In General**: Bidders are NOT permitted to converse with ENGINEER or ENGINEER's personnel having knowledge of the Project, Plans, Specifications, material sites, or conditions generally prevailing in the area of the Project to aid in pre-bid investigations. OWNER is not bound by any statements or representations made by ENGINEER or ENGINEER's personnel before the Bid opening or award of the Construction Contract, nor for any assumptions or conclusions reached by a prospective Bidder as a result of such communication unless ENGINEER issues an Addendum to all prospective Bidders.

B. **Access to Site**: The lands upon which the Work is to be performed, and rights-of-way and easements for access thereto and other lands designated for use by Bidder in performing the Work are identified in the Contract Documents. All additional off-site lands and access

thereto required for temporary construction facilities or storage of materials and equipment must be provided by Bidder.

C. **Contract Documents**: The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article 1.4; that without exception the Bid is premised upon performing and furnishing the Work required by the Contract Documents; and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

D. **Bidder's Obligations**: The submission of a Bid constitutes acknowledgement that Bidder has complied with all bidding instructions. It is the responsibility of each Bidder, before submitting a Bid, to:

1. Examine the Contract Documents thoroughly;
2. Visit the site to become familiar with local conditions that may affect cost, progress, performance, or furnishing of the Work;
3. Consider federal, state, and local Laws and Regulations that may affect cost, progress, performance, or furnishing of the Work;
4. Study and carefully correlate Bidder's observations with the Contract Documents; and
5. Identify and notify ENGINEER in writing of all specific conflicts, errors, or discrepancies in the Contract Documents, and of any doubts of Bidder about their meanings. The failure or omission of any Bidder to receive or examine any form, instrument, Addendum, or other document, visit the site and become acquainted with conditions there existing, or attend the pre-bid conference, shall in no way relieve any Bidder from obligations with respect to Bidder's Bid or to the Construction Contract.

E. **Deviations from the Terms of the Contract Documents**: OWNER will not accept any deviations whatsoever from the printed terms of the Agreement (Document 00 52 00) and the Contract Documents, except by Addendum or Change Order.

1.5 PHYSICAL CONDITIONS

A. **In General**: Before submitting a Bid, each Bidder is responsible for review of OWNER's explorations, tests, and data concerning surface conditions, subsurface conditions, and Underground Facilities at or contiguous to the site, or otherwise, that may affect cost, progress, performance, or furnishing of the Work in accordance with the time, price, and other terms and conditions of the Contract Documents.

B. **Surface and Subsurface Conditions**: Provisions concerning surface and subsurface conditions, if any, are set forth in the Geotechnical Data (Document 00 31 32). That document provides the identification of:

1. Those reports of explorations and tests of subsurface conditions at the site that have been utilized by ENGINEER in preparing the Contract Documents; and
2. Those drawings of physical conditions in or relating to existing surface and subsurface structures (except Underground Facilities) at or contiguous to the site that have been utilized by ENGINEER in preparing the Contract Documents.

C. **Underground Facilities**: Information and data indicated in the Contract Documents regarding Underground Facilities at or contiguous to the site is based upon information and

data furnished to OWNER and ENGINEER by owners of such Underground Facilities. OWNER does not assume responsibility for the accuracy or completeness thereof other than as provided in paragraph 4.3A.2 of the General Conditions or unless expressly provided in the Modifications to the General Conditions (Document 00 73 10).

D. **Additional Explorations**: On request in advance, and if possible, OWNER will provide to each Bidder access to the site to conduct any explorations and tests as each Bidder deems necessary for submission of a Bid. Bidder shall obtain permits, fill all holes, and clean up and restore the site to its former condition upon completion of such explorations. Bidder shall indemnify and save OWNER harmless during and after the performance of additional explorations.

E. **Modifications to the Contract Documents**: Provisions concerning the adequacy of the data furnished for subsurface structures and underground facilities and the possibility of changes in the documents due to differing conditions appear in Articles 4.2 and 4.3 of the General Conditions.

PART 2 BIDDING PROCEDURES

2.1 INTERPRETATIONS AND ADDENDA

A. All requests for interpretation of the Contract Documents shall be made in writing and delivered to ENGINEER no later than 7 calendar days before the Bid opening. If required, ENGINEER will send a written interpretation to all persons receiving a set of Bid Documents in the form of a written Addendum. If a Bidder's request for interpretation is not responded to by ENGINEER, Bidder shall not rely on any interpretation in the request that is contrary to the intent and terms of the Contract Documents.

B. OWNER will not be responsible for any explanations or interpretations, except those duly issued in the form of written Addenda.

C. Addenda may also be issued to modify the Bidding Documents as deemed advisable by ENGINEER.

D. Any Addenda so issued during the time of bidding shall be deemed to be included in the Bid. All Addenda shall become a part of the Contract Documents.

E. Except to postpone the Bid opening, no Addenda shall be issued within 48 hours before the Bid opening.

2.2 EQUIPMENT AND MATERIAL OPTIONS BEFORE OPENING

A. If a Bidder or Supplier wishes to use items of equipment or materials other than those identified in the Contract Documents, said Bidder or Supplier shall submit a written request for approval to ENGINEER at least 10 days before the date set for the Bid opening.

B. The procedure for submission of any such request shall be as follows: submit 1) two sets of the written request and technical brochures and 2) a statement of variances. The statement of variances must list all features of the proposed substitution that differ from the Contract Documents and must further certify that the substitution has no other variant features. The brochure and information submitted must be clearly marked showing make, model, size, options, and any other features and must include sufficient evidence for ENGINEER to evaluate each feature listed as a variance. If after installing the substituted

product, an unlisted variance is discovered, CONTRACTOR shall immediately replace the product with a specified product at no cost to OWNER.

C. Any approval of such a request by ENGINEER must be made not later than 48 hours before the Bid opening. ENGINEER's failure to approve by such time shall be deemed a denial of the request.

D. Any such approval is at the sole discretion of ENGINEER and will be in the form of an Addendum, issued to all Bidders holding Bid Documents, indicating that the additional equipment or materials are approved as equal to those specified for the Project.

2.3 BID SECURITY

A. **Delivery of Bid Security**: Bidders must deliver Bid security, in the form of either a Bid Bond or a cashier's check, to OWNER at the time they deliver their Bid. If Bid Security is not delivered with the Bid, the Bid shall not be read.

B. **Amount of Bid security**: The Bid security amount must equal 5 percent of the total amount of the Bid. The total amount of the Bid shall be the sum of all items of the Bid, constituting the maximum amount of the possible award to the Bidder.

C. **Bid Bond:** If a Bid Bond is used, the Bond shall guarantee that the Bidder, if awarded the Work, will promptly enter into the Construction Contract to perform the Work in the manner required by the Contract Documents.

D. **Cashier's Check**: If a cashier's check is used, the cashier's check must be made payable to Salt Lake City Corporation and shall guarantee that the Bidder, if awarded the Work, will promptly enter into the Construction Contract to perform the Work in the manner required by the Contract Documents. A photocopy or facsimile transmission of the check will not be accepted. Personal or company checks will not be accepted.

E. **Return of Bid Security**: OWNER will return the Bid security to all Bidders by the earlier of 45 days after the date of the Bid opening and 7 days after the effective date of the Construction Contract. The liability of OWNER in regard to cashier's checks shall be limited only to the return of the checks.

F. **Default**: If the Bidder fails, within the time limit described in Article 3.6A, to enter into the Construction Contract and to deliver to OWNER a Performance Bond, Payment Bond, or any other Bonds or documents required by the Contract Documents after Notice of Intent to Award by OWNER, the Bidder shall forfeit the amount of the Bid Bond or cashier's check as liquidated damages to OWNER.

2.4 CONTRACT TIME AND PUNCH LIST TIME

A. Provisions concerning Contract Time and Punch List Time are set forth in the Agreement (Document 00 52 00).

2.5 LIQUIDATED DAMAGES

A. Provisions concerning liquidated damages are set forth in the Agreement (Document 00 52 00).

2.6 BID FORM

A. The Bid Form (Document 00 41 00) identifies all forms comprising the Bid Documents. Additional copies may be obtained from ENGINEER.

B. All names must be typed or printed under or near the signature. The signature must meet applicable State and City code..

C. The Bid must contain an acknowledgment of receipt of all Addenda. The Addenda numbers must be filled in on the Bid Form.

D. The Bidder's address, telephone number, email address, and facsimile number for communications regarding the Bid must be shown on the first page of the Bid Form.

E. The Bidder shall make no stipulations or alterations on the Bid forms. The Bidder must use only the Bid Form and Bid Schedules bound in the Contract Documents (unless updated forms are included in an addendum, in which cause the Bidder shall use the updated forms).

F. OWNER may waive any failure to comply with the requirements of this paragraph 2.6 if OWNER determines that such failure (1) is not material to the terms of OWNER's Bid Documents and process and does not render the Bid non-compliant with Laws and Regulations pertaining to bidding, or (2) involves ministerial or minor informalities that are evident from the Bid Documents or that can be waived without prejudice to other Bidders and that do not have a substantial effect on price.

2.7 **BID SCHEDULE**

A. Any work or material that is specified in the Contract Documents or that is necessary because of the nature of the Work, but that is not listed separately in the Bid Schedule (Document 00 43 00), shall not be measured or paid for separately. The cost of such work or material shall be considered as included in the Contract Price.

B. All blanks on the Bid Schedule (Document 00 43 00) must be completed in ink or by typewriter. If applicable, furnish both the unit and the total costs for each item. Numbers shall be stated in figures, and the signature of all persons signing shall be in longhand. Any corrections, alterations or erasures made by the Bidder to the information the Bidder entered on the Bid Schedule shall be initialed in ink by the Bidder. OWNER may waive any failure to comply with the requirements of this paragraph if OWNER determines that such failure (1) is not material to the terms of OWNER's Bid Documents and process and does not render the Bid non-compliant with Laws and Regulations pertaining to bidding, or (2) involves ministerial or minor informalities that are evident from the Bid Documents or that can be waived without prejudice to other Bidders and that do not have a substantial effect on price.

2.8 **SUBMISSION OF BIDS**

A. Bids shall be submitted at the time and place indicated in the Invitation to Bid (Document 00 11 16).

B. Methods of submission

a. Bids may be submitted in an enclosed opaque sealed envelope and marked with the Project title and the name and address of the Bidder. If the Bid is sent through the mail or other delivery system, the sealed envelope must be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face of it. It is the sole responsibility of the Bidder to deliver the Bid before the scheduled time.

b. For the bid to be considered, submit one (1) electronic copy no later than the time and date specified. The electronic copy may be submitted via the U3P site or sent to

SLCDPUENG@SLCGOV.COM. The file size cannot be larger than 9 megabytes for emailed submissions. Bids may be broken into parts to maintain smaller sizes and must be clearly named with "Part x of total" in the file name along with the project number and submitter for example; "400300200_ZZZ_construction_part_1_of_1.pdf." Compile your bid, and any other documents into one single PDF file, given the limit above. Bid securities may be a separate file. Upload your file(s) for this event using U3P. Responses must be uploaded, and the electronic submission completed by the time and date specified. After uploading your response file(s), offerors MUST go to "Review and Submit" and click "SUBMIT RESPONSE" to complete the process. Responses submitted electronically through U3P require uploading of electronic attachments. U3P will accept a wide variety of document types as Word, Excel, and PDF attachments but not all. You MAY NOT submit documents that are embedded (zip files), movies, wmp and mp3 files or password protected files, etc. Such actions may cause your proposal to be deemed as "non-responsive".

C. Alternate bids, other than those called for in the Bid form, will not be considered.

D. No oral, facsimile, or modified bids will be considered. OWNER will not consider any attempted modification of a Bid written or made on the outside of the envelope containing the Bid or electronic submission.

2.9 MODIFICATIONS AND WITHDRAWAL OF BIDS

A. At any time before the Bid opening, Bids may be modified or withdrawn if a written notice of the modification or withdrawal, as the case may be, is signed by Bidder and delivered to the place where Bids are to be submitted.

B. Within two business days after Bids are opened, any Bidder may file written notice with OWNER that there was a substantial mistake made in the preparation of its Bid. Bidder must thereafter promptly demonstrate Bidder's mistake to the reasonable satisfaction of OWNER. If OWNER agrees, Bidder may withdraw its Bid and the Bid security will be returned to Bidder.

2.10 OPENING OF BIDS

A. Bids will be opened and read aloud publicly unless obviously non-responsive. An abstract of the amounts of the base schedule of prices and any alternate schedules will be made available for review after the opening of Bids.

B. Any Bids received after the time specified in the Invitation to Bid (Document 00 11 16) will be returned unopened.

2.11 BIDS SUBJECT TO ACCEPTANCE FOR 60 DAYS

A. Subject to Paragraph 2.3E hereof, Bids remain subject to acceptance for 60 days after the day of the Bid opening. OWNER may, in its sole discretion, release any Bid and return the Bid security before that date. OWNER and Bidder may agree to extend the 60-day deadline.

2.12 NONDISCRIMINATION IN EMPLOYMENT

A. Work under this Bid will obligate the Bidder and Subcontractors not to discriminate in employment practices.

B. Bidders must, if requested, submit a compliance report concerning employment practices and policies in order to maintain their eligibility to receive the award of the Construction Contract.

C. Equal opportunity employment shall be reflected in the racial and sexual composition of Bidder's work force and OWNER urges an affirmative action program to overcome under-utilization.

D. Bidders are advised that the Construction Contract and its performance are subject to the applicable provisions of all Laws and Regulations. Bidder will be obligated, upon written request, to give all applicable assurances of compliance in connection therewith.

E. Federal nondiscrimination requirements are applicable, as further described in Section 01 41 13 FEDERAL REQUIREMENTS. Bidder must be fully knowledgeable and comply with such requirements.

PART 3 AWARD OF CONSTRUCTION CONTRACT

3.1 QUALIFICATIONS OF BIDDERS

A. Minimum Qualifications (must meet all to be qualified)

1. Qualified Contractors must meet the following minimum general criteria:

    A. Contractor's OSHA Recordable Lost Time Incident Rates cannot be greater than 100 percent of the industry average, per the most recent published Bureau of Labor Statistics data: Refer to http://stats.bls.gov/

    B. Contractor's most recent (NCCI) Workers Compensation Experience Modification Rate (EMR) must be at or below 1.00.

    C. Contractor shall have proven track record of completed projects without unresolved, unrealistic, and unnecessary claims.

    D. Contractor shall, at time of bid, hold a current Utah contractor's license in a classification appropriate to the Work described herein.

    E. Contractor shall meet the minimum bid bond of Section 2.3 of this specification at time of bidding.

2. Contractor shall demonstrate their competency in completing projects similar to the work described in these construction documents. Similar projects should include the following items:

    A. Contractor shall have a minimum of ten (10) years of experience in the construction of new, or modifications to existing, water treatment and/or wastewater treatment facilities.

    B. Contractor must have completed three projects during the past ten (10) years that include structural and mechanical process modifications to either a water or wastewater treatment facility.

    C. Contractor's project superintendent shall each have at least ten (10) years of experience in the construction of projects that are similar in nature to the work described herein and shall have direct experience in at least one

of the construction projects that meets the experience requirements above.

3. The Contractor must submit complete and sufficient information to demonstrate compliance with all minimum qualification requirements listed above with their bid (Section 00 45 14). Submission of insufficient or incomplete documentation, or failure to demonstrate compliance with all minimum qualification requirements, may be grounds for disqualification as determined solely by the Owner.

B. Within seven (7) calendar days of the Owner's request, a bidder whose bid is under consideration for award shall submit to the Owner the following information for the bidder. The Owner may request like information on the bidder's Subcontractors, or bidder's Suppliers or any other information the Owner may require.

1. A current financial statement for the Work (as provided to the bonding company);
2. A chronological list of all "completed" construction work done by Bidder during the last 3 years, including project name, address, owner, contract name, and current telephone number;
3. Work Under Contract Report (Document 00 43 37);
4. A functional organization chart, indicating the organizational structure of the Bidder's project team, including the reporting responsibilities and lines of authority of the Project Manager and other Key Personnel who will be providing services during construction. Any changes from the pre-qualification submission shall be indicated and explained;
5. Owned and rented equipment that is to be used to do the Work;
6. Investigations, arbitrations, litigation, or claims that are pending, threatened, settled, or disposed of within the last 3 years;
7. Evidence of ability to perform and complete the Work in a manner and within the time limit specified. If the Project Manager and Resident Superintendent designated to construct this project are different than that provided in the pre-qualification submission, provide resumes of their work history along with their actual project titles and actual responsibilities on each given project.
8. Names of three (3) projects of similar size and nature that the Resident Superintendent has completed. Include the name, address, and telephone number of the office contracting for each project; and
10. Such other data as may be called for in the Supplementary Instructions to Bidders (Document 00 22 16) (if any).OWNER will hold all requested information confidential and, upon request, shall return such information to Bidder after acceptance or rejection of Bidder's Bid.

D. Untimely response by Bidder will release OWNER of any obligation to further negotiate or consider Bidder's Bid.

3.2 EVALUATION OF BIDS

A. OWNER reserves the right: (1) to reject any and all Bids; (2) to waive minor informalities in the Bid Schedule and elsewhere so long as the informalities (a) are not material to OWNER's Bid Documents and process and do not render the Bid non-compliant with Laws and Regulation pertaining to bidding, or (b) involve ministerial or minor informalities that are evident from the Bid Documents or that can be waived without prejudice to other

Bidders and that do not have a substantial effect on price; (3) to negotiate and agree to contract terms with the successful Bidder; and (4) to disregard non-conforming, non-responsive, unbalanced, or conditional Bids.

B. OWNER reserves the right to reject any Bid if OWNER believes that it would not be in the best interest of the Project or OWNER to make an award to that Bidder. Such rejection may be because the Bid is non-responsive, or Bidder is unqualified or of doubtful ability, or Bidder's Resident Superintendent is unqualified or of doubtful ability, or the Bid or Bidder fails to meet any other pertinent standard or criteria established by OWNER in the Supplementary Instructions to Bidders (Document 00 22 16).

C. OWNER will consider the qualifications of Bidder and such alternates, prices, and other data as may be requested in the Bid Form (Document 00 41 00), Bid Schedule (Document 00 43 00), or written requests issued prior to OWNER's Notice of Intent to Award the Construction Contract. OWNER will consider Bidder's compliance with Section 3.24.115, Salt Lake City Code. See Document 00 22 16 Supplementary Instructions to Bidders.

D. OWNER may consider the qualifications and experience of Subcontractors, Suppliers, and other persons and organizations proposed for portions of the Work as provided in the Proposed Subcontractor Form (Document 00 43 36). OWNER will consider Bidder's compliance with Section 3.24.115, Salt Lake City Code. See Document 00 22 16 Supplementary Instructions to Bidders.

E. OWNER may consider the operating costs, maintenance requirements, performance data, and guarantees of materials and equipment when such data is required to be submitted prior to the Notice of Intent to Award the Construction Contract.

F. To establish qualifications of Bidder, OWNER may request such data indicated in Article 3.1 hereinabove and conduct such investigations as OWNER deems appropriate.

G. If the Construction Contract is to be awarded, it will be awarded to the most responsive and lowest, qualified, responsible Bidder as determined by OWNER. Alternates may be accepted depending upon availability of OWNER funds. Bid alternates will be considered in determining the most responsive, lowest, qualified, and responsible Bidder.

H. ENGINEER will evaluate Bid Schedules as follows:

1. ENGINEER will resolve discrepancies in the multiplication of quantities of Work items and unit prices in favor of the unit prices.
2. Prices written out in words shall govern over prices written out in numbers.
3. ENGINEER will resolve discrepancies between the indicated sum of any column of figures and the correct sum thereof in favor of the correct sum.
4. Bids shall not contain any recapitulations of or changes in the work to be done.
5. ENGINEER may accept a Bid despite obvious errors in a Bid Schedule, such as a failure to include unit prices or a misplaced decimal point, as long as ENGINEER reasonably can discern the intention of Bidder as to the amounts to be bid.

3.3 SUBCONTRACTORS, SUPPLIERS AND OTHERS

A. Bidder shall not subcontract more than 75 percent of the dollar value of the total contemplated Work (exclusive of the supply of materials and equipment to be incorporated in the Work) without OWNER's written approval.

B. Conflict of interest restrictions pertaining to Subcontractors are described in paragraph 6.5H of the General Conditions.

C. The following firms, that have been under contract to the OWNER in the design phase of the Work, shall not be used as subcontractors by the CONTRACTOR.
   1. Design Consultant: AECOM.
   2. Geotechnical Consultants: AECOM.
   3. Surveying Consultant: CRS.

3.4 CONTRACT SECURITY AND OTHER SUBMITTALS

A. **Performance Bond (Document 00 61 13) and Payment Bond (Document 00 61 14)**: OWNER's requirements as to Performance and Payment Bonds are as set forth in the Modifications to General Conditions (Document 00 73 10). Specific requirements are set forth in the Performance Bond (Document 00 61 13) and the Payment Bond (Document 00 61 14).
   1. Bidder should carefully examine the form of the Bonds.
   2. When the successful Bidder delivers the executed Construction Contract to OWNER, it must be accompanied by the required Performance and Payment Bonds (using Documents 00 61 13 and 00 61 14, respectively).

B. **Proposed Subcontractor Form (Document 00 43 36)**: Bidder must provide this report form to OWNER within 24 hours after ENGINEER's request. See Bid Form, paragraph 1.5B (Document 00 41 00) for additional information. The form shall list the name and address of each Subcontractor who will perform work or labor or render service to Bidder at the site of the Work, or a Subcontractor who, off the job site, will specially fabricate a portion of the Work or improvement according to detail Drawings. In each instance, the nature and extent of any Work to be subcontracted in an amount in excess of 2 percent of the Bid sum shall be described. Bidder must have the written consent of OWNER to substitute for any of the Subcontractors or Suppliers designated or to employ any Subcontractor or Supplier that is not listed.

C. **Bidder Status Report (Document 00 43 38)**: Bidder must submit the completed form upon ENGINEER's request or after Bidder receives the Notice of Intent to Award.

D. **Other Information**: When a determination has been made to award the Construction Contract, Bidder is required, before the award or after the award, or both, to furnish such other information as ENGINEER requests.

3.5 ADJUSTMENTS TO THE COST OF THE WORK AFTER OPENING OF BIDS

A. The Contract Price identified in the Agreement (Document 00 52 00) represents the Cost of the Work that is to be paid by OWNER to CONTRACTOR. Adjustments to the Contract Price that are agreed to between OWNER and the successful Bidder shall be effected by signing an Agreement Supplement.

3.6 SIGNING OF AGREEMENT

A. Within 10 days, (or such longer period of time that OWNER in its discretion may allow) after OWNER gives Notice of Intent to Award the Construction Contract to the successful Bidder, Bidder shall pick up, sign, and return the required number of copies of the Agreement (Document 00 52 00) and attached documents to OWNER with the required

Bonds. A minimum of 2 originals will be signed. One executed original will be returned to Bidder.

B. Transfers, delegations, or assignments of interests in the Contract Documents are prohibited, unless prior written authorization is received from OWNER.

C. At and from the time of Bidding through the completion of the Work, Bidder shall be properly licensed to do the Work and shall be in compliance with the license laws of the State of Utah, Salt Lake City and Salt Lake County.

PART 4 MISCELLANEOUS

4.1 EQUIPMENT AND MATERIAL OPTIONS AFTER BID OPENING

A. The Construction Contract, if awarded, will be on the basis of materials and equipment described in the Drawings, Specifications, and any Addenda.

B. The procedure for submitting an application for substitution after the effective date of the Construction Contract is set forth in Section 01 25 00.

4.2 PARTNERING

A. Refer to Section 01 31 20 for description of partnering requirements.

B. OWNER's consultants listed in this project manual will be partners to the project.

END OF DOCUMENT

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DOCUMENT 00 22 16
SUPPLEMENTARY INSTRUCTIONS
(Building Improvement or Public Works Projects)

PART 1 GENERAL

1.1 INTRODUCTION

A. OWNER has determined that in accordance with Section 3.24.115 of the Salt Lake City Code the health, safety, and general welfare of the citizens of Salt Lake City are reasonably furthered by OWNER's Building Improvement or Public Works Projects (BIPW) procurement code requirements.

1.2 BIPW PROGRAM

A. The BIPW program is set forth in Salt Lake City Code Section 3.24.115 and can be found at the following web address: https://codelibrary.amlegal.com/codes/saltlakecityut Click on "CITY CODE of SALT LAKE CITY, UTAH" click on "TITLE 3 – REVENUE AND FINANCE", click on "CHAPTER 3.24 PROCUREMENT", click on "3.24.115: BUILDING IMPROVEMENT OR PUBLIC WORKS PROJECTS"

B. Bidder shall submit with its bid the Qualified Health Insurance Coverage Form. In this form Bidder certifies that the information given is true as of the time of submitting its bid. The information will be used in the manner stated in paragraph "F" below to evaluate "responsiveness" if bids are within 10% of each other. This form is used by Bidder to certify that Bidder and all subcontractors of Bidder with a subcontract value of $1,000,000 or more at the original execution of the subcontract working on the project have and will maintain qualified health insurance coverage in compliance with Salt Lake City Code 3.24.115 for the duration of the contract. Neither the failure to submit this form nor checking "No" regarding Qualified Health Insurance Coverage will render the bid non-responsive.

C. Bidder shall submit with its bid the information shown on the Work Environment Certification Form (Document 00 43 46). In that form Bidder certifies that the information given is true as of the time of submitting its bid. If "Yes" is not certified for each item, the bid will be rejected as non-responsive. See Section 3.24.115 of the Salt Lake City Code. That form is used by Bidder to certify that Bidder and all subcontractors of Bidder working on the project have and will maintain 1) a drug and alcohol testing policy; 2) a program to recruit and/or employ veterans; 3) a job training program; 4) a safety program; and 5) a formal policy of non-discrimination in compliance with Salt Lake City Code Section 3.24.115 for the duration of the contract

D. OWNER reserves the right to review or audit any information provided by Bidder to make its evaluation. Bidder shall provide or furnish access to any necessary records or other information in order to permit OWNER to verify Bidder's and/or Subcontractor's certifications. Bidder shall provide or furnish access to such records and information no later than three (3) business days after OWNER issues a written request for the same.

E. The Building Improvement or Public Works projects procurement requirements will only apply to contracts of $2,000,000 or more, as determined by the ENGINEER's estimate.

F. If more than one Bidder answers "YES" to the question on the Qualified Health Insurance Certification Form (Document 00 43 45), the following analysis will apply: A Bidder who has and will maintain an offer of qualified health insurance coverage under the Building Improvement or Public Works projects procurement requirements and whose bid is not more than 10 percent higher than the bid of another Bidder who does not have such insurance, will be deemed the more responsive Bidder. If two or more Bidders are judged to be equally responsive, OWNER will make the award to the Bidder with the lowest bid price. For purposes of this paragraph "F", references to "Bidder" with respect to qualified health insurance coverage shall be deemed to refer also to any subcontractors with a subcontract value of $1,000,000 or more at the original execution of the subcontract under such Bidder.

G. Qualified Health Insurance Coverage documentation for bidder with a contract value of $2,000,000 or more or each subcontractor of bidder with a subcontract value of $1,000,000 or more which shall include the following two documents:

1. An original statement on company letterhead signed by a duly authorized officer of the bidder/subcontractor stating that the bidder/subcontractor will maintain qualified health insurance coverage for the duration of the contract as defined in Section 26-40-115, Utah Code Annotated, as amended, or its successor in compliance with Salt Lake City Code 3.24.115.
2. A written statement of actuarial equivalency from either:
   a. An actuary selected by the bidder/subcontractor or bidder's/subcontractor's health insurer; or
   b. An underwriter who is responsible for developing the bidder's/subcontractor's health insurance premium rates.

1.3 **BIPW PROGRAM**

A. In situations in which the factors listed in the Qualified Health Insurance Certification form affect the award of the Bid, the winning Bidder will be required to enter into a Qualified Health Insurance Supplemental Agreement (Document 00 54 16) with OWNER.

1.4 **Important information for Bidder and all Subcontractors of the successful Bidder**

A. Salt Lake City Code Section 3.24.115 paragraph C.4 states the following:

1. A bidder who does not certify compliance with the factors in subsections C1b to C1f of this section and, if there is a subcontract, subsections C2b to C2f of this section, shall be deemed nonresponsive and shall be disqualified.

B. Refer to the Bid Form (Document 00 41 00) for the sequence of submittals to ensure compliance with Salt Lake City Code Section 3.24.115.

END OF DOCUMENT

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GEOTECHNICAL DATA

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Salt Lake City New Water Reclamation Facility Project

Offsite IPS Geotechnical Evaluation

Project Number: 524905396

AECOM Project: 60572288

September 2022

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Revision #	Date	Revised By:	Revision Description

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The full deliverable package has been reviewed for overall completeness, compatibility, and conformance with scope and other contract requirements. All applicable reviews have been completed, and the full deliverable package is ready for submission to the client.

Project Quality Manager: Kiran Akunuri, PE, PMP

Signature Date

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
AC	asphalt concrete
ACI	American Concrete Institute
AECOM	AECOM Technical Services, Inc.
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
bgs	below ground surface
CLSM	controlled low-strength material
ConeTec	ConeTec, Inc.
CPT	cone penetration test
CRR	cyclic resistance ratio
CSR	cyclic stress ratio
DSHA	deterministic seismic hazard analysis
ESAL	equivalent single axle load
FOS	factor of safety
HDPE	high density polyethylene
IBC	International Building Code
IGES	Intermountain GeoEnvironmental Services, Inc.
IPS	Influent Pump Station
MCE_R	Maximum Considered Earthquake
M_R	resilient modulus
NDC	Northwest Drain Canal
New WRF	Salt Lake City New Water Reclamation Facility
ohm-cm	ohm-centimeters
PCC	portland cement concrete
pcf	pounds per cubic foot
ppm	parts per million
project	Salt Lake City New Water Reclamation Facility Project
PSHA	probabilistic seismic hazard analysis
psi	pounds per square inch
SLCDPU	Salt Lake City Department of Public Utilities
SLCWRF	existing Salt Lake City Water Reclamation Facility
SPT	standard penetration test
UTBC	untreated base course

Executive Summary

This report presents the findings of the subsurface explorations, the results of the laboratory testing, the findings regarding subsurface soil conditions in the area of the proposed Influent Pump Station (IPS) and forcemains facilities, and the geotechnical recommendations for its design and construction.

The Salt Lake City New Water Reclamation Facility Project (project) will replace the existing Salt Lake City Water Reclamation Facility. The new facilities and equipment included in this portion of the overall project could include the following: Influent Pump Station (IPS), forcemain influent pipelines (forcemains), standby generators, odor control, electrical power distribution equipment, and power transmission facilities (a duct bank)s and/or overhead lines. The IPS facility will be a relatively large hydraulic structure of cast-in-place concrete construction that will have liquid channels and maintenance access.

Geotechnical drilling, logging, and sampling of 28 exploratory borings, and advancement of 24 cone penetration test (CPT) soundings within or near the proposed IPS facilities site and along the forcemains and power transmission alignments were performed for this study. The purpose of the subsurface explorations was to gather data regarding subsurface conditions and obtain soil samples for laboratory testing, to evaluate the physical and engineering properties of the subsurface soils. The subsurface information and laboratory test results were used in developing the geotechnical recommendations presented in this report.

Based on the results of our field exploration and site reconnaissance, no known geologic or geotechnical conditions preclude design and construction of the IPS facilities. Based on a review of referenced geologic data and the distance to mapped faults and fissures, the potential is low for fault-related surface rupture at the site. Because of the relatively flat grades at the site, the risk of slope instability affecting the constructed IPS is considered to be negligible.

Exploratory CPTs performed for the project suggest that the groundwater elevation is relatively shallow. Groundwater was encountered between approximately 1 and 12 feet below ground surface, at approximate elevations of 4,204 to 4,217 feet in the exploratory CPTs. Considering the anticipated depth-to-groundwater, construction is anticipated to be affected by groundwater issues (e.g., pumping subgrade, soft ground, dewatering) at some site locations. Dewatering is anticipated to facilitate construction. Dewatering may induce settlement of neighboring facilities (e.g., utilities, structures, roadways). The effects of temporary dewatering should be evaluated by the contractor, and the means to mitigate effects should be provided where needed. Water discharged during construction could require treatment, monitoring, sampling, and testing. Dewatering systems should discharge to an appropriate location, in accordance with permit requirements.

Based on the information about groundwater conditions at the site, structural design will need to consider lateral hydrostatic forces and buoyancy, assuming the groundwater level near final surface design grades. Structures with below-grade levels will need to have a subsurface drain system or be designed to resist full soil and water loads when empty.

Subsurface drain systems will need to convey collected water into storm sewers and back into the process flows by gravity or pumped sumps. The walls of structures with below-grade levels will need to be able to resist full lateral hydrostatic forces. Where subsurface drain systems are not intended to function continuously, the walls will need to resist full hydrostatic forces when empty.

Fill materials were encountered in the subsurface explorations and are anticipated in the vicinity of the proposed IPS facilities. Documentation indicating placement and compaction of the encountered fill was not available for review as part of this evaluation. These materials should be considered uncontrolled fill; the term “uncontrolled fill” refers to human-made fill, placed without engineering observation, testing, or documentation. Such uncontrolled fill is considered unsuitable to support proposed project structures in its present condition and should be removed below new structures. Uncontrolled fill may be stockpiled and tested for suitability for use on the project. Approximately 1 to 2 feet of this material may remain in place as a bridging layer to facilitate construction on the underlying soft native soils.

Based on subsurface exploration data, some loose, saturated, cohesionless sand layers are present at the site and were encountered in some of the exploratory borings. Based on subsequent analyses and the limited data from the explorations, post-liquefaction foundation settlement for the IPS facilities generally is estimated to be approximately 1 inch. However, some post-earthquake maintenance may be needed to address ground-shaking and post-liquefaction effects following a seismic event. This pertains particularly to facilities that need to remain in immediate operation and cannot accommodate a maintenance period following a seismic event.

Subsurface investigations performed near the Jordan River encountered an apparently continuous, saturated, and loose sand layer that is susceptible to lateral spreading, approximately coincident with the elevation of the centerline of the forcemains. In a potential lateral spreading event, soils above the centerline of the pipes could deform in the direction of the Jordan River. We estimate that the lateral spreading deformations will be 2 to 8 inches. These deformations should be considered in design of the forcemains where the alignment is within 200 feet of the Jordan River.

Using data collected from the subsurface explorations and the laboratory testing, analyses were performed to estimate the potential for settlement of the IPS facilities. Plans call for the IPS structure to have a mat foundation. Differential settlement at the influent connection from the influent gravity sewer line into the IPS foundation wall also was estimated. Based on discussion with process, pipeline, and structure designers, the IPS can be supported on a mat foundation, and we recommend that lightweight backfill be placed above the influent gravity sewer line connection into the IPS, so that the estimated total and differential settlements can be accounted for in the design of project improvements.

Based on the results of chemical testing, some of the tested soils contain chloride concentrations that should be considered corrosive to reinforcing steel and tendons. Based on the results of resistivity testing, some of the tested soils have a measured resistivity that should

be considered to range from negligibly to extremely corrosive to metal. The project design needs to consider the potential for corrosion and implement appropriate corrosion protection methods.

1. Introduction

This report presents the findings of AECOM Technical Services, Inc. (AECOM) from field explorations and laboratory testing that were conducted for the Salt Lake City Department of Public Utilities (SLCDPU). The purposes of this study were to assess geotechnical-related considerations pertaining to the project site for the proposed Influent pumping Station (IPS) facilities, and to provide geotechnical recommendations for design and construction of associated project improvements. The IPS facilities are planned as part of the Salt Lake City New Water Reclamation Facility (New WRF) Project, to replace the existing Salt Lake City Water Reclamation Facility (SLCWRF), which is more than 55 years old. The IPS project site is near West Reclamation Road and North 1200 West Street in Salt Lake City, Utah (Appendix A).

Construction for the New WRF has begun, independent of design of the IPS facilities. Where IPS facilities will connect to the New WRF facilities that are already being constructed, consideration needs to be given to connections and meeting the intent of the design.

1.1 Scope of Services

Our scope of services, relevant to this study, included the following:

- reviewing pertinent in-house geotechnical data, aerial photographs, and published geologic maps, soils data, historical geotechnical reports, and literature;
- coordinating and mobilizing for subsurface exploration;
- drilling, logging, and sampling of exploratory borings and advancing cone penetration test (CPT) soundings (subsurface explorations are listed in Table 3.1), to gather data regarding subsurface conditions and obtain soil samples for laboratory testing:
  - 14 exploratory borings to depths up to approximately 50 feet below ground surface (bgs) and 12 CPTs to depths up to approximately 120 feet bgs were performed near or along the alignment for the forcemain pipelines (forcemains) that will extend from the IPS to the New WRF Headworks Facility;
  - nine exploratory borings to depths up to approximately 100 feet bgs and eight CPTs to depths up to approximately 160 feet bgs were performed near the proposed IPS site;
  - five exploratory borings and two CPTs were performed for the project during previous geotechnical studies near the Northwest Drain Canal (NDC);
  - two CPTs were performed for the geotechnical study at the main plant site, near the alignment for the forcemains;
- assigning and performing laboratory tests to evaluate physical and engineering properties of the subsurface soils, consisting of in-place moisture content, unit weight, fines content, gradation and hydrometer, Atterberg limits, chemical tests (including chloride, pH, resistivity, sulfate, and total soluble salts), consolidation, triaxial unconsolidated undrained shear, triaxial consolidated drained shear, and triaxial consolidated undrained shear;

- compiling and analyzing the accumulated data for liquefaction, lateral spreading, bearing capacity, settlement, and pavement design; and
- preparing this report to present relevant data, findings, and engineering recommendations.

1.2 Project Description

Structures and improvements that are included in this study include the IPS, IPS Electrical Building, IPS Generators, IPS Odor Control, and influent forcemains. The IPS facilities are generally south of an existing pumping station that is south of the main SLCWRF site. The influent forcemains generally will extend northwest from the planned IPS facility to the Headworks facility, as shown in the site map provided in Appendix A.

Many new WRF Liquid Train facilities are not part of this study, including the Headworks Facility and a length of the influent forcemains that connect to the Headworks Facility. Geotechnical recommendations for Liquid Train facilities are reported under separate cover. Our understanding of the IPS facilities, including the forcemains, is based on preliminary structure plans.

Influent Pump Station and Forcemains

The proposed IPS will receive raw wastewater through a bifurcating wye that will transmit the influent into one or both of two wet wells. Several pumps will lift the influent to raise the hydraulic grade before conveyance through the forcemains to the Headworks Facility. The structure for the wet wells will be approximately 40 feet wide by 80 feet long and will extend approximately 54 feet below finished grade to a bearing elevation of approximately 4,168 feet. A contractor-designed wall system for excavation support will be needed to facilitate excavation and construction of the IPS. The ground floor and above-grade portion of the structure, which is expected to bear on the deeper mat foundation, will be approximately 80 feet wide by 55 feet long and is anticipated to generate an eccentric load on the deeper mat foundation.

Additional proposed facilities near the IPS will include an Odor Control structure, Generators, and an Electrical Building, to the north and northeast. An electrical duct bank will provide power to the IPS Electrical Building from a planned electrical power substation. A preferred electrical service alignment extends roughly north to south, just west of the NDC. The Odor Control structure is anticipated to be supported on a mat foundation approximately 30 feet wide by 72 feet long and bear at an elevation of 4,219 feet. The generator pad is anticipated to be supported on a mat foundation approximately 44 feet wide by 80 feet long and bear at an elevation of 4,219 feet. Two fuel tanks are planned adjacent to the generator pad, each being supported on a mat foundation approximately 12 feet wide by 35 feet long and bearing at an elevation of 4,219 feet. The Electrical Building is anticipated to be supported on spread (spot) footings 7 feet wide by 7 feet long and bear at an elevation of 4,218 feet. In the event of a power outage, the generators near the IPS can provide temporary power to the IPS.

The forcemains from the IPS to the Headworks Facility will consist of two high-density polyethylene (HDPE) pipes (each 48 inches in diameter). The forcemains will be buried with an

approximate invert depth of 7 to 10 feet bgs. The forcemains are anticipated to be constructed using conventional trenching methods (i.e., cut and cover).

1.3 Site Description

The new IPS facilities and forcemains will be on several parcels south of the main treatment plant site. The new IPS facilities will include Generators, an Electrical Building, and an Odor Control structure south of an existing pump station (on parcel 08233510010000). The new IPS will be positioned on parcel 08233510030000, which generally was undeveloped at the time of our subsurface explorations, with the exception of some overhead powerlines and the Orange Street sewer, which crosses through the parcel in an east-west direction before bending north and entering the existing pump station. The new forcemains will extend to the north and west from the new IPS facilities to the new Headworks Facility at the main project site. The new forcemains will be west of North Reclamation Road and North Catherine Street, and south of West Riverview Avenue, until extending north along North Midland Street to the Headworks Facility. The new forcemains will traverse through generally undeveloped terrain. However, the alignment also extends through and along portions of the Rose Park Golf Course (Appendix A).

2. Site Characterization

2.1 Regional Geology

The project site is near the northern end of the Jordan Valley, a north-south trending valley in north-central Utah. The Jordan Valley is a sediment-filled intermountain basin, flanked by two uplifted range blocks, the Wasatch Range and the Oquirrh Mountains. The Wasatch Range east of the project site forms the boundary between the basin and Wasatch Range, and Middle Rocky Mountains physiographic provinces in this region (USACE 1995). Surface and near-surface sediments in the Jordan Valley are dominated by Quaternary materials, deposited by Lake Bonneville in the last 30,000 years (Lund 1990).

Historic seismic refraction surveys of the Jordan Valley indicate that the Quaternary layer varies from about 600 to 2,500 feet in thickness (Mattick 1970), which is characteristic of an unconsolidated material (Arnow and Mattick 1968). The same seismic surveys indicate a Tertiary layer beneath the Quaternary sediments, extending to a depth of approximately 4,800 feet, with indications of semi-consolidated sediments. In addition, wells in the Jordan Valley have indicated a thickness of valley sediments of more than 3,000 feet.

2.2 Geologic Hazards

The following sections describe geologic hazards to which the project site may be subject, and the potential impacts each hazard may have.

2.2.1 Seismicity

The project site is within the Intermountain Seismic Belt, one of the most seismically active areas in the interior western United States. Earthquakes of moment magnitude 7.0 or more have occurred repeatedly in relatively recent geologic history along the nearby Wasatch fault zone. The site is near the northern end of the Salt Lake City segment and the southern end of the Weber segment of the fault. The mapped surface trace of the Warm Springs section of the Salt Lake City segment is near the western foot of the Wasatch Mountains, about 1 mile east of the project site. The Wasatch fault dips in a generally westward direction and likely passes under the site at some depth. The Wasatch fault zone is one of the longest and most tectonically active normal faults in North America. Half of the estimated 50 to 120 post-Bonneville surface-faulting earthquakes in the Wasatch Front region have been on the Wasatch fault, which has an estimated slip rate of between 1 and 5 millimeters per year (USGS and UGS 2019).

The Salt Lake City and Weber segments of the Wasatch fault zone have normal faults that generally trend north to south. Although other mapped faults are within 20 miles of the project site—such as the West Valley fault zone (the Taylorsville fault is about 1 mile to the southwest), the Great Salt Lake fault zone (the Antelope Island section is about 13 miles to the west), the Oquirrh fault zone (about 18 miles to the southwest), the East Canyon fault (the southern East Canyon section is about 16 miles to the east), the Main Canyon fault (about 18 miles to the east), and other sections of the Wasatch fault zone extending north and south of the project

site—the Salt Lake City segment of the Wasatch fault zone is the predominant contributor to the probabilistic seismic hazard in the project area. Grading and fill previously placed at the site have obscured pre-development surface conditions. Our explorations did not identify evidence of near-surface fault traces in the project area.

2.2.2 Liquefaction

Seismically induced liquefaction occurs when earthquake ground motion causes a sufficient increase of pore water pressures in the space between soil particles to overcome frictional resistance between particles in susceptible, typically loose, saturated, and cohesionless soils. The generation of excess pore pressures leads to greatly reduced strength within the liquefied soil layer. Liquefaction effects can include sand boils, settlement, lateral spread, loss of bearing capacity, and increased drag force on deep foundations associated with post-liquefaction settlement.

The Utah Geological Survey provides maps, which include portions of Salt Lake County, identifying liquefaction potential in the project area (Christenson and Shaw 2008). Liquefaction potential was assigned on the basis of regional soil and groundwater depth and earthquake ground-shaking probabilities and does not consider actual soil conditions. Based on the liquefaction potential map, the project area is mapped as an area with high liquefaction potential. This map is a high-level assessment of liquefaction hazard, prepared only for identifying areas where additional investigation is needed to assess actual conditions and hazard. The results of a site-specific seismic hazard analysis are presented in Section 4.1.1. Site-specific analyses of liquefaction triggering and its effects, based on subsurface exploration data, testing results, and the site-specific seismic hazard analysis, are presented in Section 4.1.2.

2.3 Mapped Soil Conditions

Geologic maps of the project site (Appendix A) show surficial deposits (other than artificial fill) to be composed of quaternary Holocene clay deposits and floodplain alluvium (Van Horn 1982). These deposits may include clay, sand, and silt, deposited where streams entered the Great Salt Lake, and consist of interlinking stream and lake deposits. Much of the deposits are saturated below a depth of 3 feet, compressible, and the surface tends to collapse under heavy loads. Shallow quaternary sediments beneath artificial fill and surficial deposits at the site are assumed to be Pleistocene silt and clay deposits, associated with transgressive-regressive Lake Bonneville cycles.

3. Field Investigation, Subsurface Materials and Conditions, and Laboratory Testing

3.1 Field Exploration

We performed geotechnical explorations of subsurface conditions within or in the vicinity of the proposed IPS facilities. Marking of existing public utility locations was conducted by Bluestakes of Utah. Additional clearance for unmarked utilities was performed by a potholing subcontractor. Subsurface explorations were performed between July 2018 and August 2021, including exploratory borings and CPTs. Explorations performed for the IPS facilities are summarized in Table 3.1. Under subcontract to AECOM, drilling was performed by ConeTec, Inc. (ConeTec) of Salt Lake City and Inberg-Miller Engineers; CPT soundings were performed by ConeTec. Some of the explorations, as noted in Table 3.1, were overseen by Intermountain GeoEnvironmental Services, Inc. (IGES) of South Salt Lake, a subconsultant to AECOM (logs and data for explorations that were overseen by IGES personnel are included in Appendices B and C, respectively).

Table 3.1. Summary of IPS Facilities Site Subsurface Investigations

Field Exploration	Nearby Facility	Ground Surface Elevation [1] (feet)	Total Depth Explored (feet)	Groundwater Depth [2, 4] (feet)
CP18-PC-1	Liquid Train	4221.6	120.1	9.8
CP20-IPSEL-01	Liquid Train	4222.55	60.2	9.2
BH19-ES-1	NDC[6]	4221.4	120.0	—
BH19-ES-2	NDC[6]	4221.0	122.0	—
BH19-IT-1	NDC[6]	4221.4	120.1	—
BH19-IT-5	NDC[6]	4215.6	60.0	—
BH19-IT-6	NDC[6]	4217.8	58.0	—
CP19-ES-1	NDC[6]	4221.4	120.1	10.0
CP19-ES-2	NDC[6]	4221.0	120.1	9.8
CPT21-OIPS-01	IPS	4217.6	86.5	0.6
CPT21-OIPS-02	IPS	4217.5	85.5	9.4
CPT21-OIPS-03	IPS	4217.9	85.5	12.5
CPT21-OIPS-04	IPS	4221.0	88.4	10.8
CPT21-OIPS-05	IPS	4217.4	137.5	10.0
CPT21-OIPS-06	IPS	4216.0	85.1	9.1
CPT21-OIPS-07	IPS	4216.5	160.8	7.6
CPT21-OIPS-08	IPS	4215.7	131.4	11.2
B21-OIPS-01	IPS	4217.5	52.0	—
B21-OIPS-02	IPS	4217.1	52.0	—
B21-OIPS-03	IPS	4218.1	49.0	—
B21-OIPS-04	IPS	4219.9	52.0	—
B21-OIPS-05	IPS	4217.2	102.0	—
B21-OIPS-06	IPS	4216.5	52.0	—

Field Exploration	Nearby Facility	Ground Surface Elevation [1] (feet)	Total Depth Explored (feet)	Groundwater Depth [2, 4] (feet)
B21-OIPS-07	IPS	4216.5	100.0	—
B21-OIPS-08	IPS	4216.1	102.0	—
B21-OIPS-09	IPS	4215.6	102.0	—
CP19-ITW-3[3]	Forcemains	4217.5	50.0	3.3
CP19-ITW-4[3]	Forcemains	4214.1	50.0	5.4
BH19-ITW-0[3]	Forcemains	4219.0	52.0	—
BH19-ITW-1[3]	Forcemains	4216.8	52.0	—
BH19-ITW-2[3]	Forcemains	4217.0	52.0	—
BH19-ITW-3N[3]	Forcemains	4218.0	52.0	—
BH19-ITW-3S[3]	Forcemains	4214.8	52.0	—
BH19-ITW-4[3]	Forcemains	4216.1	52.0	—
BH19-ITW-5[3]	Forcemains	4215.1	52.0	—
BH19-ITW-6[3]	Forcemains	4216.5	52.0	—
CP20-IS-01	Forcemains	4218.9	124.0	12.1
CP20-IS-02	Forcemains	4215.9	75.1	8.5
CP20-IS-03	Forcemains	4214.8	120.9	7.4
CP20-IS-04	Forcemains	4217.2	75.1	9.4
CP20-IS-05	Forcemains	4216.0	120.1	6.6
CP21-IS-06	Forcemains	4218.0	123.9	7.4
CP21-IS-07	Forcemains	4215.4	122.1	3.3
CP21-IS-08	Forcemains	4216.9	120.1	4.4
CP21-IS-09	Forcemains	4217.1	75.4	2.7
CP21-IS-10	Forcemains	4215.6	120.3	2.9
B21-IS-01	Forcemains	4215.6	37	—
B21-IS-02	Forcemains	4215.9	32	—
B21-IS-03	Forcemains	4216.0	35	—
B21-IS-04	Forcemains	4218.1	37	—
B21-IS-05	Forcemains	4215.6	35	—
B21-IS-06	Forcemains	4216.9	37	—

Notes:
"—" denotes a blank entry
1. Surveyed elevation is based on North American Vertical Datum of 1988. Northing and Easting coordinates are provided on the boring logs (Appendix B), in North American Datum of 1983, based on the Utah Central State Plane Projection.
2. Because of the selected mud-rotary drilling method for borings, the groundwater depth neither was readily observed nor measured in the field. For CPT explorations, the groundwater depth is inferred, based on the results of the shallowest pore pressure dissipation test performed within each sounding, assuming 100 percent hydrostatic conditions.
3. Exploration was overseen by Intermountain GeoEnvironmental Services, Inc. of South Salt Lake, a subconsultant to AECOM.
4. Groundwater considered in our analyses ranges from 4,207 to 4,212.
5. Elevation not surveyed for this exploration. The elevation was assumed based on surveyed elevations for nearby explorations.
6. The existing NDC is not a planned project facility; however, some project improvements, such as an electrical duct bank or overhead power transmission line, are planned near the NDC.

Exploratory borings generally were advanced using mud-rotary drilling methods to depths up to approximately 160 feet bgs, using a CME-75 truck-mounted drill, equipped with a 4-7/8-inch drag bit, or a CME-55 track-mounted drill, equipped with a 3-3/4-inch drag bit. Penetration resistances were obtained from the number of hammer blows observed to drive a split-spoon standard penetration test (SPT) sampler, using a 140-pound automatic hammer, dropped from a height of 30 inches. The resistance to

sampler penetration (blowcount or N-value) is noted as “N” in the boring logs (Appendix B) and refers to the number of hammer blows to advance the sampler a distance of 12 inches, beginning after an initial 6 inches of penetration into the subsurface materials. Based on recent calibration testing, the calibrated energy transfer ratio may be assumed to be 87 percent for the hammer equipped on the CME-75 drilling equipment. Calibration for energy transfer was not available for the hammer equipped on the CME-55 drill used by Inberg-Miller Engineers until after this study was essentially complete; consequently, an energy transfer ratio of 85 percent was assumed for this study based on our experience with similar equipment.

The blowcount that was recorded over the SPT sample interval (range of depths over which the blowcount was measured) was used as an indication of relative density and consistency of in-place soil materials. The blowcount at each sample depth was corrected for drilling conditions, adjusted for estimated hammer energy, to obtain the N60 value, and was adjusted for overburden stress at the depth of each sample to obtain the (N1)60 value.

AECOM engineering personnel observed subsurface exploration, prepared logs of subsurface conditions encountered in each boring, classified encountered soils, and collected soil samples for laboratory testing. In some cases, IGES personnel observed the investigations, as shown in Table 3.1. Encountered soils were classified at the time of drilling, using the Unified Soil Classification System, and in general accordance with the standard procedures described in the American Society for Testing and Materials (ASTM) Standard D2488 (ASTM 2017a). Logs of subsurface conditions that were encountered in the exploratory borings, a Key to Boring Logs (applicable to logs created by AECOM), and a Key to Soil Symbols and Terminology (applicable to logs created by IGES) are provided in Appendix B.

The CPT soundings were completed using a 25-ton, truck-mounted CPT rig, equipped with a 60-degree-apex-angle piezocone with a 15-square-centimeter tip and net area ratio of 0.8. The CPT soundings were performed by pushing an approximately 1.7-inch-diameter instrumented cone into the ground with a set of hydraulic rams to collect relatively continuous tip, sleeve, and pore pressure measurements of subsurface soil conditions. The sleeve area was approximately 225 square centimeters, with an offset between measured tip and sleeve resistance of 0.1 meter. This offset is accounted in the reported data.

The CPT soundings were performed in accordance with ConeTec’s CPT operating procedures, reported to be in general accordance with the current ASTM Standard D5778 (ASTM 2012b). Measured cone tip resistance was corrected for pore pressure effects (corrected tip resistance denoted as “q_t”) for reporting. The results of the CPT soundings, included as excerpts from multiple field investigation reports that have been prepared for the project by ConeTec, are provided in Appendix C.

3.2 Subsurface Materials and Conditions

General descriptions of local stratigraphy, fill materials, and native soil encountered in the exploratory borings that were performed at the project site are presented next.

3.2.1 Local Stratigraphy

The sediments in the project site primarily are composed of Lake Bonneville sediments. A map showing the general stratigraphic column is provided in Appendix A. Imported granular fill at the site is composed of a mix of sand, gravel, and cobbles, extending from the ground surface to approximately 4 to 10 feet

bgs. Holocene-age, post-Lake Bonneville sediment extends from the bottom of the fill to between approximately 8 to 15 feet bgs. Lake Bonneville sediments extend from approximately 15 to 112 feet bgs and primarily are composed of fine-grained materials (clay and silt), interbedded with relatively thin sand layers. Below the Lake Bonneville sediments, generally at depths more than 100 feet bgs, are unconsolidated to potentially semi-consolidated sediments of the Alpine Formation. A disconformity exists at the site between the Bonneville deposits and the Alpine Formation (Leeflang 2008), as shown in the generalized stratigraphic column figure that is provided in Appendix A.

3.2.2 Fill Materials

In explorations performed for the pump station site, fill materials were not readily observable. However, based on our understanding of site history, fill materials in the vicinity of the IPS site may be up to 5 feet thick, particularly at nearby existing utilities; fill was encountered in explorations near the forcemain alignment to depths reaching about 4 feet. Fill materials, including disturbed native materials and imported materials placed without documentation or by uncontrolled means, generally are not suitable to support structures. Fill is anticipated to be encountered at locations beyond and between the boring locations, extending to varying elevations that may be associated with existing roadway rights-of-way or buried utility improvements.

3.2.3 Native Soils

Encountered native soils predominantly were composed of fine-grained soil deposits, with a few coarse-grained strata (about 5 feet in thickness or less) and more frequent coarse-grained layers (1 to 2 feet in thickness or less), dispersed throughout the soil profile. Based on the tested samples, the fine-grained deposits primarily appeared to be composed of very soft to stiff, medium to high-plasticity fat clays; very soft to very stiff, low to medium plasticity lean clays; and non-plastic to low-plasticity silts with varying amounts of sand. Coarse-grained layers, which generally were dispersed throughout the subsurface profile, mainly were composed of very loose to dense silty to poorly graded sands.

3.2.4 Groundwater

Groundwater was encountered at depths of approximately 1 to 12 feet bgs near the IPS site and from 3 to 12 feet bgs along the alignment of the forcemains (from the IPS to the Headworks Facility). Groundwater levels fluctuate seasonally because of possible variations in ground surface topography, subsurface geologic conditions, rainfall, irrigation, and other factors. A detailed groundwater analysis was beyond the scope of this geotechnical study; however, groundwater level typically is higher in the late spring months and lower in late fall to early winter. Groundwater level also may be influenced locally by dewatering efforts for excavations during construction.

The inferred groundwater depths encountered in each of the CPTs are shown in Table 3.1. For CPT explorations, the groundwater depth is inferred, based on the results of the shallowest pore pressure dissipation test that was performed within each sounding, assuming 100 percent hydrostatic conditions. Based on the results of pore pressure dissipation testing performed for the project, an upward seepage gradient was identified with an almost linear relationship with depth. Pore pressure dissipation tests that were performed in the vicinity of the IPS site indicate pore pressure trends of approximately 118 percent of hydrostatic, with a groundwater elevation of approximately 4,210 feet.

3.3 Laboratory Testing

Laboratory testing was performed by IGES on selected soil samples, collected from exploratory borings that were completed at the project site during the 2018–2021 field investigations. The laboratory testing program included testing to aid in classification of site soils, assess physical and engineering properties of tested materials, and help assess corrosion potential. The laboratory test data are summarized in the remarks column of the boring log from which each sample was obtained, and a complete summary of all pertinent laboratory testing results from borings in the vicinity of the proposed Liquid Train facilities site is provided in Appendix E. A summary of laboratory test results for selected soil samples is shown in Table 3.2.

Table 3.2. Summary of Laboratory Test Results for Selected Soil Samples

Laboratory Test	Test Results	Notes
Atterberg Limits		Non plastic silt to high plasticity clay
Liquid Limit	NP to 62	
Plastic Limit	NP to 33	
Plasticity Index	NP to 38	
Moisture Content	19.6 to 72.1 percent	Moist to wet
Material passing #200 sieve	6.6 to 99.8 percent	—
Dry Density	62.2 to 103.3 pounds per cubic foot	—
Total Soluble Salts	400 to 8760 mg/kg	—
Sulfate Content	84.1 to 720 ppm	Moderate to severe sulfate exposure
pH	8.12 to 8.79 (unitless)	—
Chloride Content	62.4 to 1370 ppm	Corrosive to metal reinforcement
Resistivity	165 to 3015 ohm-cm	Negligibly to extremely corrosive to metal

Notes:
"—" denotes a blank entry; cm = centimeter; kg = kilogram; mg = milligram; ppm = parts per million; NP = non-plastic

4. Recommendations

This chapter presents geotechnical recommendations for design and construction of the proposed IPS facilities, including seismic design; demolition; earthwork; subgrade stabilization and dewatering; structure foundations; pipe settlement and facility connections; lateral earth pressures; concrete slab-on-grade floors; exterior concrete flatwork, curbs, and gutters; pavement design; construction in cold or wet weather; frost heave; scaling; concrete and corrosion considerations; and moisture infiltration reduction and surface drainage. These recommendations are based on our understanding of the project, engineering properties of tested soils, the geologic conditions presented in this report, and the assumption that an adequate number of tests and observations will be made during construction to evaluate compliance with these recommendations. Earthwork and site preparation at the project site should be performed in general accordance with the requirements presented in this report and referenced specifications (Utah Chapters APWA and AGC 2017).

4.1 Seismic Design

Site-specific seismic hazard analyses for the New WRF project site were completed by Lettis Consultants International, Inc. in 2020, under subcontract to AECOM (LCI 2020). These analyses consisted of a site-specific probabilistic seismic hazard analysis (PSHA), a deterministic seismic hazard analysis (DSHA), a site response analysis, and development of acceleration time histories. In accordance with the International Building Code (IBC; ICC 2017), which has been accepted and adopted by the SLCDPU, and with references to American Society of Civil Engineers (ASCE) 7-16 (ASCE 2016), design ground motion parameters were developed and may be considered appropriate for proposed IPS facilities, which are generally located south of the New WRF main project site where the site-specific data was gathered. Surface wave measurements were collected for the Lettis analyses by GeoVision Geophysical Services, Inc. and are included for convenience in Appendix D.

4.1.1 Seismic Design Parameters

ASCE 7-16 defines the horizontal, site-specific, risk-targeted, Maximum Considered Earthquake (MCE_R) spectral response acceleration as the lesser of the deterministic and probabilistic MCE_R spectra. The deterministic MCE_R spectrum is the 84th-percentile, 5 percent damped, spectral response acceleration in the maximum direction response from the maximum event on the controlling active fault (magnitude 7.2 earthquake in the Salt Lake City segment), but not less than a minimum deterministic spectrum, as defined in Figure 2-1 in ASCE 7-16. The probabilistic MCE_R spectrum was calculated using Method 1 in Chapter 21 of ASCE 7-16, which includes a 2,475-year return period uniform hazard spectrum, adjusted to maximum direction, and uses risk coefficients expected to achieve a 1 percent probability of collapse within a 50-year period (LCI 2020). As part of this analysis, the code generalized spectra were developed for Site Class E, in general accordance with Chapter 11 of ASCE 7-16, with modifications in accordance with Chapter 21 of ASCE 7-16.

For a liquefaction hazard evaluation, the geometric mean peak ground acceleration, PGA_M that was used for the analyses is shown in Table 4.1. Although the site-specific study provided a site-specific peak ground acceleration value of 0.56g (LCI 2020), a peak ground acceleration of 0.62g was selected as 80 percent of the generalized, code-based peak ground acceleration, as per Section 21.5.3 of ASCE 7-16 (ASCE 2016; LCI 2020). Table 4.1 also shows the associated mean and modal magnitudes, and the distances for an acceleration with a 2,475-year return period.

Table 4.1. Summary of 2,475-Year Return Period Ground Motion Design Parameters

Ground Motion	Peak Horizontal Ground Acceleration, PGA_M (g)	Earthquake Magnitude, M (-)		Distance, D (km)	
		Mean	Modal	Mean	Modal
2,475-Year Probabilistic	0.62[1]	7.1	7.1	3.2	2.5

Notes: g = acceleration from gravity; km = kilometer; PGA_M = geometric mean peak ground acceleration
1. PGA_M = 0.62g was taken as 80 percent of the generalized, code-based, peak ground acceleration procedure from Chapter 11 of ASCE 7-16.
Source: LCI 2020

ASCE 7-16 (ASCE 2016) defines the design spectral response acceleration at any period as two-thirds of the MCE_R spectral response acceleration, but not less than 80 percent of the generalized code-minimum spectrum, with modifications as per Chapter 21 of ASCE 7-16. The site-specific horizontal and vertical ASCE 7-16 MCE_R and design response spectra are shown in Table 4.2.

Table 4.2. Site-Specific Horizontal and Vertical ASCE 7-16 Design Spectra

Spectral Period (seconds)	Horizontal MCE_R Spectral Acceleration, S_{aM} (g)	Vertical MCE_R Spectral Acceleration (g)	Horizontal DE Spectral Acceleration, S_a (g)	Vertical DE Spectral Acceleration (g)
0.01	0.56	0.66	0.38	0.44
0.03	0.57	0.92	0.38	0.61
0.05	0.62	1.59	0.41	1.06
0.10	0.82	1.89	0.54	1.26
0.15	0.91	1.54	0.60	1.03
0.20	1.00	1.31	0.67	0.88
0.292	1.24	1.06	0.83	0.71
0.30	1.24	1.03	0.83	0.69
0.40	1.24	0.78	0.83	0.52
0.50	1.31	0.68	0.87	0.45
0.75	1.29	0.65	0.86	0.43
1.00	1.26	0.63	0.84	0.42
1.458	1.24	0.62	0.83	0.41
1.50	1.20	0.60	0.80	0.40
2.00	0.90	0.45	0.60	0.30
3.00	0.60	0.30	0.40	0.20
4.00	0.45	0.23	0.30	0.15
5.00	0.36	0.18	0.24	0.12
7.50	0.26	0.128	0.17	0.086
10.00	0.14	0.072	0.10	0.048

Notes: DE = Design Earthquake; MCE_R = Risk-Targeted Maximum Considered Earthquake

Section 21.4 of ASCE 7-16 outlines development of the design acceleration parameters to be used in seismic design of structures. The design, 5 percent damped, spectral response acceleration at short periods, S_{DS}, is taken as 90 percent of the maximum spectral acceleration value, S_a, at any period within the range of 0.2 to 5 seconds. The design, 5 percent damped, spectral response acceleration parameter

at a period of one second, S_{D1}, is taken as the maximum value of the product of the spectral period multiplied by the spectral acceleration value, at any period within the range of 1 to 5 seconds. The MCE_R, 5 percent damped, spectral response acceleration parameters for short and long periods, S_{MS} and S_{M1}, are obtained by multiplying the design spectral acceleration parameters, S_{DS} and S_{D1} by 1.5. The design acceleration parameters are summarized in Table 4.3.

Table 4.3. Summary of Site-Specific Acceleration Parameters to be Used in Seismic Design of Structures

Acceleration Parameter	Acceleration (g)
S_{DS}; design, 5 percent damped, horizontal spectral acceleration at short periods	0.83
S_{D1}; design, 5 percent damped, horizontal spectral acceleration at 1 second	1.21
S_{MS}; MCE_R, 5 percent damped, horizontal spectral acceleration at short periods	1.24
S_{M1}; MCE_R, 5 percent damped, horizontal spectral acceleration at 1 second	1.82

4.1.2 Liquefaction

Several saturated, cohesionless soil strata and layers were encountered in the subsurface explorations. In some of the explorations near the planned IPS facilities, these soils were encountered within about 25 feet bgs. A site-specific evaluation of liquefaction potential and associated effects was performed for the project site. Data from explorations outside the immediate area of the IPS facilities were considered, to characterize layer properties as appropriate, and were documented in the calculation package. The liquefaction-triggering analysis used the methodology presented by Idriss and Boulanger (2008) and as revised (including the 2014 update to magnitude scaling factor and CPT fines content prediction) by Boulanger and Idriss (2014). CPT tip resistance measurements in thin layers were corrected for thin-layer effects. This procedure calculates a factor of safety (FOS) against liquefaction triggering, by comparing the cyclic resistance ratio (CRR) of the soil to the earthquake-induced cyclic stress ratio (CSR). The ratio of these two parameters (CRR/CSR) is the FOS against liquefaction triggering. An FOS against liquefaction triggering less than 1.0 indicates that soils are anticipated to liquefy during a design seismic event.

Because near-surface, liquefaction-susceptible soils were encountered around the same elevation, we also estimated lateral spreading displacement, using the multilinear regression model proposed by Youd et al. (2002). The lateral spreading analysis predicted very little lateral spreading displacement (less than 6 inches) for encountered saturated, cohesionless soil layers. However, lateral spread is heavily reliant on layer continuity. Layers deposited in alluvial or fluvial environments commonly are discontinuous, winding, braided, and lensed. At some portions along the alignment of the forcemains from the IPS to the Headworks Facility, a shallow, 2-foot-thick liquefiable layer appeared somewhat continuous in our explorations (i.e., CP21-IS-08; CP21-IS-07; B21-IS-06; B21-IS-05); accordingly, this layer is expected in the area where the forcemains alignment is within approximately 200 feet of the Jordan River. This apparent continuous liquefiable layer coincides approximately with the centerline elevation of the forcemains. In a potential lateral spreading event, soils above the centerline of the pipes could deform in the direction of the Jordan River. Based on Youd et al. (2002), potential lateral spreading deformations are estimated to be 2 to 8 inches. These estimated lateral spreading displacements are relatively small,

and the HDPE forcemains will be flexible. However, we recommend that lateral spreading displacements be considered in design of the pipelines where the pipeline alignment is within 200 feet of the Jordan River. Additional information is provided in Appendix F.

To help reduce stress concentrations in the pipelines in areas where lateral spreading may occur, we recommend large-radius bends (in lieu of sharp, abrupt turns) in areas where the pipeline changes direction within 200 feet of the Jordan River. In this area, we also recommend that the strength of the pipeline be checked against the pressure of a passive soil wedge acting on one side of the pipeline. The design team also has discussed adding a low friction material (i.e., polyethylene plastic sheeting) at the interface between the pipes and overlying soil. Although this method is not a proven mitigation technique, adding a low-friction material may help to reduce the lateral stresses on the pipe.

The original scope of services included regular investigations along a preliminary tunnel alignment, roughly parallel to the NDC. This preliminary tunnel alignment was very similar to an electrical service alignment for duct bank or overhead power transmission. Because the tunnel has been removed from the project, a ductbank or an overhead power transmission alignment is being considered along the NDC. However, because of the narrow gravel roadway geometry and the presence of existing forcemains and other utilities in the area, much of the alignment could not be investigated. Accordingly, subsurface explorations performed along the possible electrical service alignment just west of the canal were limited; potentially damaging a forcemain or other critical infrastructure while performing subsurface investigations is not an acceptable risk. Rocky Mountain Power (RMP) has completed a foundation design for an overhead transmission line along the canal farther north, that extends to the planned power substation. It is our understanding that the resiliency of the transmission line between the substation and the IPS facilities might be limited by the performance of the RMP line during a liquefaction event or a slope failure along the canal.

One-dimensional vertical, liquefaction induced settlement was estimated using curves and equations, as presented in the monograph for estimating volumetric strains, prepared by Idriss and Boulanger (2008), which is derived from Ishihara and Yoshimine's (1992) volumetric strain charts. Liquefaction settlement estimation methods are consistent with the state of practice, but largely empirical and somewhat imprecise. Soil condition inputs are based on limited points of investigation, limited soil samples, and limited laboratory testing. As such, the provided estimates of liquefaction settlement may be more than or less than actual settlements.

Based on the liquefaction-triggering analyses performed, Table 4.4 summarizes the amount of post-liquefaction settlement that was predicted for each CPT and CPT-boring pair considered for the IPS facilities site. Table 4.4 shows that estimated post-liquefaction settlement at the ground surface generally is less than 1 inch; however, estimated post-liquefaction settlement at the ground surface may be as much as 4 to 5 inches in an isolated area in the vicinity of the Headworks Facility beyond the limits of the forcemain alignment that is part of this study (i.e., the portion of the forcemains that extends approximately 350 feet from the connection at the Headworks Facility is included in the Liquid Train study, under separate cover, and requires specific mitigative efforts in regard to the potential for post-liquefaction movements near the Headworks Facility).

Table 4.4: Estimated CPT-based Post-Liquefaction Settlement for IPS Facilities

Exploration	Estimated Post-Liquefaction Settlement at Ground Surface (inches)	Estimated Post-Liquefaction Settlement at Base of Foundation (inches)	Nearest Proposed Major Facility
BH19-ES-1[1]	1.9	1.9	NDC[4]
CP19-ES-1[1]	1.8	1.8	NDC[4]
BH19-ES-2[1]	1.7	1.7	NDC[4]
CP19-ES-2[1]	1.4	1.4	NDC[4]
CP18-PC-1	--[2]	--[2]	Area south of the Headworks Facility
CP20-IS-01	2.1	2.1	NDC[4]
CP20-IS-02	1.0	0.6	Forcemains
CP20-IS-03	0.3	--[2]	Forcemains
CP20-IS-04	0.7	0.2	Forcemains
CP20-IS-05	0.9	0.6	Forcemains
CP21-IS-06	0.7	0.6	Forcemains
CP21-IS-07	0.6	0.1	Forcemains
CP21-IS-08	1.0	--[2]	Forcemains
CP21-IS-09	0.2	0.2	Forcemains
CP21-IS-10	0.3	0.3	Forcemains
CP21-OIPS-01	0.6	0.6	IPS Electrical Building; NDC[4]
CP21-OIPS-02	--[2]	--[2]	IPS Generator Pad
CP21-OIPS-03	0.2	0.2	IPS Odor Control Structure
CP21-OIPS-04	--[2]	--[2]	IPS Generator Pad
CP21-OIPS-05	0.4	0.1	IPS
CP21-OIPS-06	0.7	0.7	Forcemains, IPS, IPS Generator Pad
CP21-OIPS-07	0.9	0.9	Forcemains, IPS
CP21-OIPS-08	0.4	--[2]	IPS

Notes:
1. Paired boring and cone penetration test.
2. Post-liquefaction settlement for the given scenario is negligible.
3. Over-excavation and replacement to elevation 4,193 will result in negligible post-liquefaction settlement.
4. The existing NDC is not a planned project facility; however, some project improvements are planned near the NDC.

4.2 Demolition

The work at the IPS facilities site may need to include demolition of existing site features, including the existing Orange Street sewer pipeline and existing pump station. The material produced by demolition

activities should be removed from the site. Demolition of these features should include rerouting, removal, or in-place abandonment of underground utilities. Utilities should be adequately capped or rerouted at the project perimeter, in accordance with the governing requirements, regulations, and the recommendations of the geotechnical consultant at the time of demolition. Where possible, abandoned underground utility pipes should be removed from the site, or if the pipes are left in place, they should be filled with flowable fill, such as grout or controlled low-strength material (CLSM). The contractor should take adequate precautions when grading the site, to reduce the potential for damage to existing utilities that are to remain in service.

4.3 Earthwork

Specifications for materials earth work practices are presented in the project specifications and generally follow the Manual of Standard Specifications (Utah Chapters APWA and AGC 2017). The following sections present additional earthwork recommendations for the project, including observation and testing, excavation, subgrade preparation, stability of temporary excavations, fill materials, and fill placement.

4.3.1 Observation and Testing

Experienced construction materials inspection personnel should perform appropriate observation and testing services during grading and construction operations. These services should include observing the removal of soft, loose, or otherwise unsuitable soils, evaluating the subgrade exposed by excavation before fill placement or construction, and observing and performing testing services during placement and compaction of structural fill and backfill soils. In-place density and moisture tests should be performed in accordance with ASTM Standard D6938 (ASTM 2017b) or alternatively, in accordance with ASTM Standard D1556 (ASTM 2015). For trenches, the test frequency should be at least one test per 200 lineal feet, per each lift of fill material placed. For structures, the test frequency should be at least once per every 10,000 square feet, or a minimum of three tests per lift below structures, whichever is more frequent. Additional tests also may be required in structural and non-structural areas, at the discretion of the geotechnical consultant during construction.

4.3.2 Excavation

Undocumented fill was encountered in some exploratory borings performed near the IPS site. The project contractor should anticipate fill to be encountered during excavation activities, particularly in paved areas and where existing underground utilities are located. Beneath the footprint and immediate vicinity of proposed structures, the full depth of undocumented fill material and any loose, disturbed, or otherwise unsuitable soil should be removed from the project area, including building and block screen/retaining walls, and extend laterally outward from the final structure footprint for a distance equal to, or greater than the total thickness of structural fill to be placed beneath the structure foundations. However, a relatively thin layer of fill that is 1 to 2 feet thick may be left in place, to help facilitate equipment operation when working near the bottom of excavations with underlying, soft, native materials. Specification 31 23 00, Excavation and Fill presents requirements for excavation.

Before excavation, the ground surface in the project area should be cleared of any surface and subsurface obstructions, pavement, debris, organics (including vegetation), and other deleterious

material. Depressions or ruts that contain water should be drained. Materials generated from clearing operations should be removed from the project area and disposed appropriately.

Trench and structure excavations should be performed in accordance with project specifications. Excavated soils may be stockpiled and used as surcharge material, or as fill or backfill, if they comply with project specifications and the applicable material requirements.

Project specifications should be followed for moisture conditioning the soils to be used for on-site trench backfill, and for compacting these soils. Compaction and suitability of trench backfill should be evaluated during construction. Off-site utility trench backfill placement procedures should meet the requirements that are outlined in the referenced specifications (Utah Chapters APWA and AGC 2017).

4.3.3 Subgrade Preparation

Experienced construction materials inspection personnel should observe areas to receive fill before placing any fill, to assess the suitability of the exposed material. Foundations, pavements, or fill may not be placed on frozen subgrade. In addition, the subgrade should be free from trash, vegetation (including roots and other organic materials), and other deleterious soils. After the removals described above have been made, exposed granular soil materials should be scarified to a depth of 6 inches, moisture-conditioned to within 2 percent of optimum moisture content, and compacted to 95 percent relative compaction, as per ASTM Standard D1557 (ASTM 2012a). Exposed native clays should not be scarified or compacted.

Where structural fill is required beneath structure foundations or exterior concrete flatwork, excavations and compacted fill should extend laterally beyond the edge of the structure to a distance greater than, or equal to the final thickness of the fill to be placed under the foundation or flatwork. In exterior concrete flatwork and pavement areas outside structure excavations, excavations needed to remove undocumented fill near buildings or walls; excavation of fill materials may be limited to 3 feet bgs or planned surface grade (whichever is lower in elevation), extending 2 feet or more outside the footprint of these improvements.

4.3.4 Stability of Temporary Excavations

Based on the soil conditions encountered in the exploratory borings, instability of excavations may exist and should be anticipated during project excavation activities. Excavations deeper than 4 feet should be shored or sloped in accordance with Occupational Safety and Health Administration regulations. If unstable conditions are encountered, excavations shallower than 4 feet deep also must be shored or sloped. On-site personnel safety and excavation stability is the responsibility of the contractor.

Temporary sloped surfaces should be kept from drying out, to minimize raveling and sloughing. Temporary grading could be required to prevent water from flowing into excavations. Surface runoff should be channeled away from the top edge of excavations, and traffic should be routed as far away from the excavation as practicable during construction. Spoils from excavations, heavy construction equipment, and other surcharge loads should be kept back from the top of excavations, at a distance equivalent to the depth of the excavation or more, unless the slopes are engineered with consideration of adjacent surface loads.

As an alternative to laying back the sides of the excavations, temporary excavations may be shored, using trench boxes or other appropriate systems. Temporary earth-retaining systems will be subjected to lateral loads, resulting from earth pressures. As a guideline, the lateral earth pressures presented in this report (see Section 4.7) also may be used in the design of temporary excavations. A structural engineer who is experienced in retaining systems for temporary excavations should be consulted by the contractor during the design of shoring systems.

4.3.5 Fill Materials

The following discussions present recommendations regarding on-site soil suitability for use as structural fill and backfill, and minimum requirements for suitable structural fill and backfill soils. Specification 31 23 00, Excavation and Fill presents the requirements for structural fill material, placement, and compaction.

4.3.5.1 On-Site Soil Suitability

The study findings indicate that the native soils encountered in the exploratory borings generally are not suitable for use as structural fill or backfill material for the project. Undocumented fill materials could vary and might not be suitable for use as structural fill or backfill material without processing.

4.3.5.2 Structural Fill

All fill placed below structure foundations should meet the requirements for structural fill or general fill described in the specifications for the project. All supplies of previously imported structural fill should be used below structures. When the supply of previously imported structural fill is exhausted, general fill may be used. Furthermore, deep fills should receive priority with the allocation of available structural fill. Specification 31 23 00, Excavation and Fill presents the requirements for structural fill material, placement, and compaction (see Section 4.7 for the lateral earth pressure discussion of unit weights associated with structural fill and structural backfill). A separation fabric may be placed on any soft clay that is encountered at the bottom of any excavation before structural fill placement; however, geotextiles should not be used in excavations for pile-supported structures. Specification 31 05 19.13, Geotextiles, presents the requirements for separation geotextiles.

4.3.5.3 Backfill

Recommendations for backfill material in the vicinity of the IPS facilities site are the same as the recommendations for structural fill (see Section 4.3.5.2).

4.3.6 Fill Placement

Following removal of all unsuitable soils and any additional excavation required to achieve design grade, experienced construction materials inspection personnel should probe the exposed subgrade to identify remaining soft, loose, or disturbed soils. Appropriate stabilization measures may need to be implemented if remaining soft, loose, or disturbed soil materials are encountered.

Structural fill should extend laterally beyond the edge of footings, at a distance equal to the structural fill depth. Structural fill should be compacted to 95 percent of the laboratory maximum dry density, as per ASTM Standard D1557 (ASTM 2012a). Where fill is to be placed against an existing slope of 4H:1V (horizontal:vertical) or steeper, the existing slope should be benched or keyed, to allow compaction

against a horizontal surface and provide interlock of the fill with the existing material. Adjacent concrete work should be allowed to cure long enough to obtain sufficient strength, to avoid detrimental effects from earthwork activity.

4.4 Subgrade Stabilization and Dewatering

Moist subgrade and relatively shallow groundwater conditions should be anticipated. Unstable subgrade could be encountered during construction and should be anticipated during excavation and earthwork operations, including pipeline trench excavation. Dewatering will be needed where excavations extend near or below groundwater, and subgrade stabilization will be needed where pumping subgrade conditions are encountered, or where subgrade is too wet to compact. Dewatering may induce settlement of neighboring facilities (e.g., utilities, structures, roadways). The effects of temporary dewatering should be evaluated by the contractor and means to mitigate effects should be provided where needed.

If the bottom of the excavation is unsuitable for foundation or pipe bedding placement, approval of mitigation efforts will be needed, in accordance with the project specifications. Mitigation may include over-excavating a minimum of 4 to 12 inches from the excavation foundation and replacing the material with granular backfill material, sand, or gravel to create a relatively level surface for foundation construction. If conditions are observed that indicate additional stabilization efforts may be needed, a combination of over-excavation, rock fill, and geogrid placement should be considered. Dewatering and use of relatively light or tracked equipment also may be needed. The geotechnical consultant/engineer should review proposed subgrade-stabilization methods before their implementation.

The purpose of dewatering during construction is to improve excavation wall and bottom stability, as well as subgrade stability, to facilitate construction. Dewatering in excavations may need to be performed in some areas, to lower groundwater to about 3 feet or more below the bottom of the anticipated excavations. Where dewatering is needed, a construction dewatering discharge permit may be required. Water discharged during construction may require treatment, monitoring, sampling, and testing. Dewatering systems should discharge to an appropriate location, in accordance with permit requirements.

4.4.1 Construction Considerations

Because of artesian groundwater conditions, significant effort may be needed to manage groundwater in excavations. Where needed, the contractor should be prepared to manage and facilitate treatment and discharge of groundwater.

4.5 Structure Foundations

IPS structures currently are anticipated to be supported on mat, spread, or strip footings. If the anticipated settlement of IPS facilities is higher than preferred by the structural engineer, or if additional uplift resistance is needed to resist buoyant forces, pile foundations may be used; such recommendations can be prepared if requested.

4.5.1 Mat Foundations

The IPS facility is anticipated to be supported by a mat foundation. We have provided design and construction recommendations appropriate for mat foundations for IPS facilities in the subsequent sections (additional information regarding mat foundations is provided in Appendix F).

4.5.1.1 Bearing Resistance

The recommended allowable bearing resistance (i.e., bearing capacity) for mat foundations were calculated using the reported structural dimensions, locations, and bearing elevations. Bearing resistances were calculated for drained (long-term, slow) and undrained (short-term, quick) loading conditions for general bearing failure. In this instance, a drained loading represents an increase in load, which is applied to a structure foundation slowly over a period of a few months or years; an undrained loading represents an increase in load, which is applied to a structure foundation rapidly over a period less than a few weeks. The allowable bearing resistances are shown in Table 4.5 and represent the total allowable load to be applied at the structure foundation.

Settlement, which is presented in Section 4.5.1.2 for mat foundations, also was considered for selecting allowable bearing resistances. Long-term settlement that occurs under permanent or sustained static loads can result in significant settlement over time. The significance of this settlement depends on the magnitude of the permanent load and the duration of the loading. The settlements discussed in Section 4.5.1.2 are appropriate only for permanent bearing pressures that are less than the maximum permanent bearing pressures shown in Table 4.5, which, if exceeded, may result in more settlement than estimated in Section 4.5.1.2. Settlement estimates also are dependent on the bearing elevation and dimensions of each structure. If the bearing elevation or dimensions change for a structure, the associated settlement also may change.

Based on soil types encountered in the subsurface explorations, a modulus of subgrade reaction was developed and is shown in Table 4.5. The recommended moduli of subgrade reaction are appropriate for the anticipated mat foundations.

Table 4.5. Summary of Maximum Allowable Bearing Resistances and Maximum Permanent Bearing Pressures for Mat Foundations

Facility	Allowable Bearing Resistance[1] (ksf)		Maximum Permanent (Sustained) Bearing Pressure (ksf)	Modulus of Subgrade Reaction[2] (pci)
	Drained (slow loading)	Undrained (quick loading)		
IPS Facility				
Construction – no backfill[3]	--[4]	1.6	1.5[3] (1.5)[5]	40
Construction – 20-foot backfill[3]	--[4]	1.9	2.9[3] (1.9)[5]	40
Construction – 50-foot backfill[3]	--[4]	2.6	5.2[3,6] (2.6)[5]	40
Long-Term Drained	7.3[6]	--[4]	5.8[3,6] (3.2)[5]	40
IPS Odor Control Structure	5.1	1.8	0.5	30

Facility	Allowable Bearing Resistance[1] (ksf)		Maximum Permanent (Sustained) Bearing Pressure (ksf)	Modulus of Subgrade Reaction[2] (pci)
	Drained (slow loading)	Undrained (quick loading)		
IPS Generator Pad	6.5	1.8	0.3	30
IPS Generator Fuel Tanks	3.0	1.8	0.3	30

Notes:

ksf = kilopounds (1,000 pounds) per square foot; pci = pounds per cubic inch.

1. Settlement estimates are dependent on bearing elevation for each structure. If the bearing elevation changes for a structure, the associated settlement also may change.
2. Subgrade modulus values are rounded.
3. The maximum bearing pressure listed should not be exceeded until the noted level of backfill around the IPS has been completed (e.g., without any backfill around the IPS bearing elevation, the maximum allowed bearing pressure is 1.5 ksf; after backfill has been completed to 20 feet above the bearing elevation of the IPS, the bearing pressure may be increased from 1.5 to 2.9 ksf, and so on).
4. The bearing resistance is not applicable for the given condition.
5. The IPS excavation will reduce the net applied load at the bearing level. The effect of the excavation was considered incrementally because backfill occurs adjacent to the structure. The bearing pressure noted in parentheses is the net bearing pressure considered for the corresponding level of backfill. For each condition listed, the allowable bearing resistance exceeds the net bearing pressure.
6. Construction of the IPS is anticipated to take place over an adequately long period for porewater pressures to dissipate, so that a partially drained condition will exist as the structure load is increased to the full, permanent dead load.

4.5.1.2 Settlement

We used Settle3 version 5.006 (Rocscience 2020) to estimate foundation settlement for IPS facilities that will be supported on mat foundations, using a one-dimensional analysis that considered elastic and primary consolidation. The secondary compression settlement was estimated in Microsoft Excel, using an adaptation of the recommendations provided by Bartlett et al. for secondary settlement estimation following surcharge loading (2017). A spreadsheet developed by AECOM, based on conventional secondary settlement theory with subdivision of clay layers, was used to perform estimates of secondary compression of structures. Vertical induced stresses were calculated using the Boussinesq (1883) method that is programmed in Settle3.

Soil rebound is anticipated during and after IPS excavations; this soil rebound is anticipated during and after the excavations of relatively large soil loads. Estimated rebound for some facilities is summarized in Table 4.6. Although much of the rebound may occur during and shortly after excavation, a portion of the rebound may occur after facility construction begins and may need to be accommodated during construction.

Estimated long-term settlement, differential settlement, and angular distortion for the IPS facilities that are supported on mat foundations are summarized in Table 4.7. The settlement shown in the table represents our estimate based on field and laboratory data. For the estimated long-term settlement, we also calculated settlement for reasonable low and high values from the field and laboratory data, and the range of calculated settlement based on these low and high cases is provided in Appendix F. Post-construction immediate and recompression settlement is anticipated to occur during construction, between construction and commissioning, and after commissioning; post construction immediate and recompression settlement may occur over a period of years and secondary compression settlement will occur over the design life of the facility.

In addition to total settlement, differential settlement should be considered in design of IPS facilities and appurtenant features. The settlement estimates shown in Table 4.7 suggest that significant long-term

differential settlement can occur between structures. Differential settlement also can occur across structure footprints. Differential settlement across facilities and between facilities should be considered for its effect on the structures, connections, appurtenant facilities, flatwork, and the hydraulic grade line for gravity flow systems. Although some amount of settlement will occur at the ground surface immediately adjacent to structures, as induced by the application of foundation and fill loads, differential settlements also should be expected from the building footprint outward into the adjacent ground.

Utilities or features connecting to a structure (pipelines penetrating into/connecting to the structure) can be adversely affected by differential settlement. In addition, maintenance of appurtenances and flatwork should be expected. We recommend that both immediate and long-term differential settlement be considered by the designers, who will need to make appropriate accommodations (such as flexible connections at pipe/structure interfaces) where needed. Additional information related to settlement affecting pipelines connecting to the IPS is presented in Section 4.6, and IPS pipe settlement calculations are provided in Appendix F.

Table 4.6. Summary of Estimated Excavation Rebound for Select Liquid Train Facilities

Facility	Bearing Elevation[1] (feet)	Estimated Excavation Rebound[2] (inches)
IPS	4,168 to 4,171	1 to 3

Notes:
1. Bearing elevation is used in settlement analysis. If bearing elevations are revised, the settlement analysis may need to be updated.
2. Estimated excavation rebound is affected by numerous factors and should be considered approximate. Actual excavation rebound may be greater or less than the estimates provided. In addition, the estimates provided were calculated based on selected soil parameters. Lower and higher soil parameters would yield lesser or greater magnitudes, respectively, than those reported here.

Table 4.7. Summary of Estimated Mat Foundation Settlement

Facility	Estimated Long-Term Settlement[1] (inches)			Differential Settlement[1] (inches)	Angular Distortion (radians)
	Post-Construction Immediate and Recompression	Secondary[2]	Total		
IPS	2-1/2	0	2-1/2	1/2	0.001
IPS Generator Pad	1	0	1	1/2	0.001
IPS Odor Control Structure	1	1/2	1-1/2	3/4	0.002

Notes:
1. Settlement reported here is our estimate, based on field and laboratory data.
2. Secondary settlement is estimated for the design life of the proposed IPS facilities, which is assumed to be 50 years.

Estimated total and differential post-liquefaction settlement of structures supported on mat foundations are summarized in Table 4.8. Estimated post-liquefaction settlement for the facilities supported on mat foundations generally is anticipated to be 1 inch or less. More information on anticipated post-liquefaction settlement is presented in Section 4.1.2; the liquefaction calculation information is provided in Appendix F. Settlement estimation often is imprecise, and soil conditions are assessed based on limited points of investigation, limited soil samples, and limited laboratory testing. Our estimates of settlement in this report may be more or less than actual settlements, and the locations of maximum settlement may vary.

Table 4.8. Summary of Estimated Post-Liquefaction Settlement for IPS Facilities Supported on Mat Foundations

Facility	Estimated Post-Liquefaction Settlement[1] (inches)	Estimated Differential Post-Liquefaction Settlement[1] (inches)
IPS	<1[2]	<1[2]

Notes:
1. More information on anticipated post-liquefaction settlement is presented in Section 4.1.2, and liquefaction calculation information is provided in Appendix F.
2. Partly because of the deep bearing elevation of the IPS, estimated post-liquefaction settlement is negligible; however, estimated post-liquefaction settlement at the ground surface in the vicinity of the IPS may be on the order of 1 inch. At such locations, sidewalks, flatwork, connections, and other appurtenant facilities adjacent to the IPS may require maintenance and repairs, following a seismic event. Facilities adjacent to the IPS that will need to remain in immediate operation and cannot accommodate a maintenance period following a seismic event, such as the forcemains out of the IPS, should be designed to accommodate post-liquefaction settlement on the order of 1 inch.

4.5.2 Spread Footings

Spread (spot) footings are anticipated for the IPS Electrical Building. Recommendations for spread footings are presented next.

4.5.2.1 Frost Depth and Foundation Embedment

Consistent with the IBC (ICC 2017) and local practices, the minimum foundation embedment to be applied to structures and walls for frost protection at the project site is 30 inches, which represents the depth from the bottom of the foundation to the lowest adjacent final grade. A minimum embedment of 30 inches will be appropriate for project structures; however, other design considerations, such as reduction of foundation settlement, may result in deeper foundations.

4.5.2.2 Bearing Resistance

The recommended allowable bearing resistance (i.e., bearing capacity) for the foundations for the IPS Electrical Building is shown in Table 4.9. This bearing resistance is based on the anticipated foundation size, location, and bearing elevation provided by the design team. The spread footings are expected to be founded on structural fill not less than 12 inches in thickness beneath the footings. If the foundation dimensions or embedment are modified, the geotechnical engineer should be consulted so that the allowable bearing resistances may be revised. If allowable bearing resistance is needed for other facilities, the geotechnical engineer should be contacted so that bearing resistance recommendations specific to those facilities may be provided.

Settlement, which is presented in Section 4.5.2.4 for spread footings, also was considered when selecting allowable bearing resistance. Long-term settlement that occurs under permanent or sustained static loads can result in significant settlement over time. The significance of this settlement will depend on the magnitude of the permanent load and the duration of the loading. The settlement discussed in Section 4.5.2.4 is appropriate only for permanent bearing pressure that is less than the maximum permanent bearing pressure shown in Table 4.9, and if exceeded, may result in more settlement than estimated in Section 4.5.2.4. Settlement estimates also are dependent on the dimensions and bearing elevation for each structure. If the dimensions or bearing elevation change for a structure, the associated settlement also may change.

Based on soil types encountered in the subsurface explorations, a modulus of subgrade reaction was developed for the anticipated conditions, as shown in Table 4.9. The recommended modulus of subgrade reaction is appropriate for the anticipated spread footing foundations.

Table 4.9. Summary of Recommended Allowable Bearing Resistance for Spread Footings

Facility[1]	Foundation Size/Type	Allowable Drained (slow loading) Bearing Resistance (ksf)	Allowable Undrained (quick loading) Bearing Resistance (ksf)	Maximum Permanent (Sustained) Bearing Pressure (ksf)	Modulus of Subgrade Reaction[2], k (pci)
IPS Electrical Building	7 feet by 7 feet/ Spot	3.4[3]	2.0[3]	1.5	30

Notes: ksf = kilopounds (1,000 pounds) per square foot
1. Settlement estimates are dependent on dimensions and bearing elevation for each structure. If the dimensions or bearing elevation change for a structure, the associated settlement also may change.
2. The subgrade modulus values are rounded.
3. The assumed bearing elevation is at least 42 inches below the adjacent finished grade.

4.5.2.3 Sliding Resistance

An interface friction angle of approximately 0.65ϕ should be used to estimate sliding resistance between the base of the foundation and the soil. We recommend that a friction ratio (ratio of shear to normal stress at the base of the foundation) of approximately 0.4 be used for design. Because the displacement required to mobilize ultimate active and passive earth pressure conditions can be substantial, we recommend neglecting the contributions of active or passive earth pressure to sliding resistance. If passive resistance is considered, the passive resistance should be implemented as recommended in Section 4.7.

4.5.2.4 Settlement

We used Settle3 (Rocscience 2020) to estimate foundation settlement for the IPS Electrical Building, which is anticipated to be supported on spread and strip footings; the settlement is based on a one-dimensional analysis considering elastic and primary consolidation. The secondary compression settlement was estimated in Microsoft Excel, using an adaptation of the recommendations provided by Bartlett et al. for secondary settlement estimation following surcharge loading (2017). Vertical induced stresses were calculated using the Boussinesq (1883) method that is programmed in Settle3.

Estimated long-term settlement, differential settlement, and angular distortion for the IPS Electrical Building, supported on spread and strip footings, are summarized in Table 4.10. The settlement shown in the table represents our estimate based on field and laboratory data. Immediate and recompression settlement is anticipated to occur during construction, between construction and commissioning, and after commissioning; post construction immediate and recompression settlement may occur over a period of years while secondary compression settlement is long-term settlement that will occur over the design life of the building.

In addition to total settlement, differential settlement should be considered in design of the IPS facilities and appurtenant features. Settlement estimates suggest that significant long-term differential settlement can occur between structures. Differential settlement also can occur across structure footprints.

Differential settlements across facilities and between facilities should be considered for their effects on the structures, connections, and appurtenant facilities. Although some amount of settlement will occur at the ground surface immediately adjacent to the facilities, as induced by the application of foundation and fill loads, differential settlements should be expected from the building footprint outward into the adjacent ground. Utilities or features connecting to a structure from the outside can be adversely affected. We recommend that both immediate and long-term differential settlement be considered by the designers, and appropriate accommodations, such as flexible connections at the structure interface, be implemented as needed. Section 4.6 presents additional information related to pipe and facility connections.

Table 4.10. Summary of Estimated Spread and Strip Footing Settlement for the IPS Electrical Building

Facility	Estimated Long-Term Settlement[1] (inches)			Differential Settlement[1] (inches)	Angular Distortion (radians)
	Post-Construction Immediate and Recompression	Secondary[2]	Total		
IPS Electrical Building	1/2	0	1/2	1/4	<0.001

Notes:
1. Settlement reported represents our estimate based on field and laboratory data. Additional information relating to settlement estimates is provided in Appendix F.
2. Secondary compression settlement is estimated for the design life of the proposed IPS facilities, which is assumed to be 50 years.

Estimated total post-liquefaction settlement for the IPS Electrical Building is on the order of 1 inch, with differential post-liquefaction settlement of similar magnitude. The IPS Electrical Building as well as sidewalks, flatwork, connections, and other appurtenant facilities near the structures may require minor maintenance and repairs, following a seismic event. More information on anticipated post-liquefaction settlement is presented in Section 4.1.2, and the Liquefaction Calculation is provided in Appendix F.

Settlement estimation often is imprecise, and soil conditions are assessed based on limited points of investigation, limited soil samples, and limited laboratory testing. Our estimates of settlement in this report may be more than or less than actual settlements, and the locations of maximum settlement may vary.

4.6 Pipe Settlement and Facility Connections

A summary of estimated differential settlements between new pipelines and connected structures is presented in this section. Settlement analysis was performed for the following pipeline alignment areas:

- Pipeline Alignment 1: includes about 40 feet of the influent gravity sewer line connecting into the IPS and the forcemains from the IPS to the Headworks Facility

Differential settlement should be considered for its effect on pipelines and pipeline connections to structures. We recommend that, for utilities or features connecting to structures, both immediate and long-term differential settlement be considered by the designers, and accommodations such as flexible connections near the structure interface may be needed to accommodate movements. The estimated differential settlement between the pipeline connection at each structure and the pipeline 10 feet away from the structure is summarized in Table 4.11. For locations where pipes extend between structures which are less than 10 feet apart, settlement was considered at the mid point between the structures.

The differential settlement shown in Table 4.11 may not be distributed evenly along the pipeline from the edge of each facility. Depending on the time and loading condition that the pipelines are connected to each structure, all or some portion of the construction/short-term differential settlement shown in Table 4.11 may apply to the pipe connections. In addition, long-term differential settlement is expected to occur over the design life of the IPS, so that the pipe connection will need to accommodate this portion of the total differential settlement as well. The total differential settlement shown in Table 4.11 is a summation of the construction/short-term and long-term differential settlements and may be considered a conservative estimate of differential settlement. A lower value for the total differential settlement may be used by adding 100 percent of the long-term settlement to a portion of the construction/short-term differential settlement; this estimation should be done in consultation with the geotechnical engineer.

To help limit the amount of differential settlement between the IPS and the bifurcating wye inlet, we recommend constructing the below-grade portion of the IPS and backfilling the excavation up to finished grade, where possible, before connecting the bifurcating wye inlet to the IPS. We also recommend a material with an average saturated unit weight of 100 pcf or less for backfill material above the bifurcating wye.

Table 4.11. Differential Settlement of Pipelines and Connected Structures

Pipeline Alignment	Facility/ Pipeline Connection	Estimated Construction / Short Term Differential Settlement (inches)	Estimated Long Term Differential Settlement (inches)	Estimated Total Differential Settlement (inches)
IPS Area and Headworks Influent	Raw Sewer Influent to IPS Inlet	<1/4	<1/4	<1/4
	IPS Inlet to IPS Structure	<1/4	<1/4	<1/4
	IPS Structure to Forcemains	1/2	<1/4	1/2

In addition to differential settlement, total settlement should be considered during design of IPS facilities and appurtenant features, such as pipelines. Additional information related to settlement affecting pipelines and facilities is included in the pipe settlement calculations, provided in Appendix F.

4.6.1 Modulus of Soil Reaction (E′)

Our understanding is that cut-and-cover methods will be used to install the new forcemains. We have provided the following recommendations for modulus of soil reaction (E′) to be used along the pipeline alignments for design.

The modulus can be used to characterize the soil–pipe relationship when estimating pipe deflection caused by external loads on the pipe; the modulus will depend on several factors, including trench width, pipe diameter, invert depth, backfill material, backfill compaction, and relative compaction density of the trench wall soils (i.e., native materials above the invert, outside the trench). The pipeline designer should have a sound understanding of how these and other factors will influence the input parameters in equations used for pipeline design, and the designer will need to consider the effects of the actual pipeline construction methods on those parameters.

Based on information from the pipeline designer, we understand that forcemain pipelines with a diameter of 48 inches are planned to be installed within a range of invert elevations. The soil type in our calculation (e.g., the material near pipe centerline elevations outside the pipeline trench) was considered for the area near the IPS.

4.6.1.1 Analysis

The constrained modulus of soil, M_s is used in the Iowa formula, as described in the referenced document (AWWA 2013) and also is understood to be the modulus of soil reaction, E′, used for the pipeline design.

The composite value of constrained modulus, M_s was calculated using the methodology used in the referenced AWWA (2013) document. The composite constrained modulus, M_s is calculated by multiplying the stress-dependent constrained modulus of the pipe zone embedment, M_{sb} by a soil support combining factor. The combining factor depends on the relative stiffness of the native soil to the trench backfill material at the pipe centerline, and the ratio of the trench width to the pipe diameter. A description of the calculation and analysis is provided in Appendix F.

The analysis was performed using the following assumptions:

- Class II soil material, described in Table 6.1 (AWWA 2013), will be used to backfill pipe trenches.
- Embedment soil (i.e., pipe zone backfill) will be compacted to 95 percent standard proctor density.
- Although CLSM could have an M_{sb} of as much as 25,000 psi (AWWA 2013), an M_{sb} of 25,000 psi could be higher than the actual M_{sb}. A conservative value equal to the calculated M_{sb} for class II material also is used for CSLM.
- The effective vertical stress at the centerline depth is calculated using a soil unit weight of 125 pcf for the compacted backfill material.
- A groundwater elevation of 4,209 feet was used at the IPS.
- M_{sb} can be estimated reasonably by linearly interpolating between values in Table 5.4 (AWWA 2013).

To estimate the soil support combining factor, S_c, the constrained modulus of the native soil, M_{sn}, near the pipe centerline elevation is needed. Values for M_{sn} were estimated from Table 5.6 (AWWA 2013), based on the undrained shear strength for clay soils, S_u, or based on the general soil description for granular soil. Values for S_c were estimated by linear interpolation of Table 5.5 in the referenced document (AWWA 2013), using the calculated M_{sn} to M_{sb} ratio and the calculated trench width (B_d) to pipe outer diameter (D) ratio, B_d/D, by assuming 12 inches of trench width beyond each side of the pipe.

4.6.1.2 Results

Detailed calculations of M_s versus elevation for the analyses area near the IPS are included in Attachment 2 of the E′ calculations, provided in Appendix F. Considering that M_s can be highly sensitive to soil type, ranging from about 850 to 4,600 psi (e.g., the modulus of soil reaction or constrained modulus, E′ or M_s, generally is lower where fine-grained, clayey, and silty soil layers are dominant, and is higher where coarse grained, granular soils are dominant), and considering that many coarse-grained soil layers at the project site are relatively thin and interbedded, we recommend that values derived from

fine-grained layers be used for most pipeline invert elevations. A summary of estimated E′ values is shown in Table 4.12.

Table 4.12. Modulus of Soil Reaction, E′

Pipe Diameter (inches)	Invert Elevation [Centerline Elevation] (feet)		Modulus of Subgrade Reaction, E′ (pounds per square inch)
	From	To	
48	4,206 [4,208]	4,210 [4,212]	900

4.7 Lateral Earth Pressures

Earth-retaining and buried structures should be designed considering the lateral earth pressures presented in this section. Typically, the resulting lateral earth pressure distribution for soils is assumed to increase linearly from the ground surface (top of the soil adjacent to the wall or foundation) to the base of the wall or foundation. To facilitate the application of this pressure distribution in design for each of the specific structures in the IPS facilities, Table 4.13 and Table 4.14 show recommended static and seismic (pseudostatic) components, respectively, of lateral earth-equivalent fluid weights. These equivalent fluid weights are based on a weighted average unit weight described further in Appendix F. For fill soils (such as structural fill below and around structures), the selected unit weights are 135 pcf for active and at rest evaluations and 115 pcf for passive calculations. For lightweight fill soils that may be used adjacent to the IPS, the selected unit weights are 100 pcf for active and at rest evaluations, and 70 pcf for passive calculations. Unit weights used for native soils and structures anticipated to experience lateral earth pressures from both fill and native soils are provided in Appendix F. The equivalent fluid weights shown in Table 4.13 may be used to estimate the lateral earth pressure at a depth bgs, by multiplying the associated equivalent fluid weight by the depth bgs of the point in question. The pseudostatic components shown in Table 4.14 should be used in conjunction with the appropriate static equivalent fluid weights shown in Table 4.13. The seismic components of equivalent fluid weight shown in Table 4.14 represent the increase (or decrease in the case of passive earth pressure) in lateral earth pressure for the pseudostatic case. The seismic equivalent fluid weight (Table 4.14) should be added to (used together with) the static equivalent fluid weight (Table 4.13) for the pseudostatic case. Where submerged equivalent fluid unit weights are used, which account only lateral earth pressure, fluid (water) pressure will need to be added to the submerged equivalent fluid weights shown.

More movement is required to mobilize full passive earth pressures than active earth pressures. More soil strain and movement generally are needed for fine-grained soils to develop full strength, as compared to coarse-grained soils. The magnitude of movement required to mobilize full active and passive earth pressures can be approximated in terms of the ratio of movement of the top of the wall (needed to reach minimum active or maximum passive pressure) to the height of the wall. For the conditions and soil types observed, we recommend that values of 0.002 and 0.04 be assumed for this ratio in active and passive earth pressure conditions, respectively, for structures bearing above an elevation of 4,218 feet in the area of the IPS. For structures bearing below an elevation of 4,218 feet in the area of the IPS, and below the original ground surface along the forcemains from the IPS to the Headworks Facility, we recommend that ratios of movement at the top of wall to the height of wall of 0.01 and 0.05 be used for active and passive earth pressure conditions, respectively. Non-yielding walls, such

as basement walls or structure walls with strong moment connections (preventing rotation), require design using at-rest wall pressures.

Table 4.13. Summary of Recommended Lateral Earth Equivalent Fluid Weights for the Static Load Case

Liquid Train Facility	Static Load Case		
	Active [submerged [1,2]] (pcf)	At-Rest [submerged [1,2]] (pcf)	Passive [submerged [1,2]] (pcf)
Forcemains	44 [22]	95 [48]	394 [160]
IPS Area – Native	44 [22]	95 [48]	394 [160]
IPS Area – Fill[3,4]	34 [19]	60 [32]	896 [410]
IPS Area – Lightweight Fill[3,5]	30 [11]	50 [19]	398 [43]

Notes:
pcf = pounds per cubic foot

1. Equivalent fluid weights generally were calculated using a weighted average soil unit weight. Submerged equivalent fluid weights are appropriate where the surrounding soil is submerged and only account soil pressure; submerged equivalent fluid weights do not include water pressures, which must be added for design.
2. The dynamic components of equivalent fluid weights, respectively, should be added to the static equivalent fluid weights, as needed, for the seismic (pseudostatic) case.
3. Soil characteristics were obtained solely from fill material properties.
4. Recommended for facilities in the IPS area bearing in fill (at or above an elevation of approximately 4,218 feet).
5. Recommended for facilities in the IPS area bearing in lightweight fill (total in-place unit weight of between 70 to 100 pcf).

Table 4.14. Summary of Recommended Dynamic (Seismic) Component of Lateral Earth Equivalent Fluid Weights for the Pseudostatic Load Case

Liquid Train Facility	Pseudostatic Load Case[1]		
	Active [submerged[2]] (pcf)	At-Rest [submerged[2]] (pcf)	Passive[3,4] [submerged[2]] (pcf)
Forcemains	39 [20]	52 [26]	-90 [-37]
IPS Area – Native	39 [20]	52 [26]	-90 [-37]
IPS Area – Fill[5,6]	35 [19]	56 [30]	-296 [-135]
IPS Area – Lightweight Fill[5,7]	29 [11]	41 [16]	-127 [-14]

Notes:
pcf = pounds per cubic foot

1. The pseudostatic component of lateral earth equivalent fluid weight should be added to the static lateral earth equivalent fluid weight, as needed, for the seismic (pseudostatic) case.
2. Submerged unit weights account only pseudostatic pressure because of soil and are appropriate for use where the surrounding soil is submerged; submerged equivalent fluid weights do not include water pressures, which will need to be added to the equivalent fluid weights shown.
3. Lateral earth equivalent fluid weights for the seismic (pseudostatic) active and passive load cases were based on a seismic coefficient equal to half of the 2,475-year return period peak horizontal ground acceleration (see Section 4.1). Lateral earth equivalent fluid weights for the seismic (pseudostatic) at-rest load case were based on the 2,475-year return period peak horizontal ground acceleration (free-field).
4. As indicated by the negative sign (-), the pseudostatic component of lateral earth equivalent fluid weight for the passive case should be subtracted from (reduce) the static lateral earth-equivalent fluid weights, as needed, for the seismic (pseudostatic) case.
5. Soil characteristics were obtained solely from the fill material properties.
6. Recommended for facilities in the IPS area that bear entirely in fill (at or above an elevation of 4,218 feet).
7. Recommended for facilities in the IPS area bearing in lightweight fill (total in-place unit weight of between 70 to 100 pcf).

Backfill placed behind retaining walls or subsurface walls should satisfy the material and placement recommendations presented in Section 4.3. Over-compaction adjacent to retaining walls or subsurface walls should be avoided; recommended lateral earth pressures assume that compaction behind retaining walls or subsurface walls will be accomplished with relatively light compaction equipment.

4.8 Concrete Slab-on-Grade Floors

Concrete slab-on-grade floors should be designed by the project's structural engineer and be based on anticipated loading conditions. We recommend that concrete slab-on-grade floors be founded on at least 12 inches of compacted structural fill, as described in Section 4.3, to help protect against frost and adverse effects of seasonal moisture changes. The aggregate base underlying concrete slab-on-grade floors should be compacted to 95 percent of the laboratory maximum dry density, as per ASTM Standard D1557 (ASTM 2012a). Use of a vapor barrier or retarder is recommended, particularly in areas where moisture-sensitive flooring is to be used.

4.9 Exterior Concrete Flatwork, Curbs, and Gutters

Exterior concrete flatwork, such as walkways and larger slabs, should be founded on 4 inches of untreated base course, overlying 12 inches or more of compacted structural fill (reworked fill, and/or native or imported soils). The structural fill thickness may include 6 inches of scarified and recompacted soils (see Section 4.3.5). The untreated base course should be compacted to 95 percent relative compaction, as per ASTM Standard D1557 (ASTM 2012a). Flatwork should not be connected to any adjacent structures because differential settlement can adversely affect the performance of the flatwork.

To reduce the potential for shrinkage cracks, the flatwork should be constructed with adequately spaced control joints. Crack control joint spacing should be in accordance with the recommendations of the structural engineer.

Formation of shrinkage cracks in concrete slabs and other cracks from minor soil movement may be reduced further by using steel reinforcement, such as welded wire mesh. However, because of the inherent difficulty in positioning welded wire mesh in the middle of concrete flatwork, other crack control methods should be considered, such as placing steel reinforcing bars on chairs in the concrete, or the use of fiber mesh.

Exterior concrete flatwork, curbs, and gutters should be constructed in accordance with the recommendations of the project's civil or structural engineer and governing agency requirements. Recommendations regarding concrete to be used in project construction are presented in Section 4.13.

4.10 Pavement Design

We recommend that mix designs be made for the asphalt concrete (AC) and portland cement concrete (PCC) by an engineering company that specializes in this type of work, and that a minimum 600 psi, flexural strength PCC be used in concrete pavements. In addition, paving operations should be observed and tested by a qualified testing laboratory. we also recommend that the structural engineer be consulted for appropriate reinforcement of concrete pavement.

In providing these recommendations for pavement sections, we have assumed that AC will be mixed and placed in accordance with Section 32.12.16 of the referenced specifications (Utah Chapters APWA and

AGC 2017). We also have assumed that untreated base course (UTBC) will conform to Section 32.11.23, Part 2.1 of the referenced specifications (Utah Chapters APWA and AGC 2017). UTBC materials should be placed and compacted to 95 percent relative compaction, as per ASTM Standard D1557 (ASTM 2012a), and in accordance with the referenced specifications (Utah Chapters APWA and AGC 2017).

Adequate surface drainage should be provided to reduce ponding and infiltration of water into the pavement and subgrade materials. We suggest that the paved areas have a surface gradient of 1 percent or more. In addition, surface runoff from surrounding areas should be intercepted, collected, and not permitted to flow onto the pavement or infiltrate the base and subgrade. We recommend that perimeter swales, edge drains, curbs, and gutters, or a combination of these drainage devices be constructed to reduce the adverse effects of surface water runoff. Additional recommendations regarding flexible and rigid pavement are presented next.

4.10.1 Flexible Pavement

To form a basis for design of flexible pavement for on-site paved parking and driving areas, we have assumed the following:

- a design ESAL value of 121,500 for general plant traffic areas
- 85 percent reliability
- 0.45 standard deviation
- 4.2 initial serviceability
- 2.5 terminal serviceability
- a subgrade resilient modulus (M_R) of 15,000 psi
- a 20-year design life

Using these values, structural numbers associated with the on-site parking and driving areas were calculated using the design procedures presented in the AASHTO Guide for Design of Pavement Structures (AASHTO 1993). Table 4.15 shows recommended structural pavement sections placed over granular fill for general plant traffic areas and light vehicle parking and driving areas. The granular fill can be the existing fill at the site or can be imported granular fill that is not susceptible to frost heave.

Table 4.15. Recommended Flexible Pavement Section

Traffic Type	Flexible Design ESAL[1]	Asphalt Pavement Thickness ($a_{asphalt}$ = *0.4*) (inches)	Untreated Base Thickness (a_{base} = *0.1*) (inches)	Granular Fill[2] (inches)	Structural Number	
					Provided	Needed
General Plant Traffic or Vehicle Parking and Drive Areas	121,500	4	6	24	2.20	1.79

Notes: ESAL = Equivalent Single Axle Load

1. For the design number of ESALs, minimum thicknesses control the pavement section; for the minimum pavement section, up to 420,000 ESALs can be supported.
2. Existing fill or imported granular fill that is not susceptible to frost heave.

4.10.2 Rigid Pavement

We recommend that PCC pavement be used in areas used by truck traffic, in the vicinity of trash dumpsters and other areas that support relatively heavy traffic loads. Our experience indicates that refuse truck traffic and other heavy traffic can shorten the useful life of PCC pavement substantially. To form a basis for design of rigid pavement, we have assumed the following parameters:

- a design ESAL value of 385,700
- 90 percent reliability
- 0.35 standard deviation
- 4.5 initial serviceability
- 2.5 terminal serviceability
- a resilient modulus (M_R) of 15,000 psi
- a concrete modulus of rupture of 600 psi and modulus of elasticity of 3,600,000 psi
- a load transfer coefficient of 2.8 and a drainage coefficient of 1.0
- an effective modulus of subgrade reaction of 200 pounds per cubic inch
- a subgrade consisting of 2 feet or more of granular fill
- a 40-year design life

Using these values, rigid pavement section thicknesses were calculated using the design procedures in the AASHTO Guide for Design of Pavement Structures (AASHTO 1993). Table 4.16 shows recommended rigid pavement sections placed over granular fill.

Table 4.16. Recommended Rigid Pavement Section

Traffic Type	Rigid Design ESAL[1]	Concrete Pavement Thickness (inches)	Untreated Base Thickness (inches)	Granular Fill[2] (inches)
Areas with Heavy Traffic	385,700	6	6	24

Notes: ESAL = Equivalent Single Axle Load

1. Concrete thickness assumes that concrete pavement is constructed without tied-edge support; a minimum thickness of 6 inches is recommended, otherwise a thickness of 5-1/2 inches can support the design ESALs. In addition, up to 770,000 ESALs can be supported by the recommended pavement section.
2. Existing fill or imported granular fill that is not susceptible to frost heave.

4.11 Construction in Cold or Wet Weather

During construction, the project site should be graded so that surface water can drain quickly away from improvement areas. Based on the encountered soil conditions, ponding of water in or near excavations should be avoided. Water that accumulates in excavations should be pumped out promptly or otherwise removed, and these areas should be allowed to dry sufficiently before resuming construction. Berms, ditches, and similar means should be used to decrease stormwater entering the work area and efficiently convey it off-site.

Earthwork activities undertaken during the cold weather season may be difficult and should be done by an experienced contractor. Fill should not be placed on top of frozen soils. The frozen soils should be removed (or completely thawed) before placement of new engineered fill or other construction material. Frozen soil should not be used as structural fill or backfill. After it has thawed completely, the frozen soil may be re-used (provided it meets the selection criteria). In addition, compaction of the soils may be more difficult because of the viscosity change in water at lower temperatures.

If construction proceeds during cold weather, foundations slabs or other concrete elements should not be placed on frozen subgrade soil. Frozen soil should be removed from beneath concrete elements or should be thawed and recompacted. To limit the potential for soil freezing, the amount of time passing between excavation and construction should be minimized. Blankets, straw, soil cover, or heating may be used to inhibit the moisture in the soil from freezing.

4.12 Frost Heave

Some encountered soils may be susceptible to frost heave, if allowed to become saturated and exposed to freezing temperatures and a repeated freeze/thaw cycling. The formation of ice in the underlying soils can result in 2 inches or more of heave for pavements, flatwork, and other hardscaping in sustained cold weather. A portion of this movement may be recovered when the soils thaw, but because of loss of soil density, some degree of displacement will remain. Frost heave of hardscaping also can occur in areas where subgrade soils are placed on engineered fill.

In areas where hardscape movements are a design concern (i.e., exterior flatwork adjacent to a building within a doorway swing zone), replacing the subgrade soils with 3 feet or more of clean, coarse sand or gravel; supporting the element on foundations similar to the building; or spanning over a void should be considered. Detailed recommendations can be provided on request.

4.13 Scaling

Climatic conditions in the project area during and after construction, including relatively low humidity, large temperature changes, and repeated freeze-thaw cycles, may cause surficial scaling and spalling of exterior concrete. Occurrence of surficial scaling and spalling can be aggravated by poor workmanship during construction, such as “over-finishing” concrete surfaces and the use of de-icing salts on exterior concrete flatwork, particularly during the first winter after construction. The use of de-icing salts on nearby roadways, which can be transferred by vehicle traffic onto newly placed concrete, can be sufficient to induce scaling.

Concrete mix design criteria should be coordinated with other project requirements, including the criteria for soluble sulfate resistance that is presented in Section 4.14, and where specified by the structural engineer. The following measures can be beneficial and may reduce the occurrence of concrete scaling. Other factors, including workmanship, still may cause surface damage to concrete, even when these measures are followed:

- curing concrete in accordance with applicable codes and guidelines;
- maintaining a water/cement ratio of 0.45 or less, by weight, for exterior concrete mixes;
- including Type F fly ash in exterior concrete mixes, as 20 percent of the cementitious material;
- specifying a 28-day compressive strength of 4,500 psi, or more, for exterior concrete;
- including a fiber mesh reinforcement in the concrete mix; and
- avoiding use of de-icing salts through the first full winter after construction.

4.14 Concrete and Corrosion Considerations

Based on the results of chemical testing, some of the tested on-site soils show moderate to severe sulfate exposure, as described in Section 318 of the American Concrete Institute (ACI) manual (ACI 2017), which is referenced by the IBC (ICC 2015). We recommend that concrete in contact with on-site soils, along with subsurface walls up to 12 inches above finished grade, contain Type II cement and have a design compressive strength of 4,000 psi. In addition, reinforcing bars in cast-against-grade concrete should be covered by approximately 3 inches or more of concrete. Concrete should be placed with an approximately 4-inch slump, or as specified by the structural engineer of record, and good densification procedures should be used during placement, to reduce the potential for honeycombing. Concrete samples should be obtained, as indicated in Section 318 of the ACI Manual (ACI 2017), and should be tested by experienced construction materials testing personnel in accordance with project specifications. Structural concrete should be placed in accordance with the ACI Manual and referenced specifications (Utah Chapters APWA and AGC 2017).

Based on the results of chemical testing, some of the tested soils contain chloride concentrations that should be considered corrosive to reinforcing steel and tendons. In addition, some of the tested soils have measured resistivity that should be considered to range from negligibly to extremely corrosive to metal. The designs should implement appropriate corrosion protection methods.

4.15 Moisture Infiltration Reduction and Surface Drainage

Positive drainage should be established and maintained away from IPS facilities. Positive drainage, such as providing a surface gradient of 5 percent or more away from the facilities for a distance of 10 feet (measured perpendicular from the exterior of a structure), should be considered where possible. Where

this is not practical, positive drainage should be provided with approved alternative drainage features. Structure settlement relative to the ground surface over the lifetime of a structure also should be considered.

Adequate surface drainage should be provided, to channel surface water away from the facilities and direct it to a suitable outlet, such as a storm drain. Adequate surface drainage may be enhanced by use of graded swales, area drains, and other drainage devices. Surface runoff should not be allowed to pond near a facility. Because of the nature of this site, regrading may be necessary over time, to maintain positive drainage away from structures and direct surface water into suitable drainage collection features.

Roof drains should have downspouts that extend to an appropriate outlet, such as a storm drain or street. If this is not practical, downspouts should discharge 5 feet or more away from the facility or onto concrete flatwork or asphalt that slopes away from the structure. Downspouts should not be allowed to discharge onto the ground surface adjacent to the facility's foundations.

We recommend that low-water use (drip irrigated) landscaping be used on site, particularly within 5 feet of a facility and exterior site improvements, including areas of concrete flatwork and masonry block walls. Irrigation heads should be oriented so that they spray away from the facility and block wall surfaces.

A relatively impermeable barrier should be placed against retaining structures, where retained soil is in contact with the retaining wall, to help reduce unsightly staining of the exposed wall face and potential for degradation of the wall.

5. Limitations

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practices and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. No evaluation is detailed enough to reveal every subsurface condition. Variations may exist, and conditions not observed or described in this report may be encountered during project construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation can be performed on request.

The recommendations presented in this report are based on field exploration, laboratory testing, review of referenced maps and literature, and our understanding of the proposed project construction. The soil data used in preparation of this report were obtained from a limited number of subsurface explorations. Variations in the soil conditions possibly exist between or beyond the locations explored. If soil conditions are encountered during project construction that are different from those outlined in this report, we should be notified immediately to review the situation and make supplementary recommendations as needed. In addition, if the scope of the proposed construction, including the types of structures, anticipated loads, and maximum cut and fill depths changes from what is described in this report, we should be notified. This study was limited to assessment of geotechnical aspects of the project and did not include evaluation of structural items, environmental concerns, or the presence of hazardous materials.

The recommendations presented in this report also assume that an adequate number of tests and observations will be made during site construction, to evaluate compliance with the recommendations. These tests and observations should be provided under the direction of a qualified geotechnical consultant. Such testing and observations should include the following:

- review of site construction plans for conformance with the geotechnical recommendations;
- observation and testing during site preparation, grading, structure excavations, foundation installation, and placement of fill, aggregate base, concrete, mortar, grout, asphalt concrete, and steel reinforcement; and
- consultation, as needed during construction.

This document is intended to be used in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. We should be contacted if additional information is needed, or if questions regarding the content, interpretations presented, or completeness of this document arise.

Site conditions may change with time because of natural processes or the activities of people at the project site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur because of government action or the broadening of

knowledge. Therefore, the findings in this report may be invalidated over time, in part or in whole, by changes over which we have no control.

This report is intended for the exclusive use of the SLCDPU. Any use or re-use of the findings, conclusions, and/or recommendations of this report by parties other than the SLCDPU is undertaken at its sole risk. This report may not provide sufficient data to prepare an accurate bid by contractors. Bidders and their geotechnical consultants can perform an independent evaluation of the subsurface conditions in the project area; independent evaluations can include review of other geotechnical reports prepared for nearby areas, site reconnaissance, and additional subsurface exploration, laboratory testing, and geotechnical analyses.

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Appendix A Project Maps

Project Vicinity Map

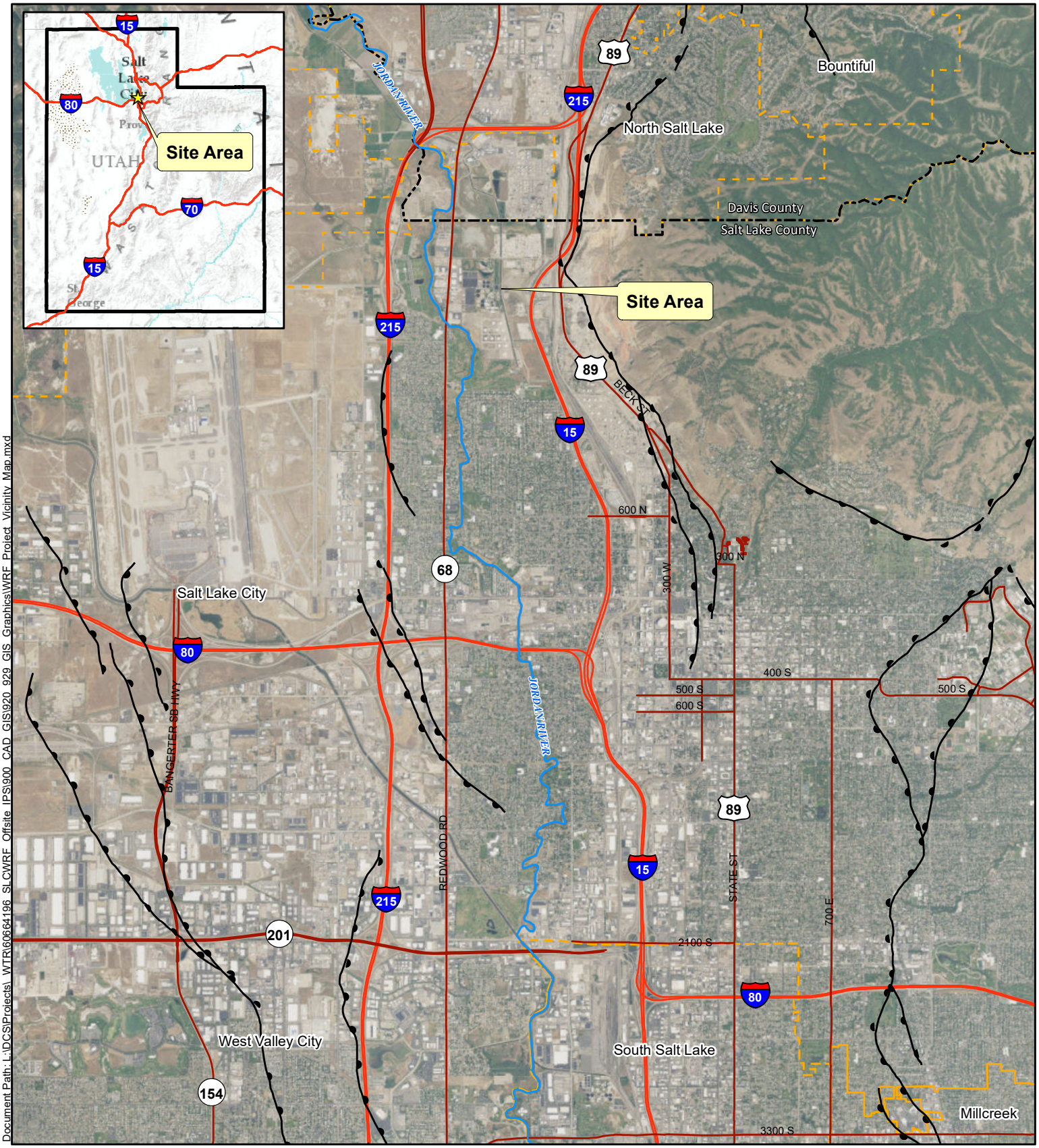
Project Location

Geology

Subsurface Investigations

Generalized Stratigraphic Column

Area B Site Plan



Fault (Dashed where inferred)
Water Feature
Major Road
Interstate
County Line
Municipalities

N
W E
S

0 0.75 1.5 3 Miles

00 31 32-51

Project Vicinity Map

Salt Lake City Water Reclamation Facility

SLC New WRF Facility - IPS
Salt Lake City, Utah

AECOM | Date: 8/2022

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Proposed Improvements

Area Of Interest

Project boundary

Influent Pipeline

Effluent Pipeline

N E S W

0 250 500 1,000 Feet

Project Location

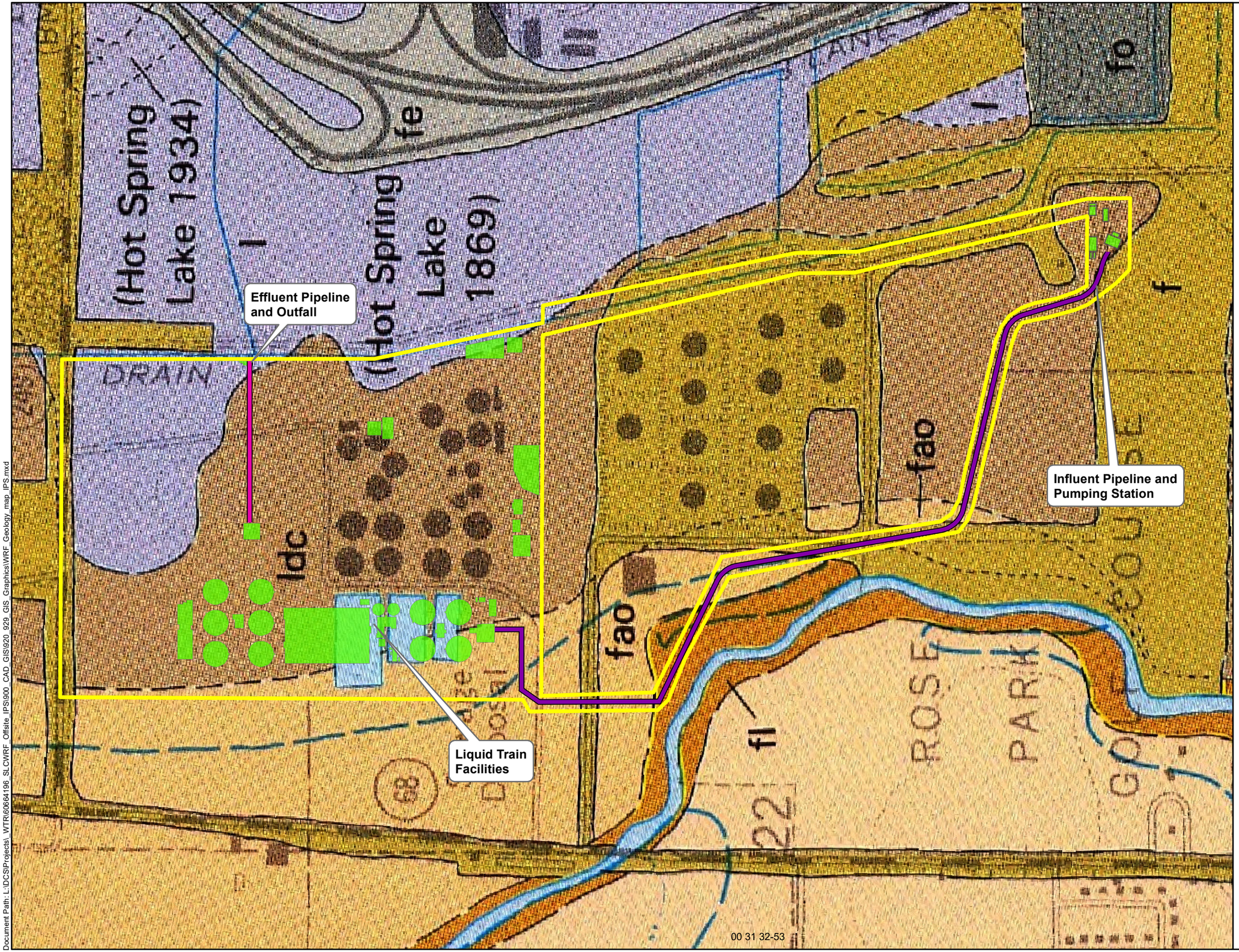
Salt Lake City Public Utilities

SLC New WRF Facility - IPS

Salt Lake City, Utah

AECOM | Date: 8/2022

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Proposed Building

Project boundary

Influent Pipeline

Effluent Pipeline

l — Modern Day Dry Lake or Marsh Deposit (Holocene)

ldc — Clay (Holocene)

fao — Floodplain Alluvium, Undifferentiated (Holocene), Older unit

f — Artificial Fill

fl — Levees, Natural and Artificial (Holocene)

fo — Oil Sump

Contact
Long-dashed where approximately located; short dashed where inferred

N E S W

0 250 500 1,000 Feet

00 31 32-53

Geology

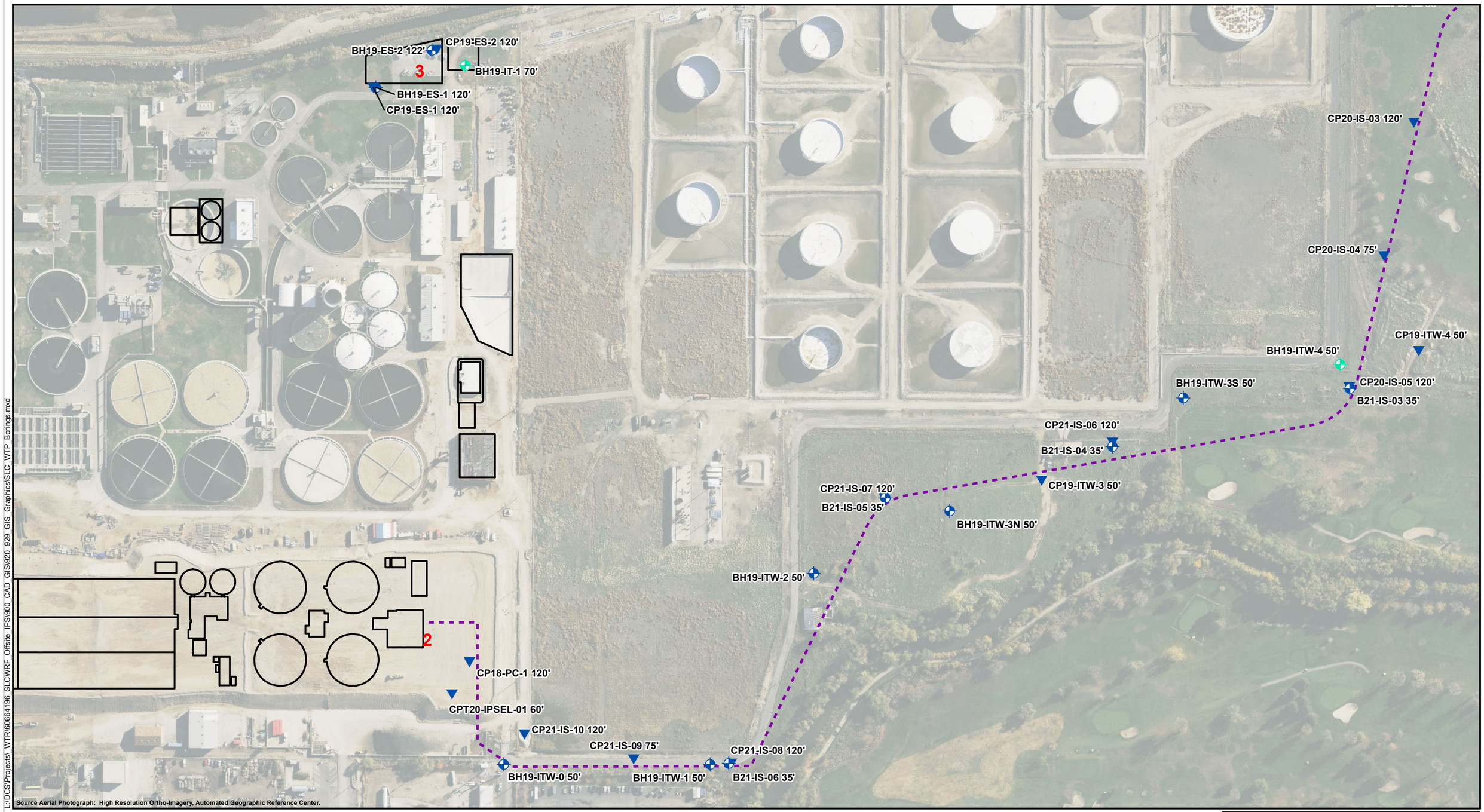
Salt Lake City Public Utilities

SLC New WRF Facility - IPS

Salt Lake City, Utah

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Boring
Boring with Piezometer
Cone Penetration Test
Proposed Facility
Influent Pipeline
Effluent Pipeline

1) IPS Facility
2) Headworks Facility
3) Electrical Substation Facility

N E S W

125 0 125 250
Feet

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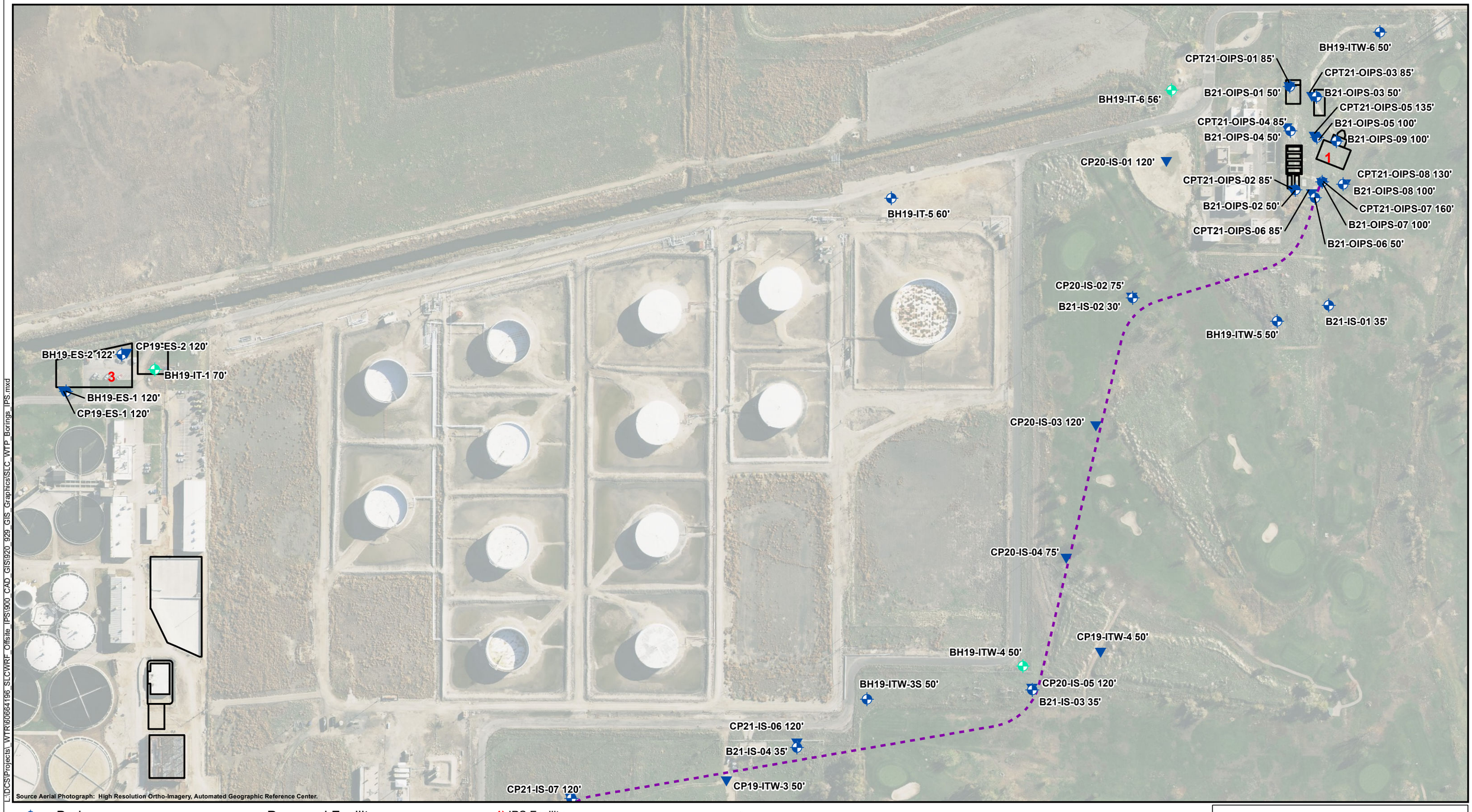
Subsurface Investigations

Salt Lake City Public Utilities

SLC New WRF Facility - IPS

Salt Lake City, Utah

AECOM | Date: 8/2022



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Boring
Boring with Piezometer
Cone Penetration Test

Proposed Facility
Influent Pipeline
Effluent Pipeline

1) IPS Facility
2) Headworks Facility
3) Electrical Substation Facility

N E S W

125 0 125 250
Feet

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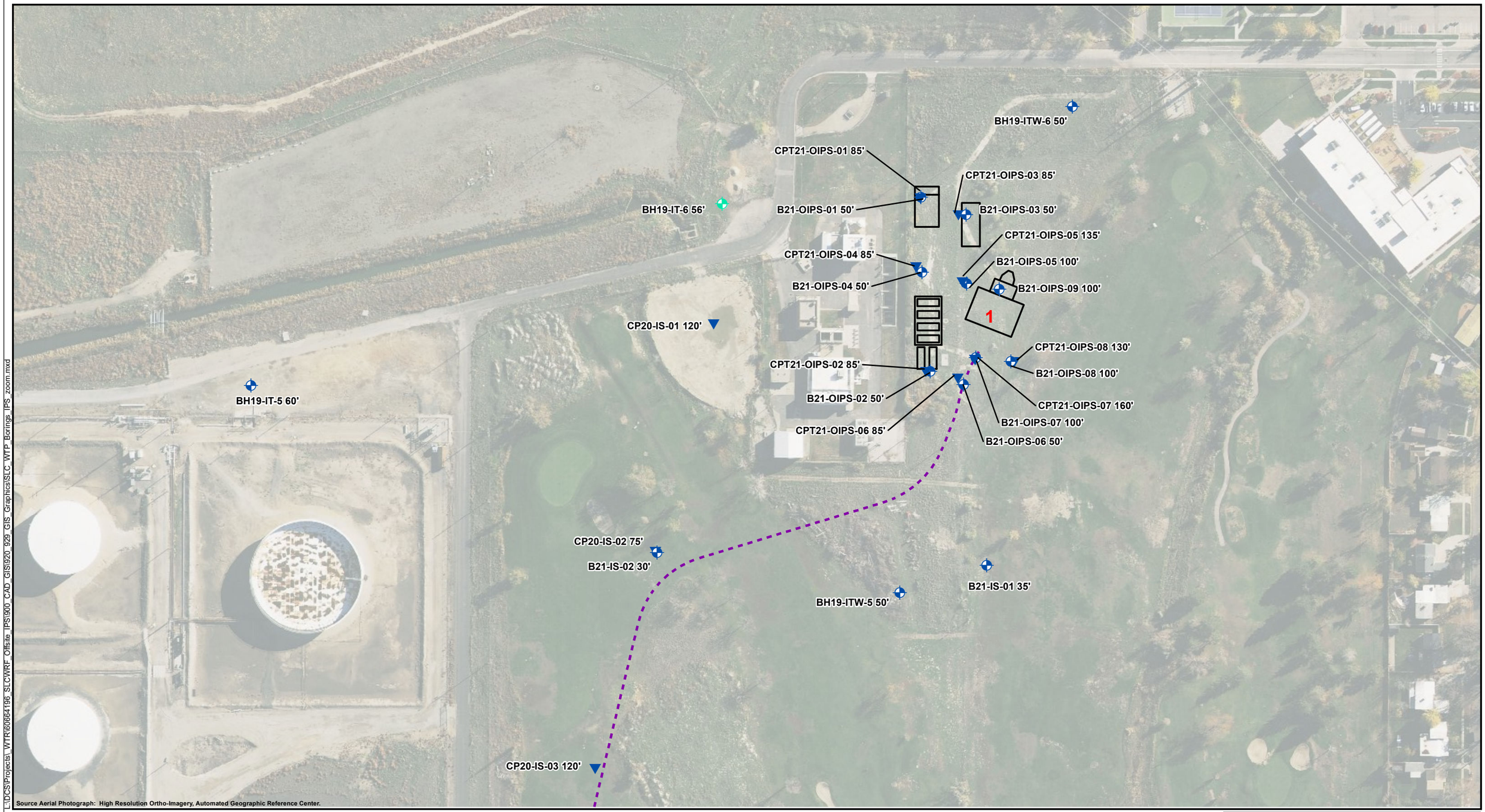
Subsurface Investigations

Salt Lake City Public Utilities

SLC New WRF Facility - IPS

Salt Lake City, Utah

AECOM | Date: 8/2022



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- Boring
- Boring with Piezometer
- Cone Penetration Test
- Proposed Facility
- Influent Pipeline
- Effluent Pipeline

1) IPS Facility
2) Headworks Facility
3) Electrical Substation Facility

N E S W

125 0 125 250 Feet

00 31 32-56

Subsurface Investigations

Salt Lake City Public Utilities

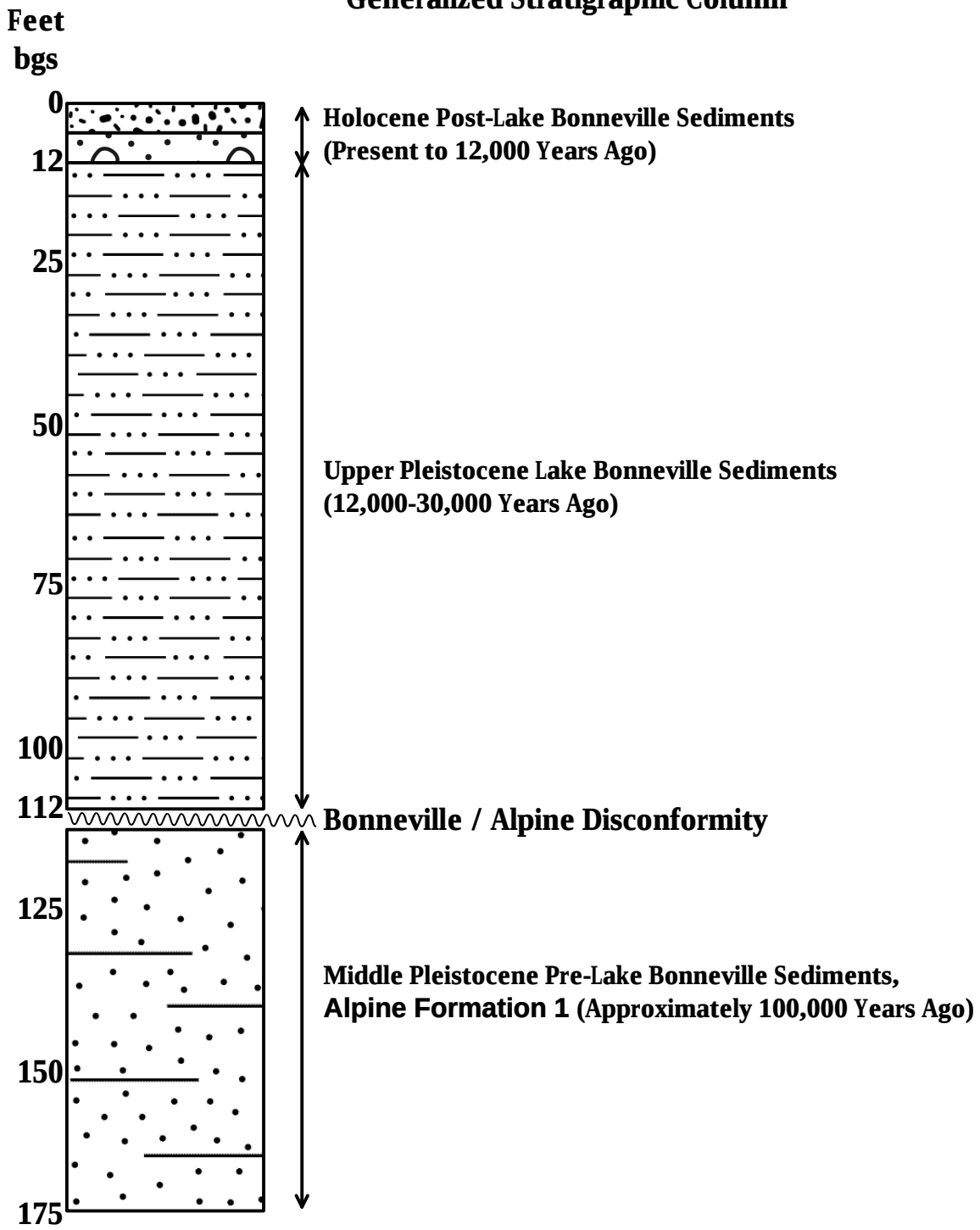
SLC New WRF Facility - IPS

Salt Lake City, Utah

AECOM | Date: 8/2022

Salt Lake City Water Reclamation Facility

Generalized Stratigraphic Column



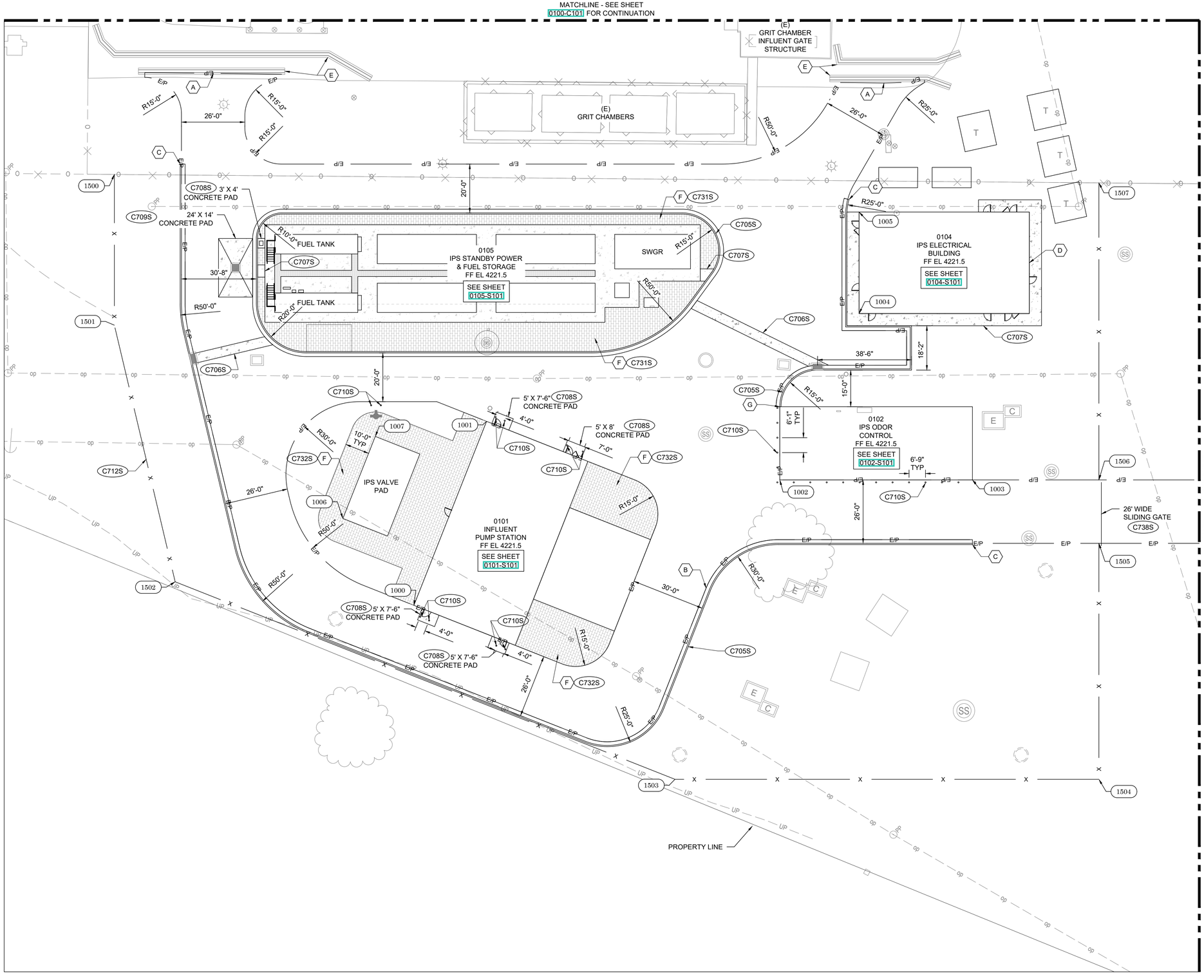
Key

- **Fill**
- **Holocene Post-Lake Bonneville Sediments, (Present to 12,000 Years Ago) generally consisting of gravely sands.**
- **Upper Pleistocene Lake Bonneville Sediments, (12,000-30,000 Years Ago), generally consists of clayey silt with silty sand.**
- **Upper Pleistocene Pre-Lake Bonneville Sediments, Alpine Formation 1, (30,000-100,000 Years Ago) generally consisting of sandy silt and silty sand.**

Salt Lake City Water Reclamation Facility	
Generalized Stratigraphic Column	
Figure A6	
Drafted By: Brian Packer	**Date:** January 9, 2019
Reviewed By: Lawrence Cannon	**Project Number:** 60572288

AECOM

30 31 32-57



KEYNOTES

A. SAWCUT EXISTING PAVEMENT TO NEAT STRAIGHT LINE PRIOR TO PAVING NEW ACCESS ROAD.

B. TRANSITION TO SPILL PAN.

C. TAPER CURB END TO BE FLUSH WITH PAVEMENT.

D. INSTALL 1/2" FIBER EXPANSION BOARD BETWEEN STRUCTURE AND SIDEWALK OF SLAB-ON-GRADE.

E. REMOVE NEW JERSEY BARRIERS FROM SITE WHEN BYPASS FEEDER IS DEMOLISHED.

F. INSTALL 8"X12" INTERLOCKING CONCRETE PAVERS (ICP) SET ON SAND OVER A COMPACTED AGGREGATE BASE (UTBC). INSTALL PAVERS IN A 90 DEGREE HERRINGBONE PATTERN. COLORS SHALL BE LIGHT GREY AND DARK GREY.

G. DOWEL CURB AND GUTTER INTO IPS ODOR CONTROL PAD PER DETAIL C711S.

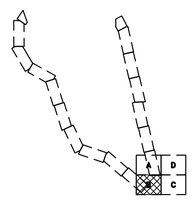
GENERAL NOTES

1. SIDEWALKS ARE 5 FT WIDE UNLESS NOTED OTHERWISE.
2. INSTALL SIX FOOT HIGH FENCE PER TYPICAL DETAIL C712S.
3. INSTALL BOLLARDS 1 FOOT FROM THE EDGE OF ASPHALT AND 4 FT APART CENTER TO CENTER AROUND FIRE HYDRANT.

SCALE IN FEET

Know what's below. Call 811 before you dig.
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UTILITY NOTIFICATION CENTER, INC.
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KEY PLAN



SCALE: 1" = 20'

PROJECT ADDRESS:
1365 W 2300 N
SALT LAKE CITY, UT
84116, UNITED STATES

DESIGNED BY: G. STEPHENSON
DRAWN BY: G. STEPHENSON
CHECKED BY: M. CHAMBERS
APPROVED BY: G.DAVIES
DATE: -
EWO NO.: -
ACCOUNT NO.: 524905396

REVISIONS

NO.	DATE	MADE BY	AUTH. BY

LAST CONFORMED SET: ---

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY
PUMP STATION SITE

AREA B SITE PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

DRAWING No.
0100-C102

SHEET - OF ----

VERIFY SCALE BAR IS ONE INCH ON ORIGINAL DRAWING

FILE: H:\Projects\407 - AECOM\03.100 SLCWRF Upgrades\Task 8 Design\CAD\Working\20-SHEETS\10_Forcemain_IPS\2_Site Plan\524905350_0100-C102.dwg DATE: 7/18/2022 1:41 PM

Appendix B Exploratory Boring Logs

Key to Boring Logs

CONSISTENCY OR CONDITION OF SOILS

Fine-Grained Soils (Silt and Clay): Major portion passing #200 sieve

Relative Consistency	N_{60} SPT, Blows/foot	Shear Strength, tsf	Unconfined Compressive Strength, tsf	Field Behavior
Very Soft	< 2	< 0.13	< 0.25	Easily penetrated several inches by fist
Soft	2 - 4	0.13 - 0.25	0.25 - 0.5	Easily penetrated several inches by thumb
Medium Stiff	5 - 8	0.25 - 0.5	0.5 - 1	Penetrated several inches by thumb with moderate effort
Stiff	9 - 15	0.5 - 1	1 - 2	Readily indented by thumb but penetrated only with great effort
Very Stiff	16 - 30	1 - 2	2 - 4	Readily indented with thumbnail
Hard	> 30	> 2	> 4	Indented with difficulty by thumbnail

Coarse-Grained Soils (Sand and Gravel): Major portion retained on #200 sieve

Apparent Density	$(N_1)_{60}$ SPT, Blows/foot	Relative Density, %	Field Test with 1/2-in Steel Rod
Very Loose	< 5	0 - 20	Very easily penetrated when pushed by hand
Loose	5 - 10	20 - 40	Easily penetrated when pushed by hand
Medium Dense	11 - 30	40 - 70	Easily penetrated when driven with 5-lb hammer
Dense	31 - 50	70 - 85	Penetrated 1 ft with difficulty when driven with 5-lb hammer
Very Dense	> 50	85 - 100	Penetrated less than 3 in. when driven with 5-lb hammer

Particle Size Descriptions for Sand and Gravel

Description	Gravel Size	Sand Size	Size Requirement
Coarse	3-in. to 3/4-in.	#4 to #10 sieve	<30% medium to fine sand or <12% fine gravel
Coarse to medium	- -	- -	<12% fine sand
Medium	- -	#10 to #40 sieve	<12% coarse sand and >30% medium sand
Medium to fine	- -	- -	<30% medium sand or <12% coarse gravel
Fine	3/4-in. to #4 sieve	#40 to #200 sieve	<30% medium sand or <12% coarse gravel
Coarse to fine	- -	- -	>12% of each size

Moisture Conditions

Dry	No indication of moisture, dusty
Slightly Moist	Appears dry, but some moisture present
Moist	Damp but no visible water
Wet	Visible free water

Structure and Layering of Soils

Stratum	>12 inches thick
Layer	1/2 inch to < 12 inches
Seam	1/16 inch to 1/2 inch
Parting	< 1/16 inch
Frequent	More than one per foot
Varved	Frequent alternating layers, seams, or partings of sand, silt, or clay
Pocket	Small erratic deposit
Lens	Non-continuous lenticular deposit

Plasticity of Fine-Grained Soils

Nonplastic	1/8-in thread cannot be rolled at any water content
Low	Thread can barely be rolled and lump cannot be formed when drier than the plastic limit
Medium	Thead is easy to roll with little time required to reach plastic limit. Thread cannot be rerolled after reaching the plastic limit.
High	Considerable time rolling and kneading to reach plastic limit. Thread can be rerolled several times after reaching plastic limit.

Unified Soil Classification System

Major Divisions			Symbols: Graphic	Symbols: Letter
Coarse-Grained Soils: More than 50% of Material is Retained on No. 200 Sieve	Gravels: More than 50% of Coarse Fraction is Retained on No. 4 Sieve	Clean Gravels (little or no fines)		GW
				GP
		Gravels with Fines (appreciable amount of fines)		GM
				GC
	Sands: More than 50% of Coarse Fraction Passes No. 4 Sieve	Clean Sand (little or no fines)		SW
				SP
		Sands with Fines (appreciable amount of fines)		SM
				SC
Fine-Grained Soils: More than 50% of Material Passes No. 200 Sieve	Silts and Clays	Liquid Limit Less than 50		ML
				CL
				OL
	Silts and Clays	Liquid Limit 50, or more		MH
				CH
				OH
Highly Organic Soils				PT

Note: Dual Symbols are used to indicate borderline soil classifications

TYPICAL SAMPLER GRAPHIC SYMBOLS

- 3.25" OD Dames & Moore Sampler
- S — 3" OD Shelby Tube
- Non-standard Sample
- 2" OD Split Spoon (SPT)
- P — Piston Sample
- Grab Sample

TYPICAL WATER LEVEL SYMBOLS

- Measured Water Level after minimum of 24 hours
- Estimated or observed water level at time of drilling

KEY TERMINOLOGY

CBR	- California bearing ratio
CONS	- One-Dimensional Consolidation Test
CORR	- Corrosion tests
DS	- Direct shear test
F	- Percent fines by weight passing #200 sieve
G	- Percent gravel by weight
γ_d	- Dry unit weight
$\gamma_{d\text{-}max}$	- Maximum dry unit weight as per ASTM D698 or D1557
LL	- Liquid Limit
N	- Number of blows to drive sampler through the second and third 6-inch soil intervals using a 140-lb hammer dropped 30 inches
N_{60}	- SPT N value corrected for field procedures
$(N_1)_{60}$	- SPT N_{60} value corrected for effective overburden pressure
NP	- Nonplastic
OD	- Outer diameter
PI	- Plasticity index
PP	- Pocket penetrometer
S	- Percent sand by weight
SG	- Specific gravity
SPT	- Standard Penetration Test
SS	- Direct simple shear test
TV	- Torvane
TXCD	- Consolidated drained triaxial test
TXCU	- Consolidated undrained triaxial test
TXCY	- Cyclic triaxial test
TXUU	- Unconsolidated undrained triaxial test
UC	- Unconfined compression test
W	- Moisture content
W_{opt}	- Optimum moisture content associated with ASTM D698 or D1557

Descriptions and layers are interpretive; field descriptions may have been modified to reflect lab test results. Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced; they are not warranted to be representative of subsurface conditions at other locations or times.

Project: SLC Public Utilities Waste Water Reclamation Facility
Project Location: Salt Lake City, UT
Project Number: 60572288

Log of Boring BH19-ES-1

Sheet 1 of 5

Date(s) Drilled: **7/12/2019-7/16/2019**	Drill Rig Type: **CME-75**	Logged By: **BB**	Checked By: **BE**
Drilling Contractor: **ConeTec**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 87%**	Total Depth of Borehole: **120 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **4 7/8-inch Drag Bit**	Borehole Backfill: **Soil Cement**	Surface Elevation: **4221.37 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube**	Estimated Groundwater Level at Time of Drilling: **10 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7464303.7 Easting: 1521509.8**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0								FILL: Poorly graded GRAVEL with sand (GP), medium dense to dense, moist to wet, gray brown	
4220										
	5									
4215										Casing driven to 8 feet
	10		1	1 1 7 9 N=8	10	12	25		▽	
4210			2	0 1 2 2 N=3	4	4	21		NATIVE: SILT (ML), soft, wet, very dark gray Silty SAND (SM), very loose, wet, dark gray brown	Weight of hammer for upper 6 inches
			3	0 0 2 2 N=2	3	3	58		Elastic SILT with sand (MH), soft to medium stiff, wet, brown gray to black	Weight of hammer for upper 12 inches LL=51; PI=18; F=77.4%; CORR
	15		4	1 2 2 1 N=4	6	6	0			
4205			5	2 2 1 1 N=3	4	5	38		Silty SAND (SM), loose, wet, tan	NP; F=41.2%
	20								Lean CLAY (CL), soft, wet, dark green gray	
4200		S	6 7	0 1 1 0 N=2	3	3	0 100		...two-inch-thick layer of sandy silt, occasional seams of silt	Shelby tube pushed with 500 psi hydraulic pressure at 20 feet No recovery; followed by split spoon Weight of hammer for upper 6 inches and lower 6 inches LL=34; PI=15
	25		8A	2 3					...two-inch-thick layer of silty sand ...nine-inch-thick layer of silt with sand	Sample 8B (silt): NP; F=76.5%

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Project: SLC Public Utilities Waste Water Reclamation Facility
Project Location: Salt Lake City, UT
Project Number: 60572288

Log of Boring BH19-ES-1

Sheet 2 of 5

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25		8B 8C	2 2 N=5	7	7	88		...medium stiff, dark gray, occasional seams of sandy silt	
4195										
	30		9A 9B	3 2 1 1 N=3	4	4	88		...four-inch-thick layer of silty sand ...soft, occasional 1/2-inch-thick layers of silt	
4190									Fat CLAY (CH), soft, wet, dark gray	
	35	S	10				29			Hydraulic pressure = 500 psi W=57.1%; LL=55; PI=29; γ_d=67.5 pcf; CONS
4185										
	40		11 12	0 5 3 2 N=8	12	11	0 100		...stiff, very dark gray to black ...two-inch-thick layer of silty sand	Weight of hammer for upper 6 inches Shelby tube pushed with 500 psi hydraulic pressure at 40 feet No recovery; followed by split spoon
4180										
	45		13A 13B 13C	13 7 2 1 N=9	13	12	79		...seven-inch-thick layer of silty sand Lean CLAY (CL), stiff, wet, very dark gray to black	Sample 13B (sand): F=21.7%
4175										
	50									
4170										
			14A 14B	3 6 2 3 N=8	12	10	54		...dark gray Sandy SILT (ML), stiff, wet, dark gray	Sample 14B: F=52.6%
	55								Lean CLAY (CL), very soft, wet, very dark gray	

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Project: SLC Public Utilities Waste Water Reclamation Facility
Project Location: Salt Lake City, UT
Project Number: 60572288

Log of Boring BH19-ES-1

Sheet 3 of 5

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	55									Hydraulic pressure = 700 psi LL=35; PI=15
4165		S	15				46			
	60		16A 16B	4 1 0 1 N=1	1	1	79		...three-inch thick layer of silty sand ...occasional partings of silty sand	Weight of hammer for middle 9 inches
4160										
	65		17A 17B	10 16 11 6 N=27	40	31	79		Silty SAND (SM), dense, wet, dark gray ...with gravel Lean CLAY (CL), medium stiff, wet, dark gray	
4155										
	70		18	1 1 3 1 N=4	6	4	67		...medium stiff; occasional one-inch-thick layers of silt	LL=28; PI=9
4150										
	75		19A 19B	12 25 10 6 N=35	52	37	96		...very stiff Silty SAND (SM), dense, wet, very dark gray	
4145									Lean CLAY (CL), stiff, wet, very dark gray	
	80		20	0 3 5 5 N=8	12	8	100		...occasional seams of brown silt in upper 12 inches of sample	Hole cave-in when attempting to sample at 80 feet; redrilled to depth Weight of hammer for upper 6 inches
4140									Silty SAND (SM), medium dense, wet, brown gray	
	85								Lean CLAY (CL), medium stiff, wet, very dark gray	

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Project: SLC Public Utilities Waste Water Reclamation Facility
Project Location: Salt Lake City, UT
Project Number: 60572288

Log of Boring BH19-ES-1

Sheet 4 of 5

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4135	85	S	21				88			Weight of rods pushed tube for 18 inches; hydraulic pressure = 400 psi for last 6 inches W=34.6%; LL=31; PI=12; γ_d=87.6 pcf; CONS
4130	90		22A 22B	0 0 4 14 N=4	6	4	100		...moist to wet; occasional layers up to two inches thick with black coloring	Weight of rods for upper 12 inches
									Silty SAND (SM), medium dense, moist to wet, brown gray	
									SILT with sand (ML), stiff, wet, dark gray	
4125	95		23A 23B	2 3 4 4 N=7	10	7	100		...six-inch-thick layer of lean clay	
									Fat CLAY (CH), medium stiff, wet, dark gray	
4120	100	S	24				88		SILT (ML), medium stiff, wet, dark gray	Weight of rods pushed tube for 12 inches; hydraulic pressure = 600 psi for last 12 inches Clay: W=39.4%; LL=51; PI=30; γ_d=81.7 pcf; CONS
									Lean CLAY (CL), soft, wet, very dark gray	
4115	105		25A 25B	6 1 2 1 N=3	4	3	50		...four-inch-thick layer of dark gray brown silt with sand ...occasional seams of dark gray brown silt with sand	
									SILT (ML), stiff, wet, very dark gray	
4110	110		26A 26B	1 2 6 11 N=8	12	7	100		...five-inch-thick layer of lean clay with black coloring	
									Silty SAND (SM), dense, wet, very dark gray	
	115									

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Project: SLC Public Utilities Waste Water Reclamation Facility
Project Location: Salt Lake City, UT
Project Number: 60572288

Log of Boring BH19-ES-1

Sheet 5 of 5

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	115									
4105			27A 27B	20 23 19 25 N=42	62	37	79		Sandy SILT (ML), hard, wet, very dark gray	
			28	3 4 5 5 N=9	13	8	100		Lean CLAY (CL), stiff, moist to wet, very dark gray; frequent partings and seams of silt	
	120									Bottom of exploration
4100										
4095										
4090										
4085										
4080										

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Project: SLC Public Utilities Waste Water Reclamation Facility Project Location: Salt Lake City, UT Project Number: 60572288	**Log of Boring BH19-ES-2** Sheet 1 of 5

Date(s) Drilled: **7/17/2019-7/19/2019**	Drill Rig Type: **CME-75**	Logged By: **BB**	Checked By: **BE**
Drilling Contractor: **ConeTec**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 87%**	Total Depth of Borehole: **122 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **4 7/8-inch Drag Bit**	Borehole Backfill: **Soil Cement**	Surface Elevation: **4221.02 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube**	Estimated Groundwater Level at Time of Drilling: **9.8 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7464148.6 Easting: 1521612.2**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0								FILL: Silty SAND with gravel (SM), loose to medium dense, moist	
4220										
	5									
4215										
										Casing driven to 8 feet
	10		1	1 3 3 3 N=6	8	9	25		NATIVE: Silty SAND (SM), loose, wet, brown gray, trace gravel ▽	F=33.9%
4210									Lean CLAY (CL), very soft, wet, brown gray mottled with black coloring	
			2A 2B	1 0 1 0 N=1	1	1	79		Elastic SILT with sand (MH), very soft, wet, brown gray mottled with medium brown gray and black coloring	Weight of hammer for second six inches; weight of hammer for last six inches Sample 2B: LL=53; PI=21; F=84.6%
									...tan	
			3A 3B	1 1 0 0 N=1	1	1	100		SILT with sand (ML), very soft, wet, tan	Weight of hammer for last 12 inches Sample 3B: NP; F=70.8%
	15								...trace gravel	
4205			4	0 1 0 0 N=1	1	2	21			Weight of hammer for first six inches; weight of hammer for last 12 inches
									...four-inch-thick layer of sandy silt with gravel	
			5A 5B 5C	2 1 0 0 N=1	1	2	92		...medium brown gray transitioning to dark green gray	Weight of hammer for last 12 inches
									Lean CLAY (CL), very soft, wet, dark green gray	
	20								...soft, dark olive green	
4200		S	6				67			Hydraulic pressure = 500 psi W=37%; LL=36; PI=17; F=98.6%; γ_d=84.1 pcf; CONS; TXUU
									...dark green gray	
									...very soft	
			7A 7B 7C	1 0 1 0 N=1	1	1	100		...three-inch-thick layer of silty sand ...very dark gray	Sample 7C: LL=30; PI=10
	25									

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Project: SLC Public Utilities Waste Water Reclamation Facility
Project Location: Salt Lake City, UT
Project Number: 60572288

Log of Boring BH19-ES-2

Sheet 2 of 5

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25									
4195			8A 8B	1 2 2 0 N=4	6	6	46		...medium stiff, occasional 1/2- to 1 1/2-inch-thick layers of black silty sand	Weight of hammer for last 6 inches
									Silty SAND (SM), loose, wet, black	Sample 8B: F=37.9%
									SILT with sand (ML), medium stiff, wet, dark gray	
	30		9A 9B	0 4 2 1 N=6	9	9	58		...five-inch-thick layer of lean clay	Weight of hammer for first six inches
4190									...one-inch-thick layer of silty sand	
									Fat CLAY (CL), soft, wet, dark gray	
	35	S	10				63			Weight of rods pushed tube for first six inches; hydraulic pressure = 500 psi W=56.3%; LL=56; PI=31; γ_d=66.2 pcf; CONS
4185									Lean CLAY (CL), very soft, wet, black	
	40		11A 11B	0 0 0 0 N=0	0	0	100			Weight of hammer for 24 inches
4180									Fat CLAY (CH), very soft, wet, very dark gray	
									...three-inch-thick layer of silty sand	
	45		12A 12B 12C	1 0 0 1 N=0	0	0	88		Lean CLAY (CL), very soft, wet, very dark gray to black; trace sand, trace gravel	Weight of hammer for middle 12 inches
4175									...one-inch-thick layer of silty sand	
									Fat CLAY (CH), medium stiff, wet, very dark gray	
	50									
4170			13A 13B	3 1 3 7 N=4	6	5	75		...three-inch-thick layer of silty sand ...four-inch-thick layer of sandy lean clay	
									Silty SAND (SM), loose, wet, gray	Sample 13B: F=46.1%
									Lean CLAY (CL), very soft, wet, very dark gray	
	55									

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Project: SLC Public Utilities Waste Water Reclamation Facility
Project Location: Salt Lake City, UT
Project Number: 60572288

Log of Boring BH19-ES-2

Sheet 3 of 5

Elevation feet	Depth, feet	Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	55									
4165		S	14				96			Hydraulic pressure = 300 psi W=41%; LL=39; PI=18; γ_d=79 pcf; CONS
									SILT (ML), very stiff, wet, very dark gray	
				9 12					...five-inch-thick layer of silty sand	
			15A 15B	4 3 N=16	24	19	58		Lean CLAY (CL), very stiff, wet, very dark gray	
	60									
4160										
	65			0 0					...soft ...one-inch-thick layer of clayey sand	Weight of hammer for first 16 inches
4155			16	3 5 N=3	4	3	79		...one-inch-thick layer of silt	
	70			0 5						Weight of rods for first 6 inches
4150			17A 17B	3 3 N=8	12	9	88		...four-inch-thick layer of sandy silt ...stiff	
									Silty SAND (SM), loose, wet, dark gray	
	75			7 3						
4145			18	6 13 N=9	13	10	33		...brown gray	
				10 5					SILT (ML), very stiff, wet, dark brown gray	
			19A 19B	7 6 N=12	18	13	71			
	80									
4140										
									Lean CLAY (CL), soft, wet, very dark gray to black	
	85									

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Project: SLC Public Utilities Waste Water Reclamation Facility
Project Location: Salt Lake City, UT
Project Number: 60572288

Log of Boring BH19-ES-2

Sheet 4 of 5

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4135	85	S	20				79			Weight of rods pushed tube for 24 inches
4130	90		21A 21B	0 7 10 11 N=17	25	17	100		...very stiff, occasional partings of silt	Weight of hammer for first 6 inches
									SILT (ML), very stiff, wet, very dark green gray	
4125	95		22	0 2 4 6 N=6	9	6	0		...stiff	Weight of hammer for first 6 inches; no recovery; 1/8th-inch-thick silt cake in perimeter of bottom inch of sampler
									Fat CLAY (CH), medium stiff, moist to wet, dark gray	
4120	100	S	23				96		SILT with sand (ML), stiff, wet, very dark gray	Hydraulic pressure = 700 psi Clay: W=36.4%; LL=51; PI=31; γ_d=81.8 pcf; CONS
									Lean CLAY (CL), very stiff, moist to wet, dark gray	
4115	105		24A 24B	11 11 7 4 N=18	27	16	100		...six-inch-thick layer of sandy silt	
4110	110		25A 25B	5 2 5 19 N=7	10	6	92		...stiff	LL=32; PI=12; F=90.8%
	115									

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Project: SLC Public Utilities Waste Water Reclamation Facility
Project Location: Salt Lake City, UT
Project Number: 60572288

Log of Boring BH19-ES-2

Sheet 5 of 5

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4105	115		26	8 9 11 25 N=20	30	18	79		...sandy, very stiff	
									Fat CLAY (CH), very soft, moist to wet, very dark gray; occasional partings of silt	
4100	120		27	0 0 0 0 N=0	0	0	100			Weight of rods for first 12 inches; weight of hammer for last 12 inches LL=62; PI=38
										Bottom of exploration
4095										
4090										
4085										
4080										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-01

Date(s) Drilled: **8/9/2021-8/9/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **52 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4217.55 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube**	Estimated Groundwater Level at Time of Drilling: **12 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7460898.61 Easting: 1522358.65**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0									Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
4215										*Soil lithology inferred from nearby CPT (CPT21-OIPS-01) at select depths where sampling interval appeared to not capture lithologic layers
	5		1	4 3 3 3 N=6	6	9	71		NATIVE: Sandy Lean CLAY (CL), medium stiff, wet, green gray; some gravel partings	
			2	3 4 3 3 N=7	8	10	75		Silty CLAY with Sand (CL-ML), medium stiff, wet, green gray	LL=27; PI=6; F=75.0%
4210										
	10									
4205									Lean CLAY (CL), medium stiff, wet, very dark green gray ▽	
	15		3A 3B	1 2 2 0 N=4	5	5	100		...frequent interbedded high dilatancy silt layers 4- to 6-inches thick ...some rootlets	
4200									Fat CLAY (CH), medium stiff, wet, very dark green gray	
	20		4A 4B	1 7 5 5 N=12	16	17	83		...occasional interbedded high dilatancy, silt layers Silty SAND (SM), medium dense, wet, very dark green gray; high dilatancy	NP; F=44.5%
4195			5	3 3 3 4 N=6	8	8	100		...loose, very dark gray, low plasticity; higher plasticity in lower 6 inches of sampler	
	25								Lean CLAY (CL), very soft, wet, very dark gray	

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-01

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25									
4190		SS	6				100		...occasional silt layers; organic odor	W=51.1%; LL=41; PI=18; G=0.0%; S=3.7%; F=96.3%; γ_d=72 pcf; CONS 500 psi=hydraulic pressure
	30		7	0 0 0 0 N=0	0	0	100		...occasional silt seams less than 0.4-inch thick	Weight of hammer for 24 inches
4185										
	35									
4180			8	13 14 3 0 N=17	24	22	50		...no silt, very stiff, with gravel, some rootlets	
	40									
4175			9A 9B	5 2 3 4 N=5	7	6	88		...medium stiff ...no sand; frequent silt layers less than 1-inch thick	
	45									
4170									Fat CLAY with gravel (CH), very stiff, wet, very dark gray	
			10A 10B	8 13 6 3 N=19	27	23	100		...frequent silt seams 1-inch thick; some rootlets SILT (ML), very stiff, wet, very dark gray; high dilatancy	
	50		11	0 0 0 3 N=0	0	0	54		Fat CLAY with gravel (CH), very soft, wet, very dark gray	Weight of hammer for upper 18 inches
4165										Bottom of exploration

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-02

Date(s) Drilled: **8/6/2021-8/6/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **52 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4217.05 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube**	Estimated Groundwater Level at Time of Drilling: **12 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7460883.17 Easting: 1522070.61**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0									Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
4215										
	5		1	2 2 3 4 N=5	5	8	79		NATIVE: Lean CLAY (CL), medium stiff, moist, green gray; some silt layers 1- to 2-inches thick	*Soil lithology inferred from nearby CPT (CPT21-OIPS-02) at select depths where sampling interval appeared to not capture lithologic layers
4210			2	4 4 4 3 N=8	9	11	79		...stiff; frequent silt layers 2- to 4-inches thick; some coarse sand partings	
	10									
4205									SILT with Sand (ML), soft, wet, very dark gray ▽	
	15		3	1 2 0 0 N=2	2	3	100			LL=30; PI=7; F=86.2% Weight of hammer for lower 18 inches
4200										
	20		4A 4B	2 2 3 0 N=5	7	7	100		...medium stiff; high dilatancy Lean CLAY (CL), soft, wet, very dark gray; interbedded silt seams	NP; F=75.8%
4195										
	25									

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-02

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25									
4190			5	0 0 2 2 N=2	3	3	100		...very dark green gray; interbedded silt layes 1- to 2-inches thick	Weight of hammer for upper 18 inches
	30									LL=47; PI=22; F=98.3%
4185			6	0 0 1 1 N=1	1	1	100		...very soft; occasional silt layers 1-inch thick	Weight of hammer for upper 18 inches
	35								...with sand; some rootlets	
4180			7	0 0 0 0 N=0	0	0	29			Weight of hammer for 24 inches
	40								...gravelly, stiff, very dark gray; some interbedded high dilatancy silt layers 3-inches thick	
4175			8	0 1 9 5 N=10	14	13	100			
	45	S	9				100		...no gravel, trace sand, medium stiff; some occasional silt layers less than 1-inch thick	W=36.8%; LL=37; PI=16; G=0.0%; S=3%; F=97.0%; γ_d=84.3 pcf; CONS 300 psi=hydraulic pressure
4170			10	8 5 3 2 N=8	11	10	100		...stiff, some gravel partings; frequent high dilatancy silt layers 2- to 6-inches thick; some rootlets	
	50		11A 11B	1 6 5 4 N=11	16	13	100		...very stiff, no gravel ...with a silty sand layer 3-inches thick ...some silt seams	
4165										Bottom of exploration

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-03

Date(s) Drilled: **8/5/2021-8/5/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **49 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4218.10 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube**	Estimated Groundwater Level at Time of Drilling: **12 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7460824.12 Easting: 1522329.66**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0									Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
4215									NATIVE: SILT (ML), medium stiff, moist, light green gray	*Soil lithology inferred from nearby CPT (CPT21-OIPS-03) at select depths where sampling interval appeared to not capture lithologic layers
	5		1	5 3 3 4 N=6	7	9	75		...some rootlets and oxidation seams	
4210									Lean CLAY (CL), very soft, wet, light green gray	
	10		2	2 1 0 1 N=1	1	1	88		...frequent silt layers 2- to 3-inches thick ; occasional oxidation	
4205									Lean CLAY with Sand (CL), soft, wet, very dark gray	
	15		3	0 2 0 1 N=2	3	3	100		...some peats and rootlets; occasional oxidation	LL=37; PI=17; F=86.6%
4200										
	20		4A 4B	0 3 3 10 N=6	8	8	92		...interbedded silt seams; some oxidation	
4195			5	5 7 7 10 N=14	19	19	88		Silty SAND (SM), loose, wet, black	G=0.0%; S=50.3%; F=49.7%
	25								Lean CLAY (CL), very soft, wet, dark brown gray	

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-03

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25									
4190		SS	6				100		...some silt seams	300 psi=hydraulic pressure
	30		7	0 0 0 0 N=0	0	0	100		...gray; some rootlets and oxidation	Weight of hammer for 24 inches
4185										
	35		8	11 4 2 3 N=6	9	8	100		...stiff, very dark gray; frequent silt layers 1- to 5-inches thick; some gravel	
4180										
	40		9	1 2 9 5 N=11	16	14	100		...very stiff; frequent silt seams	
4175										
	45								Fat CLAY (CH), very stiff, wet, very dark gray	
4170			10A 10B	0 2 11 10 N=13	18	16	100		...some silt seams ...with a silt layer 6-inches thick, black; some gravel	Bottom of exploration
4165										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-04

Date(s) Drilled: **8/9/2021-8/9/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **52 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4219.85 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube**	Estimated Groundwater Level at Time of Drilling: **12 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7460896.91 Easting: 1522235.05**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0									Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
4215	5		1	2 3 5 8 N=8	9	14	58		NATIVE: Lean CLAY with sand and gravel (CL), stiff, moist, gray brown	*Soil lithology inferred from nearby CPT (CPT21-OIPS-04) at select depths where sampling interval appeared to not capture lithologic layers
			2A 2B	1 3 7 6 N=10	11	15	42		...no sand, stiff; frequent silt layers less than 0.5-inch thick ...no gravel, medium stiff, dark brown gray; no gravel; occasional silt layers less than 1-inch thick	
4210	10									
		S	3				96		...soft, wet; some gray brown partings	500 psi=hydraulic pressure
4205	15		4A 4B	0 0 0 0 0 N=0	0	0	100		...very soft; occasional silt seams less than 0.5-inch thick ...very dark green gray; occasional silt layers less than 1-inch thick; some partings of coarse sand	Weight of hammer for 24 inches
									Fat CLAY (CH), very soft, wet, very dark green gray	
4200	20		5	0 0 1 4 N=1	1	1	100		...frequent silt layers 1- to 2-inches thick; some rootlets	Weight of hammer for upper 12 inches
4195	25		6A	9 12					Silty SAND (SM), medium dense, wet, very dark gray; some gravel	NP; G=2.6%; S=79.5%; F=17.9%

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-04

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25		6B	10 7 N=22	30	30	83		SILT (ML), very stiff, wet, very dark gray; high dilatancy	
									Fat CLAY (CH), very soft, wet, very dark gray	
4190	30		7	0 0 0 0 N=0	0	0	100		...frequent interbedded silt seams less than 0.5-inch thick	Weight of hammer for upper 18 inches
4185	35		8A 8B	4 2 1 10 N=3	4	4	100		...soft; occasional silt seams less than 0.5-inch thick	
									Silty SAND (SM), very loose, wet, very dark gray	
									Fat CLAY with gravel (CH), stiff, wet, very dark gray	
4180	40		9	0 4 2 2 N=6	9	8	100			
									Lean CLAY (CL), soft, wet, very dark gray	
4175	45		10A 10B	1 2 0 1 N=2	3	2	100		...frequent sandy silt layers 0.5- to 1-inch thick ; some gravel	
									Fat CLAY (CH), stiff, wet, very dark gray	
4170	50		11A 11B	11 5 2 1 N=7	10	8	100		...frequent high dilatancy silt layers 1- to 2-inches thick	
										Bottom of exploration
4165										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-05

Date(s) Drilled: **8/10/2021-8/10/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **102 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4217.20 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube**	Estimated Groundwater Level at Time of Drilling: **12 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7460822.98 Easting: 1522216.13**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0									Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
4215										
	5		1	2 3 3 3 N=6	6	9	58		NATIVE: Lean CLAY (CL), medium stiff, moist, gray brown; frequent silt seams less than 0.5-inch thick	*Soil lithology inferred from nearby CPT (CPT21-OIPS-05) at select depths where sampling interval appeared to not capture lithologic layers
4210			2	3 4 2 3 N=6	7	9	83		...frequent sandy silt layers less than 1-inch thick; occasional oxidation	
	10									
4205									▽	
	15		3A 3B	1 0 1 3 N=1	1	1	100		...very soft, wet, dark gray; frequent high dilatancy sandy silt layers 0.5- to 1-inch thick ; frequent rootlets	
4200										
	20		4A 4B	4 10 9 9 N=19	26	27	83		...soft Silty SAND (SM), medium dense, wet, very dark gray; high dilatancy	G=0.1%; S=81.9%; F=18.1%
4195			5A 5B	3 8 6 6 N=14	19	19	75		...some rootlets	NP; F=47.7%
	25								Fat CLAY (CH), very soft, wet, very dark gray	

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-05

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25								...interbedded silt seams less than 0.5-inch thick	
			6	0 0 0 0 N=0	0	0	100			Weight of hammer for 24 inches
4190										
	30									
			7	0 0 0 0 N=0	0	0	100		... occasional interbedded silt seams less than 0.2-inch thick	Weight of hammer for 24 inches
4185										
									Lean CLAY (CL), stiff, wet, very dark gray	
	35		8A 8B	4 2 4 6 N=6	9	8	96		...frequent interbedded high dilatancy sandy silt layers 2- to 4-inches thick; some occasional partings of coarse sand	
4180										
									Fat CLAY (CH), stiff, wet, very dark gray	
	40		9A 9B	0 1 5 5 N=6	9	8	100		...occasional interbedded silt seams less than 0.5-inch thick ...frequent interbedded high dilatancy sandy silt layers 2- to 4-inches thick	
4175										
	45									
			10A 10B	1 11 7 7 N=18	26	22	100		...very stiff; some occasional silt seams less than 0.2-inch thick ...with a silt layer 4-inches thick	
4170										
	50								...stiff	
			11A 11B	2 4 3 3 N=7	10	8	100			
4165									Lean CLAY (CL), stiff, wet, very dark gray ...frequent silt layers less than 1-inch thick	
	55									

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-05

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	55									
4160			12A 12B	0 5 10 3 N=15	21	17	100		...very stiff, frequent interbedded silt layers 2- to 4-inches thick	
	60									
4155										
	65	SS	13				63		...trace sand, trace gravel, very soft, wet, very dark gray	W=51.5%; LL=40; PI=21; G=1.2%; S=7.1%; F=91.7%; γ_d=73.8 pcf; CONS 600 psi=hydraulic pressure
4150			14	0 0 1 2 N=1	1	1	100		...no gravel	Weight of hammer for upper 12 inches
	70									
4145										
	75									
									Silty SAND (SM), very dense, wet, very dark gray	
4140			15	20 31 30 37 N=61	86	62	92		...high dilatancy	
	80		16	12 24 25 29 N=49	69	49	92		...dense	
4135									Lean CLAY (CL), very stiff, wet, very dark gray	
	85									

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-05

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	85									
4130										
	90		17A 17B	17 8 7 10 N=15	21	14	100		...frequent high dilatancy silt layers 1- to 2-inches thick	
4125										
	95									
4120										
		S	18				88		...soft; occasional silt layers less than 1-inch thick	600 psi=hydraulic pressure
	100		19	0 0 3 5 N=3	4	3	100		. . .	Weight of hammer for upper 12 inches
4115										Bottom of exploration
4110										
4105										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-06

Date(s) Drilled: **8/6/2021-8/6/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **52 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4216.50 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube, 3-inch Diameter Modified California**	Estimated Groundwater Level at Time of Drilling: **12 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7460828.22 Easting: 1522048.69**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0									Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
4215										
	5		1	3 4 5 6 N=9	10	14	83		NATIVE: SILT (ML), stiff, moist, gray brown; oxidation staining and some partings of sand	*Soil lithology inferred from nearby CPT (CPT21-OIPS-06) at select depths where sampling interval appeared to not capture lithologic layers
4210										
	10		2A 2B	2 6 N=NA	NA	NA	100		Lean CLAY (CL), medium stiff, moist, dark green gray ...frequent silt layers 2- to 3-inches thick; frequent oxidation ...dark olive gray	
4205									▽	
	15		3	1 5 2 1 N=7	8	9	92		...wet, very dark gray; frequent interbedded high dilatancy silt layers 2- to 5-inches thick	
4200									Poorly graded SAND with silt (SP-SM), dense, wet, very dark gray	
	20		4	7 16 15 20 N=31	42	44	75		...high dilatancy	G=2.0%; S=88.7%; F=9.3%
4195										
	25		5	13 20 16 3 N=36	48	49	58		...some gravel Lean CLAY (CL), very soft, wet, very dark green gray;	

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-06

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25								interbedded silt seams	
4190			6	0 0 0 2 N=0	0	0	100			Weight of hammer for upper 18 inches
			7				100		...no silt, medium stiff; organic odor	W=53.3%; LL=48; PI=22; G=0.0%; S=0.3%; F=99.7%; γ_d=70.1 pcf; CONS 300 psi=hydraulic pressure
	30									
4185			8	3 0 10 7 N=10	14	13	71		...stiff; frequent silt layers 1- to 3-inches thick	
	35									
4180			9	0 2 4 4 N=6	9	8	100		...very dark gray; some gravel; occasional interbedded silt seams	
	40									
4175			10	7 2 1 6 N=3	4	4	100		...soft; frequent silt layes 1- to 2-inches thick	
	45									
4170			11	0 8 6 3 N=14	20	17	100		...very stiff; occasional silt lenses; some coarse partings of sand; silt in lower 6 inches of sampler	
	50									
4165			12	4 0 2 4 N=2	3	2	100		...soft; occasional silt layers 1- to 2-inches thick	
										Bottom of exploration

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-07

Date(s) Drilled: **8/11/2021-8/11/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **100 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4216.52 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube**	Estimated Groundwater Level at Time of Drilling: **12 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7460807.9 Easting: 1522092.99**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0									Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
4215									NATIVE: Lean CLAY (CL), medium stiff, moist, green gray	*Soil lithology inferred from nearby CPT (CPT21-OIPS-07) at select depths where sampling interval appeared to not capture lithologic layers
	5		1A 1B	2 2 5 6 N=7	8	11	71		...frequent interbedded silt layers 2- to 4-inches thick	
4210									Fat CLAY (CH), soft, wet, olive green; organic odor	
	10	S	2				100			W=44.7%; LL=50; PI=30; G=0.0%; S=0.6%; F=99.4%; γ_d=76.9 pcf; CONS 500 psi=hydraulic pressure
4205			3A 3B	0 0 0 5 N=0	0	0	100		Lean CLAY with Sand (CL), very soft, dark green gray; frequent interbedded silt layers less than 1-inch thick	Weight of hammer for upper 18 inches LL=27; PI=9; F=72.9%
	15		4	2 8 8 7 N=16	19	21	58		Sandy SILT (ML), very stiff, wet, very dark gray; high dilatancy	NP; F=51.8%
4200			5	2 5 4 11 N=9	12	13	58		Silty SAND (SM), medium dense, wet, very dark gray; high dilatancy	
	20		6	8 14 15 16 N=29	39	40	67		...dense, high dilatancy	G=0.7%; S=85.3%; F=14.0%
4195										
	25									

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-07

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4190	25		7	10 11 11 9 N=22	30	29	58		...medium dense; coarser sand partings	
									Fat CLAY (CH), very soft, wet, very dark gray	
4185	30		8	0 0 0 3 N=0	0	0	100			Weight of hammer for upper 18 inches
4180	35		9	1 0 0 2 N=0	0	0	100		...black; some gravel partings	Weight of hammer for middle 12 inches
4175	40		10A 10B	8 4 3 5 N=7	10	9	88		...stiff; frequent interbedded high dilatancy silt layers 1- to 2-inches thick	
4170	45		11A 11B	4 8 4 6 N=12	17	15	100		...very stiff, very dark gray	
4165	50		12A 12B	5 0 0 5 N=0	0	0	96		...very soft	Weight of hammer for middle 12 inches
	55									

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-07

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4160	55									
4155	60		13	0 0 0 1 N=0	0	0	100		...very dark green gray; occasional silt seams less than 0.4-inch thick ; occasional coarse sand partings	Weight of hammer for upper 18 inches
4150	65		14	0 0 0 5 N=0	0	0	100		...black; very few silt seams less than 0.1-inch thick	Weight of hammer for upper 18 inches
									Lean CLAY (CL), soft, wet, very dark gray	
4145	70		15	2 0 3 8 N=3	4	3	100		...frequent silt layers 1- to 2-inches thick	
									Poorly graded SAND with silt (SP-SM), very dense, wet, very dark gray	
4140	75		16	21 29 31 34 N=60	85	62	92			
									Lean CLAY (CL), stiff, wet, very dark green gray	
4135	80									
	85									

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-07

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4130	85		17	0 3 4 7 N=7	10	7	100		...interbedded silt seams less than 0.2-inch thick	
4125	90		18	8 9 6 9 N=15	21	14	100		...very stiff, very dark gray; high dilatancy silt seamss less than 0.5-inch thick	
4120	95		19				100		...black	W=42.7%; LL=49; PI=26; G=0.0%; S=0.2%; F=99.8%; γ_d=77.1 pcf; CONS 400 psi=hydraulic pressure
			20	0 4 3 7 N=7	10	6	88		. . .	
4115	100									Bottom of exploration
4110										
4105										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-08

Date(s) Drilled: **8/12/2021-8/12/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **102 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4216.09 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube**	Estimated Groundwater Level at Time of Drilling: **12 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7460749.65 Easting: 1522086.89**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4215	0									Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
									NATIVE: SILT (ML), medium stiff, moist, gray brown	*Soil lithology inferred from nearby CPT (CPT21-OIPS-08) at select depths where sampling interval appeared to not capture lithologic layers
4210	5		1	3 3 3 4 N=6	7	9	83			
									Lean CLAY (CL), very soft, wet, green gray	
4205	10		2	0 0 0 1 N=0	0	0	100		...occasional silt seams less than 0.5-inch thick; occasional oxidation and rootlets	Weight of hammer for upper 18 inches
			3	4 3 6 4 N=9	11	12	83		Silty SAND (SM), medium dense, wet, very dark gray; high dilatancy	NP; F=45.9%
4200	15		4	6 11 14 17 N=25	34	37	75		Poorly graded SAND with silt (SP-SM), dense, wet, very dark gray; high dilatancy	G=0.0%; S=88.9%; F=11.0%
4195	20		5	10 15 17 16 N=32	43	45	67		...coarse partings of sand	
									Fat CLAY (CH), very soft, wet, very dark gray	
	25									

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-08

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4190	25		6	0 0 0 1 N=0	0	0	100		...interbedded silt seams less than 0.2-inch thick	Weight of hammer for upper 18 inches
4185	30		7A 7B	3 2 3 8 N=5	7	7	100		...medium stiff; interbedded silt layers less than 1-inch thick	
4180	35		8	1 3 3 2 N=6	9	8	100		...stiff	
4175	40		9	1 5 1 2 N=6	9	8	100		...interbedded high dilatancy silt seams less than 0.5-inch thick	
4170	45		10A 10B	5 7 3 1 N=10	14	12	96		...very stiff; frequent interbedded high dilatancy silt layers 2- to 4-inches thick	
4165	50		11A 11B	3 0 0 2 N=0	0	0	100		...very soft	Weight of hammer for middle 12 inches
	55									

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-08

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	55								Lean CLAY (CL), soft, wet, very dark gray	
4160										
			12	0 0 3 5 N=3	4	3	100		...occasional silt seams less than 0.1-inch thick	CORR Weight of hammer for upper 12 inches
	60									
4155										
	65	S	13				92		. . .	W=44.4%; LL=45; PI=23; G=0.0%; S=0.3%; F=99.7%; γ_d=76.7 pcf; CONS 400 psi=hydraulic pressure
4150			14	0 0 0 2 N=0	0	0	33		...no silt, very soft, black	Weight of hammer for upper 18 inches
	70									
4145									Silty SAND (SM), very dense, wet, very dark gray	
			15	25 29 31 33 N=60	85	62	92		...high dilatancy	G=0.0%; S=85.8%; F=14.2%
4140	75									
									Lean CLAY (CL), soft, wet, very dark green gray	
	80									
4135			16A 16B	2 0 2 5 N=2	3	2	100		...interbedded high dilatancy silt layers 1- to 2-inches thick	
	85									

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-08

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	85									
4130										
			17	9 24 16 12 N=40	57	39	100		SILT (ML), hard, wet, very dark gray; high dilatancy	
	90									
4125										
									Lean CLAY (CL), stiff, wet, very dark gray	
		S					0			400 psi=hydraulic pressure No recovery
	95									
4120		S	18				100			500 psi=hydraulic pressure
			19	0 0 6 14 N=6	9	6	100		...some rootlets	Weight of hammer for upper 12 inches
	100									
4115			20	6 9 12 15 N=21	30	19	100		...very stiff; some occasional silt seams less than 0.2-inch thick	
										Bottom of exploration
4110										
4105										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-09

Date(s) Drilled: **8/7/2021-8/7/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **102 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4215.64 feet**	
Sampling Method(s): **24-inch Standard Split Spoon, 3-inch Diameter Thin-Walled Shelby Tube**	Estimated Groundwater Level at Time of Drilling: **12 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7460768.7 Easting: 1522206.06**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4215	0									Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
			1	4 4 4 2 N=8	9	12	83		NATIVE: Lean CLAY (CL), stiff, moist, green gray; frequent low plasticity silt layers 0.5- to 1-inch thick ; some oxidation	*Soil lithology inferred from nearby CPT (SCPT-06) at select depths where sampling interval appeared to not capture lithologic layers
4210	5									
			2	0 0 0 2 N=0	0	0	100		...very soft; frequent silt seams ...peats and rootlets	Weight of hammer for upper 18 inches
4205	10								▽ Fat CLAY (CH), very soft, wet, very dark green gray	
4200	15		3	0 0 0 0 N=0	0	0	100		...occasional silt seams 0.2- to 0.5-inch thick ; frequent interbedded peats and rootlets	Weight of hammer for 24 inches
									Poorly graded SAND with silt (SP-SM), medium dense, wet, black	
			4	6 10 9 6 N=19	26	27	75		...high dilatancy	G=0.0%; S=88%; F=12.0%
4195	20								Fat CLAY (CH), very soft, wet, very dark green gray	
	25									

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-09

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4190	25		5	0 0 0 1 N=0	0	0	100		...interbedded silt layers less than 1-inch thick	Weight of hammer for upper 18 inches
4185	30		6A 6B	0 3 1 10 N=4	6	5	100		...medium stiff; some occasional oxidation	
									Sandy SILT (ML), medium stiff, wet, dark gray	
									Fat CLAY (CH), very soft, wet, very dark gray	
4180	35			0 0 0 0 N=0	0	0	0			Weight of hammer for 24 inches No recovery
	40		7	0 4 8 5 N=12	17	15	75		...very stiff; interbedded silt seams 0.25- to 0.5-inch thick	
4175										
4170	45		8A 8B 8C	6 8 4 1 N=12	17	15	100		SILT with Sand (ML), very stiff, wet, very dark gray; high dilatancy; some coarse partings of sand	LL=21; PI=2; F=71.0%
									Fat CLAY (CH), stiff, very dark gray, wet; occasional silt layers less than 1-inch thick	
			9A 9B	0 0 9 6 N=9	13	11	100		...frequent high dilatancy silt layers less than 1-inch thick	Weight of hammer for upper 12 inches
4165	50								SILT (ML), stiff, wet, very dark gray	
									Lean CLAY with Sand (CL), very soft, wet, black	
	55									

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-09

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4160	55		10	0 0 0 0 N=0	0	0	100		...occasional silt lenses less than 1-inch thick	LL=37; PI=18; F=82.7% Weight of hammer for 24 inches
4155	60		11	0 0 0 0 N=0	0	0	88		...no silt	Weight of hammer for 24 inches
4150	65		12	0 0 2 8 N=2	3	2	100		...soft, dark green gray; occasional silt layers less than 1-inch thick ...peats and rootlets	Weight of hammer for upper 12 inches
4145	70		13A 13B	1 6 8 10 N=14	20	15	100		...peats and rootlets in upper 1 inch ...very stiff, very dark gray; frequent silt layers 1- to 2-inches thick	
4140	75		14	21 31 37 40 N=68	96	70	100		Silty SAND (SM), very dense, wet, very dark gray ...high dilatancy	NP; G=0.0%; S=72.2%; F=27.8%
4135	80		15A 15B	26 29 32 18 N=61	86	62	96		Poorly graded SAND with silt (SP-SM), very dense, wet, very dark gray; highly dilatancy Lean CLAY (CL), very stiff, wet, very dark green gray; frequent interbedded silt seams less than 0.5-inch thick	
	85									

Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-OIPS-09

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4130	85		16A 16B	1 1 2 7 N=3	4	3	100		...soft; frequent interbedded high dilatancy silt layers 1- to 2-inches thick	
4125	90		17	9 5 8 10 N=13	18	12	100		...very stiff, very dark gray; interbedded silt layers less than 1-inch thick	
4120	95	SS	18				100		...no silt, very dark green gray	W=34.8%; LL=39; PI=18; G=0.0%; S=1.3%; F=98.7%; γ_d=87 pcf; CONS 500 psi=hydraulic pressure
			19	5 6 6 9 N=12	17	11	100		...very dark gray; frequent silt layers 0.5- to 1-inch thick	
4115	100		20	3 2 8 12 N=10	14	9	100		...stiff, very dark green gray	
										Bottom of exploration
4110										
4105										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-01

Date(s) Drilled: **8/5/2021-8/5/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **37 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4215.57 feet**	
Sampling Method(s): **24-inch Standard Split Spoon**	Estimated Groundwater Level at Time of Drilling: **8.5 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7460789.78 Easting: 1521749.41**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4215	0								FILL: Poorly graded SAND with silt and gravel (SP-SM), medium dense, moist, gray brown	Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
									NATIVE: Sandy Lean CLAY (CL), stiff, moist, green gray	
4210	5		1	2 5 4 5 N=9	10	14	100		...interbedded silt layers 1- to 2-inches thick; occasional oxidation staining and rootlets	CORR
									▽ Fat CLAY (CH), very soft, wet, very dark gray	
4205	10		2A 2B	0 0 0 1 N=0	0	0	100		...interbedded low plasticity silt layers 1- to 2-inches thick; oxidation staining and rootlets SILT with Sand (ML), very soft, wet, very dark gray; high dilatancy	Weight of hammer for upper 18 inches LL=30; PI=5; F=78.7%
4200	15		3A 3B	2 7 10 11 N=17	23	25	88		...stiff; with rootlets; organic odor Silty SAND (SM), medium dense, wet, very dark gray	G=0.0%; S=84.4%; F=15.6%
									SILT (ML), very soft, wet, very dark gray	
4195	20		4A 4B	1 0 0 0 N=0	0	0	100		Lean CLAY (CL), very soft, wet, very dark gray; interbedded silt lenses	Weight of hammer for lower 18 inches
									Fat CLAY (CH), very soft, wet, dark green gray	
	25									

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-01

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4190	25		5	0 0 0 0 N=0	0	0	100		...interbedded silt seams	Weight of hammer for 24 inches
4185	30		6	0 2 0 0 N=2	3	3	88		...sandy, soft, black; frequent silt layers 1- to 2-inches thick; organic rootlets	Weight of hammer for lower 12 inches
4180	35		7	0 1 4 1 N=5	7	7	46		...gravelly, no sand, medium stiff; frequent silt layers 2-inches thick	
4175										Bottom of exploration
4170										
4165										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-02

Date(s) Drilled: **8/4/2021-8/4/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **32 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4215.88 feet**	
Sampling Method(s): **24-inch Standard Split Spoon**	Estimated Groundwater Level at Time of Drilling: **8.5 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7461335.36 Easting: 1521770.68**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4215	0								FILL: Poorly graded SAND with silt and gravel (SP-SM), medium dense, moist, gray brown	Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
	5		1	2 2 2 2 N=4	4	6	96		NATIVE: Lean CLAY with Sand (CL), soft, moist, green gray; frequent silt layers 1- to 2-inches thick; occasional gravel traces	*Soil lithology inferred from nearby CPT (CP20-IS-02) at select depths where sampling interval appeared to not capture lithologic layers
4210			2A 2B	0 0 3 6 N=3	3	4	100		...wet; with a silt layer 6-inches thick, ...frequent silt layers 2- to 4-inches thick; oxidation traces	Weight of hammer for upper 12 inches
			3A 3B	0 0 0 0 N=0	0	0	75		...very soft ▽ ...interbedded silt layers 1- to 2-inches thick; oxidation traces	LL=29; PI=14; F=74.4% Weight of hammer for 24 inches
4205	10								Fat CLAY (CH), very soft, wet, very dark gray	
	15		4	0 0 0 0 N=0	0	0	100		...occasional silt layers 2- to 3-inches thick; oxidation traces and some rootlets	Weight of hammer for 24 inches
4200			5	3 2 2 3 N=4	5	6	100		Silty CLAY with Sand (CL-ML), medium stiff, wet, very dark gray ...some rootlets	LL=26; PI=5; F=76.0%
			6	2 3 6 7 N=9	12	13	75		Silty SAND (SM), medium dense, wet, very dark gray	G=0.0%; S=76%; F=24.0%
4195	20		7	1 5 7 9 N=12	16	17	71		...some rootlets	
	25								Lean CLAY (CL), very soft, wet, dark green gray	

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-02

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25								...interbedded silt lenses	
4190			8	0 0 0 0 N=0	0	0	100			Weight of hammer for 24 inches
	30									
4185			9	1 0 5 2 N=5	7	7	100		...medium stiff, frequent silt layers 1- to 2-inches thick	
										Bottom of exploration
4180										
4175										
4170										
4165										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-03

Date(s) Drilled: **8/4/2021-8/4/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **35 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4216.04 feet**	
Sampling Method(s): **24-inch Standard Split Spoon**	Estimated Groundwater Level at Time of Drilling: **6.5 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7461614.83 Easting: 1520678.72**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4215	0								FILL: Poorly graded SAND with silt and gravel (SP-SM), medium dense, moist, gray brown	Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
	5		1	2 2 2 2 N=4	4	6	88		NATIVE: Lean CLAY with Sand (CL), soft, wet, green gray; oxidation traces	*Soil lithology inferred from nearby CPT (CP20-IS-05) at select depths where sampling interval appeared to not capture lithologic layers
4210			2	1 0 0 0 2 N=0	0	0	100		▽ CORR ...very soft	Weight of hammer for middle 12 inches
	10		3	0 0 0 1 N=0	0	0	92		...no sand, very dark green gray	LL=40; PI=19 Weight of hammer for upper 18 inches
4205										
	15		4	1 2 0 0 N=2	3	3	100		...soft, silt layers 1- to 2-inches thick; organic odor	Weight of hammer for lower 12 inches
4200										
									Fat CLAY (CH), very soft, wet, dark green gray	
	20		5	0 0 0 0 N=0	0	0	100		...organic odor	Weight of hammer for 24 inches
4195										
	25									

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-03

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25									
4190			6A 6B	0 0 1 3 N=1	1	1	100		...black; a silt layer 3-inches thick	Weight of hammer for upper 12 inches
									SILT (ML), very soft, wet, black	
			7	0 0 0 1 N=0	0	0	75			Weight of hammer for upper 18 inches
	30								Fat CLAY (CH), soft,wet,black	
4185										
									...occasional partings of fine sand	
			8A 8B	4 1 1 1 N=2	3	3	100		Lean CLAY (CL), soft, wet, dark gray brown; frequent silt layers 1- to 4-inches thick	
	35									Bottom of exploration
4180										
4175										
4170										
4165										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-04

Date(s) Drilled: **8/3/2021-8/3/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **37 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4218.05 feet**	
Sampling Method(s): **24-inch Standard Split Spoon**	Estimated Groundwater Level at Time of Drilling: **7.3 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7462269.83 Easting: 1520518.96**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0								FILL: Poorly graded SAND with silt and gravel (SP-SM), dense, moist, dark gray brown	Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
4215										
	5								NATIVE: Sandy Lean CLAY (CL), medium stiff, wet, brown gray	
			1	0 2 3 3 N=5	6	7	83		...some gravel partings; oxidation staining	LL=33; PI=16; F=68.8%
4210			2	1 1 1 2 N=2	2	3	96		...soft, dark brown gray; oxidation staining	CORR
	10		3	0 0 0 2 N=0	0	0	100		... very soft, gray brown; occasional fine sand partings; oxidation staining	Weight of hammer for upper 18 inches
4205										
	15								Fat CLAY (CH), very soft, wet, dark brown gray	
			4	0 0 0 0 N=0	0	0	100			LL=50; PI=26 Weight of hammer for 24 inches
4200			5A 5B	1 2 2 1 N=4	5	6	100		...medium stiff; with a silt layer 4-inches thick ...no silt	
	20		6	0 0 2 3 N=2	3	3	100		...soft; occasional oxidation	Weight of hammer for upper 12 inches
4195										
	25									

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-04

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25									
			7	0 0 0 0 N=0	0	0	100		...very soft, very dark gray	Weight of hammer for 24 inches
4190										
	30								...soft, black	
			8A 8B	0 0 3 2 N=3	4	4	100		...with a silt layer 4-inches thick, black ...no silt	Weight of hammer for upper 12 inches
4185										
	35								...sandy, dark brown gray	
			9	3 0 2 0 N=2	3	3	100			
										Bottom of exploration
4180										
4175										
4170										
4165										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-05

Date(s) Drilled: **8/2/2021-8/2/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **35 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4215.61 feet**	
Sampling Method(s): **24-inch Standard Split Spoon**	Estimated Groundwater Level at Time of Drilling: **3.3 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7462897.11 Easting: 1520376.88**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4215	0								FILL: Lean CLAY with sand and gravel (CL), medium stiff, moist, dark gray brown	Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
									▽	
									NATIVE: Lean CLAY with sand (CL), soft, wet, light gray	*Soil lithology inferred from nearby CPT (CP21-IS-07) at select depths where sampling interval appeared to not capture lithologic layers
4210	5		1A 1B	0 1 2 N=3	3	4	100		Silty SAND (SM), very loose, wet, light gray	
									Lean CLAY (CL), very soft, wet, dark gray	
4205	10		2	0 0 0 1 N=0	0	0	100		...frequent silt layers 1- to 2-inches thick	LL=38; PI=17; F=93.5% Weight of hammer for upper 18 inches
			3A 3B	0 0 0 0 N=0	0	0	100		...with a silt layer 6-inches thick, light gray; clay seams Fat CLAY (CH), very soft, wet, light gray; silt seams	Weight of hammer for 24 inches
4200	15		4A 4B	0 0 3 0 N=3	4	4	100		Lean CLAY (CL), soft, wet, dark gray; low plasticity silt seams Sandy SILT (ML), soft, wet, dark gray	Weight of hammer for upper 12 inches LL=23; PI=3; F=67.7%
									Lean CLAY, soft, wet, dark gray; frequent silt layers	
									Fat CLAY (CH), soft, wet, light gray	
4195	20		5	0 1 2 4 N=3	4	4	100		...with a low to high dilatancy silt layer 10-inches thick	
	25									

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-05

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4190	25		6	0 0 0 0 N=0	0	0	100		...very soft, dark gray, no silt	Weight of hammer for 24 inches
			7A 7B	0 0 3 1 N=3	4	4	100		...soft	Weight of hammer for upper 12 inches
4185	30								Silty SAND (SM), very loose, wet, dark gray Fat CLAY (CH), soft, wet, light gray	
			8A 8B	4 0 2 0 N=2	3	3	100		...a silt layer 9-inches thick	
4180	35									Bottom of exploration
4175										
4170										
4165										

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-06

Sheet 1 of 2

Date(s) Drilled: **8/3/2021-8/3/2021**	Drill Rig Type: **CME-55**	Logged By: **NA**	Checked By: **SM**
Drilling Contractor: **Inberg-Miller**	Hammer Information: **140-pound Automatic Hammer, 30-inch drop, ETR = 85%**	Total Depth of Borehole: **37 feet**	
Drilling Method: **Mud Rotary** Bit Size/Type: **3 3/4-inch Drag Bit**	Borehole Backfill: **Bentonite Grout**	Surface Elevation: **4216.88 feet**	
Sampling Method(s): **24-inch Standard Split Spoon**	Estimated Groundwater Level at Time of Drilling: **4.3 feet**	Groundwater Level and Date Measured: **Not Measured**	
Location: **Northing: 7463329.74 Easting: 1519643.98**		Survey Datum: **NAD83 (Horizontal), NAVD88 (Vertical)**	

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0								6- inches of ASPHALT pavement	
									FILL: Poorly graded SAND with gravel (SP), medium dense, moist, gray brown	Vaccum extraction utility clearance performed to 4 feet below existing ground surface prior to drilling
4215										*Soil lithology inferred from nearby CPT (CP21-IS-08) at select depths where sampling interval appeared to not capture lithologic layers
	5								NATIVE: Poorly graded SAND with silt (SP-SM), very loose, wet, dark gray	G=1.1%; S=89.9%; F=8.9%
			1A 1B	2 1 0 0 N=1	1	2	63			Weight of hammer for lower 12 inches
4210			2	0 0 0 0 N=0	0	0	100		Lean CLAY with sand (CL), very soft, wet, black ...sandy	Weight of hammer for 24 inches
	10		3	0 0 0 0 N=0	0	0	17			Weight of hammer for 24 inches
4205									Sandy lean CLAY (CL), medium stiff, wet, dark gray	
	15		4	0 3 2 2 N=5	6	7	100		...low plasticity	LL=27; PI=8; F=67.5%
4200			5	2 3 5 4 N=8	11	12	79		Silty SAND (SM), medium stiff, wet, very dark gray	
									Lean CLAY (CL), very soft, wet, dark green gray ...oxidation lenses	
	20		6A 6B	0 1 0 0 N=1	1	1	100		...very dark green gray	Weight of hammer for lower 12 inches
4195										
	25								Fat CLAY (CH), very soft, wet, dark brown gray	

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Project: SLC Public Utilities Waste Water Reclamation Facility-Offsite IPS
Project Location: Salt Lake City, UT
Project Number: 60664196

Log of Boring B21-IS-06

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/6inch	SPT N_{60} blowcount	SPT $(N_1)_{60}$ blowcount	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	25								...occasional oxidation lenses; organic odor	
4190			7	0 0 0 3 N=0	0	0	100			Weight of hammer for upper 18 inches
	30								...stiff	
			8A 8B 8C	6 15 14 10 N=29	41	39	100		Sandy SILT (ML), very stiff, wet, dark gray brown	NP; G=0.0%; S=36.2%; F=63.8%
4185									Lean CLAY (CL), very stiff, wet, dark green brown; silt lenses	
									Fat CLAY (CH), very soft, wet, very dark gray	
	35									
			9	0 0 0 1 N=0	0	0	100		...organic odor	Weight of hammer for upper 18 inches
4180										Bottom of exploration
4175										
4170										
4165										

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

LOG KEY SYMBOLS

BORING SAMPLE LOCATION

TEST-PIT SAMPLE LOCATION

WATER LEVEL (level after completion)

WATER LEVEL (level where first encountered)

CEMENTATION

DESCRIPTION	DESCRIPTION
WEAKELY	CRUMBLES OR BREAKS WITH HANDLING OR SLIGHT FINGER PRESSURE
MODERATELY	CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE
STRONGLY	WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE

OTHER TESTS KEY

C	CONSOLIDATION	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	DS	DIRECT SHEAR
UC	UNCONFINED COMPRESSION	T	TRIAXIAL
S	SOLUBILITY	R	RESISTIVITY
O	ORGANIC CONTENT	RV	R-VALUE
CBR	CALIFORNIA BEARING RATIO	SU	SOLUBLE SULFATES
COMP	MOISTURE/DENSITY RELATIONSHIP	PM	PERMEABILITY
CI	CALIFORNIA IMPACT	-200	% FINER THAN #200
COL	COLLAPSE POTENTIAL	Gs	SPECIFIC GRAVITY
SS	SHRINK SWELL	SL	SWELL LOAD

MODIFIERS

DESCRIPTION	%
TRACE	<5
SOME	5 - 12
WITH	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER, USUALLY SOIL BELOW WATER TABLE

STRATIFICATION

DESCRIPTION	THICKNESS	DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2"	OCCASIONAL	ONE OR LESS PER FOOT OF THICKNESS
LAYER	1/2 - 12"	FREQUENT	MORE THAN ONE PER FOOT OF THICKNESS

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil conditions between individual sample locations.
3. Logs represent general soil conditions observed at the point of exploration on the date indicated.
4. In general, Unified Soil Classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT (blows/ft)	MODIFIED CA. SAMPLER (blows/ft)	CALIFORNIA SAMPLER (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
VERY LOOSE	<4	<4	<5	0 - 15	EASILY PENETRATED WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
LOOSE	4 - 10	5 - 12	5 - 15	15 - 35	DIFFICULT TO PENETRATE WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
MEDIUM DENSE	10 - 30	12 - 35	15 - 40	35 - 65	EASILY PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
DENSE	30 - 50	35 - 60	40 - 70	65 - 85	DIFFICULT TO PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
VERY DENSE	>50	>60	>70	85 - 100	PENETRATED ONLY A FEW INCHES WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNTRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
VERY SOFT	<2	<0.125	<0.25	EASILY PENETRATED SEVERAL INCHES BY THUMB. EXUDES BETWEEN THUMB AND FINGERS WHEN SQUEEZED BY HAND.
SOFT	2 - 4	0.125 - 0.25	0.25 - 0.5	EASILY PENETRATED ONE INCH BY THUMB. MOLDED BY LIGHT FINGER PRESSURE.
MEDIUM STIFF	4 - 8	0.25 - 0.5	0.5 - 1.0	PENETRATED OVER 1/2 INCH BY THUMB WITH MODERATE EFFORT. MOLDED BY STRONG FINGER PRESSURE.
STIFF	8 - 15	0.5 - 1.0	1.0 - 2.0	INDENTED ABOUT 1/2 INCH BY THUMB BUT PENETRATED ONLY WITH GREAT EFFORT.
VERY STIFF	15 - 30	1.0 - 2.0	2.0 - 4.0	READILY INDENTED BY THUMBNAIL.
HARD	>30	>2.0	>4.0	INDENTED WITH DIFFICULTY BY THUMBNAIL.

IGES

Key to Soil Symbols and Terminology

Figure A-9

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DATE
STARTED: 4/10/19
COMPLETED: 4/10/19
BACKFILLED: 4/11/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-1

LOCATION
NORTHING 7,464,056.81 EASTING 1,521,570.29 ELEVATION 4,221.4

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4220	0														
	5					Casing driven to ± 13 feet below existing ground surface (b.e.g.s.). Vacuum extraction utility clearance performed to ± 9 feet b.e.g.s. prior to drilling. Cobbles (apparent fill) up to 8.5 inches in diameter extracted from hole.									
4215															
	10														
4210															
	15					NO RECOVERY	1 1 2								
4205						CLAY - medium stiff, wet, light brown									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

Copyright (c) 2020, IGES, INC.

SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-10a

DATE
STARTED: 4/10/19
COMPLETED: 4/10/19
BACKFILLED: 4/11/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-1

LOCATION
NORTHING 7,464,056.81 EASTING 1,521,570.29 ELEVATION 4,221.4

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4200	20				CL	- trace fine sand	WH 2 1	4	●						
4195	25				CL		2 3 2	4	●						
4190	30				CL	CLAY with sand - medium stiff, wet, dark gray - fine sand seams up to 1 inch thick	2 2 1	4	●						
4185	35					NO RECOVERY	1 2 2								
						CLAY - very soft, wet, gray, dark gray									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
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NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-10b

DATE
STARTED: 4/10/19
COMPLETED: 4/10/19
BACKFILLED: 4/11/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-1
Sheet 3 of 4

LOCATION
NORTHING 7,464,056.81 EASTING 1,521,570.29 ELEVATION 4,221.4

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4180	40				CL	- occasional fine sand laminae, mica	WH/1.5'	0	●						
	45					NO RECOVERY	10								
4175							15								
							20								
							15								
					CL	CLAY to Sandy CLAY - stiff, moist, gray - increasing coarse fraction with depth, fine sand	2								
							3	5	●						
							5								
							6								
					ML	Interlayered SILT and CLAY - medium stiff, moist (ML) to wet (CL), gray	3								
					CL		4								
	50						4	5	●						
							13								
4170					ML	Interlayered Silty SAND and SILT - stiff / loose, moist, brown, gray - 1/2 inch layers of fine to medium sand	1								
					SM		3								
							4	7	●						
							7								
						TOP/BOTTOM: Gray CLAY									
	55					CLAY - very soft, wet, gray	2								
							6								
4165					ML	Sandy SILT - very stiff, moist, gray - fine sand	10	17	●						
							16								
					CL	CLAY - hard (very soft visually), wet, gray	12								
							24	24	●						
							22								
							10								
						- interlayered very stiff sandy silt seams, 0.5-1.5 inches	3								
							4		●						

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

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SAMPLE TYPE
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- 3" O.D. THIN-WALLED SHELBY TUBE
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- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-10c

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

DATE
STARTED: 4/10/19
COMPLETED: 4/10/19
BACKFILLED: 4/11/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-1
Sheet 4 of 4

LOCATION
NORTHING 7,464,056.81 EASTING 1,521,570.29 ELEVATION 4,221.4

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4160	60					NO RECOVERY	5 4	9							
							WR 5 7 7								
					ML	Sandy SILT - very stiff, wet, gray	7 12	19							
					GP	grading to Poorly-Graded GRAVEL - medium dense, wet, gray	7 6								
	65				CL	CLAY - medium stiff, wet, gray	5 2 5 12	4							
4155					CL-ML	SILTY CLAY - soft, wet, gray	WH/1' 2 4	2							
					CL	CLAY - medium stiff, wet, gray	5 3 6	5							
	70					-Groundwater not observed due to mud rotary drilling -Monitoring well installed following sampling. Screened ~ 59 - 69 feet Bottom of Boring @ 70.5 Feet									
4150															
	75														
4145															

N - OBSERVED UNCORRECTED BLOW COUNT
N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-10d

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

DATE
STARTED: 4/11/19
COMPLETED: 4/11/19
BACKFILLED: 4/12/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-5

LOCATION
NORTHING 7,462,007.48 EASTING 1,522,047.10 ELEVATION 4,215.6

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4215	0					Casing driven to ± 8 feet below existing ground surface (b.e.g.s.). Vacuum extraction utility clearance performed to ± 7.5 feet b.e.g.s. prior to drilling.									
4210	5														
4205	10				CL	CLAY - medium stiff, wet, light gray - fine sand laminae, decomposed organics, iron-oxide staining	1 3 2	3	●						
4200	15				CL	- soft	1 1 1	3	●						
						Driller noted increase in drilling resistance, possible gravel lense.									
					SP-	Poorly-Graded SAND with silt -									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-11a

DATE
STARTED: 4/11/19
COMPLETED: 4/11/19
BACKFILLED: 4/12/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-5
Sheet 2 of 4

LOCATION
NORTHING 7,462,007.48 EASTING 1,522,047.10 ELEVATION 4,215.6

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4195	20				SM	medium dense, wet, gray - fine sand, mica, low plasticity fines	10 16 18	19							
4190	25				CL	CLAY - very soft, wet, light gray - occasional fine sand seam, organic odor	WH/1.5'	0							
4185	30				CL	- soft	WH/1' 3	2							
					CL	CLAY - medium stiff, wet, dark gray, gray streaks	4 5 2 18	5							
4180	35				SM CL	Silty SAND in shoe - stiff	WH 4 2 2	8							
						NO RECOVERY	WH 2 6 9								
						CLAY - very stiff, wet, gray - single 1									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-11b

DATE
STARTED: 4/11/19
COMPLETED: 4/11/19
BACKFILLED: 4/12/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-5
Sheet 3 of 4

LOCATION
NORTHING 7,462,007.48 EASTING 1,522,047.10 ELEVATION 4,215.6

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4175	40				CL	inch piece of gravel	WH 6 5 6	14							
					SP	Poorly-Graded SAND - medium sand									
					CL	CLAY - soft, wet, gray - occasional subangular gravel in matrix	WH/1' 4 8	3							
					CL	CLAY with sand - medium stiff, wet, gray - fine sand, occasional subangular fine gravel	1 2 3 2	6							
4170	45				GC	TOP: Clayey GRAVEL - medium dense, wet, gray									
					CL	BOTTOM: CLAY - soft, wet, gray									
					ML	Interlayered very soft CLAY and stiff Sandy SILT - wet	3 5 3 7	9							
					CL										
					ML										
4165	50				CL	CLAY - medium stiff, wet, gray - occasional sandy silt lenses	3 3 3 3	4							
					CL		WH 3 2 5	5							
					ML	Sandy SILT lense									
					CL	CLAY - stiff , wet, gray	5 10 11 6	11							
4160	55					Clayey SAND lense									
					ML	Sandy SILT - very stiff, moist, gray - fine sand	2 6 6 6	13							
					ML	SILT - soft to medium stiff with depth, wet, gray	WH/1' 2 1	2							

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-11c

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

DATE
STARTED: 4/11/19
COMPLETED: 4/11/19
BACKFILLED: 4/12/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-5
Sheet 4 of 4

LOCATION
NORTHING 7,462,007.48 EASTING 1,522,047.10 ELEVATION 4,215.6

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4155	60					-Groundwater not observed due to mud rotary drilling -Exploration backfilled with cement grout and bentonite chips at surface Bottom of Boring @ 60 Feet									
4150	65														
4145	70														
4140	75														

N - OBSERVED UNCORRECTED BLOW COUNT
N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-11d

DATE
STARTED: 4/12/19
COMPLETED: 4/12/19
BACKFILLED: 4/15/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-6
Sheet 1 of 4

LOCATION
NORTHING 7,461,227.29 EASTING 1,522,347.21 ELEVATION 4,217.8

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4215	0					Casing driven to ± 9 feet below existing ground surface (b.e.g.s.). Vacuum extraction utility clearance performed to ± 7.5 feet b.e.g.s. prior to drilling.									
4210	5														
	10				CL	CLAY - medium stiff, wet, light gray, brown - trace fine sand, trace fine gravel	2 2 3	5	●						
4205	15				ML	Interlayered CLAY and Sandy SILT - medium stiff, wet, light gray - fine sand, mica, decomposed organics at ± 16.3 feet	1 1 3	5	●		43	64	30	6	H ●
					CL										
					ML										
4200						Lean CLAY - very soft, wet, gray -									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-12a

DATE
STARTED: 4/12/19
COMPLETED: 4/12/19
BACKFILLED: 4/15/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-6

LOCATION
NORTHING 7,461,227.29 EASTING 1,522,347.21 ELEVATION 4,217.8

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4195	20				CL	trace fine sand, mica	WH/1.5'	0			49	93	36	16	
	25				CL	Trace Recovery - medium stiff	2 2 2	5							
4190	30				CL	CLAY - very soft, wet, gray - fine sand laminae, organic odor	WH/1' 1	1							
4185	35				CL	CLAY with sand - stiff, wet, gray, dark gray - fine to medium sand lenses, faint organic odor	2 6 5 10	8							
4180					CL	Sandy CLAY - very soft, wet, gray	WH/2'	0							
					SC										

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-12b

DATE
STARTED: 4/12/19
COMPLETED: 4/12/19
BACKFILLED: 4/15/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-6
Sheet 3 of 4

LOCATION
NORTHING 7,461,227.29 EASTING 1,522,347.21 ELEVATION 4,217.8

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4175	40				CL	CLAY - very soft, wet, gray, dark gray	WH/1' 2 2	1							
					CL		WH/1' 1 2	1							
						Driller indicated possible gravel layer from drill response									
	45					NO RECOVERY	1 3 7 5	6							
					CL	CLAY - stiff, wet, gray - occasional fine sand laminae	3 4 3 4	8							
4170						TOP/BOTTOM: CLAY - soft, wet, gray									
	50				ML	Sandy SILT - medium stiff, wet, gray	2 1 4 6	5							
					CL	CLAY - stiff, wet, gray	2 8 13 5	11							
4165						- with sandy silt layers									
					ML		2 3 5 6	8							
	55				CL										
					ML										
						Sandy CLAY to CLAY - stiff, wet, gray to dark gray - fine to medium sand, mica									
4160					CL		4 4 12 8	9							
						-Groundwater not observed due to mud rotary drilling -Exploration not advanced to 58 feet due to casing seal blow out and leaking drilling fluids -Monitoring well installed following									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-12c

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

DATE
STARTED: 4/12/19
COMPLETED: 4/12/19
BACKFILLED: 4/15/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-IT-6
Sheet 4 of 4

LOCATION
NORTHING 7,461,227.29 EASTING 1,522,347.21 ELEVATION 4,217.8

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4155	60					sampling. Screened ~ 54.7 - 44.7 feet									
						Bottom of Boring @ 58 Feet									
4150	65														
	70														
4145	75														
4140															

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-12d

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

DATE
STARTED: 10/3/19
COMPLETED: 10/4/19
BACKFILLED: 10/4/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-0
Sheet 1 of 3

LOCATION
NORTHING 7,463,951.03 EASTING 1,519,641.44 ELEVATION 4,219.0

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4215	0					Casing driven to ± 8.5 feet below existing ground surface (b.e.g.s.). Upon initial drillout, bit became wedged necessitating casing removal and reinstallation. Vacuum extraction utility clearance performed to ± 7.5 feet b.e.g.s. prior to drilling. PID monitoring performed on each sample and was observed to be 0.0 ppm unless otherwise noted										
	5														
4210						BAD SAMPLE - Poorly graded sand from utility clearance procedure and reinstallation of casing	WH/1' 2 1	3							
	10				ML	Sandy SILT - very soft, wet, light brown - fine sand, occasional subrounded fine gravel									
4205					CL	Lean CLAY with sand - very soft, wet, black to gray to light brown - fine sand, organics at layer interface	WH/1' 1 1	1							
	15					Casing extended to 13.5 feet below ground surface due to circulation issues NO RECOVERY	WH/1.5'	0							
					CL	Lean CLAY with sand - soft, wet, gray				94	30	83	30	9	
4200					SP-SM	Poorly Graded SAND with silt - loose, wet, no staining - does not appear to be utility clearance sand									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-2a

DATE
STARTED: 10/3/19
COMPLETED: 10/4/19
BACKFILLED: 10/4/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-0

LOCATION
NORTHING 7,463,951.03 EASTING 1,519,641.44 ELEVATION 4,219.0

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
	20				ML	Vane Shear Test at 20.67 feet (60x120 double tapered) Split spoon driven 19-21 feet following testing (blows:1,1,3,2) Sandy SILT - medium stiff, moist, gray - 1 inch in tip					21	9			
					CL	Lean CLAY - very soft, wet, light gray	1 1				45	94	47	27	
4195					ML	SILT with sand - very stiff, moist, gray - nonplastic fines, fine sand, occasional decomposed wood	7 7	11			26	74	NP	NP	
	25				CL	Lean CLAY - medium stiff, wet, gray - interlayered silt and clay, organics throughout	WH 1 2	4			38	98	36	15	
						NO RECOVERY in Shelby tube or split spoon - drill to 29 for VST									
4190					CH	Vane Shear Test at 30.75 feet (60x120 double tapered) Split spoon driven 29-31 feet following testing (blows:WH,1,1,1) Fat CLAY - very soft, wet, light gray - silt and fine sand laminae throughout, occasional nonfibrous organics					46	98	51	28	
	30				ML	Sandy SILT - very stiff, moist, gray - fine sand	4 10 11	27			31	64			
4185	35				CH	Fat CLAY - soft, wet, light gray				62	65	100	60	32	
					CH	Fat CLAY - very soft, wet, interbedded light gray, gray, black - organic odor, at liquid limit	WH/1.5' 1	0							
4180						Fat CLAY - very soft, wet,									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-2b

DATE
STARTED: 10/3/19
COMPLETED: 10/4/19
BACKFILLED: 10/4/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-0
Sheet 3 of 3

LOCATION
NORTHING 7,463,951.03 EASTING 1,519,641.44 ELEVATION 4,219.0

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4175	40				CH	interbedded light gray, gray, black - organic odor, at liquid limit	WH 1 1 2	2							
	45				CL	Lean CLAY - very soft, wet, gray, black	WR/1' WH/1'	0							
4170	50				CL	Lean CLAY - very soft, wet, gray, black	WR/1.5' WH	0							
4165	55					-Groundwater not observed due to mud rotary drilling -Exploration backfilled with cement grout and bentonite chips at surface. Patched with portland cement Bottom of Boring @ 52 Feet									
4160															

N - OBSERVED UNCORRECTED BLOW COUNT
N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-2c

DATE
STARTED: 8/22/19
COMPLETED: 8/22/19
BACKFILLED: 8/22/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-1

LOCATION
NORTHING 7,463,380.90 EASTING 1,519,640.34 ELEVATION 4,216.8

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4215	0					Casing driven to ± 8 feet below existing ground surface (b.e.g.s.). Vacuum extraction utility clearance performed to ± 7.5 feet b.e.g.s. prior to drilling. PID monitoring performed on each sample and was observed to be 0.0 ppm unless otherwise noted									
4210	5														
4205	10				CL	Lean CLAY with sand - very soft, wet, wet, gray to black - fine to coarse sand, shells up to 1/8 inch	WH/1' 1/1'	0	●						
4200	15				CL	Interlayered Lean CLAY - soft, wet, blue-gray and Clayey SAND - loose, wet, gray - fine sand	1								
					SC		1								
					CL		2	3	●						
					SC		5								
					CL	Sandy Lean CLAY - soft, wet, gray - fine sand									
					CL	Lean CLAY - soft, wet, light gray - occasional fine sand lenses	1 2 1 1	4	●						
						TRACE RECOVERY - Apparent									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-3a

DATE
STARTED: 8/22/19
COMPLETED: 8/22/19
BACKFILLED: 8/22/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-1

LOCATION
NORTHING 7,463,380.90 EASTING 1,519,640.34 ELEVATION 4,216.8

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit (10 20 30 40 50 60 70 80 90)
4195	20				CL	slough - Lean CLAY - very soft, wet, gray	2	2							
							1								
							1								
					CL										
										80	41	87	33	14	
					CL	Lean CLAY - soft, wet, gray - occasional silt and sand lamina									
	25					Vane Shear Test at 25 feet (50x100 double tapered) Split spoon driven 24-26 feet following testing (blows:WH/2') Lean CLAY - very soft, wet, gray - occasional silt lenses, organics (peat) in shoe					52	97	45	24	
4190					CL	Lean CLAY - very soft, wet, gray - occasional silt and fine sand laminae	2								
							1	2			41	99	36	16	
					CL	Lean CLAY - very soft, wet, gray - occasional silt and fine sand laminae	1								
							1								
	30						2	6							
							3								
					ML	SILT - medium stiff, moist, gray - fine sand	10				27	90			
					CL-ML	Silty CLAY - soft, wet, gray									
4185					SM	Silty SAND lens				93	31	93	26	4	
					ML	SILT with sand - medium stiff, wet, gray									
					CL	Vane Shear Test at 34 feet (50x100 double tapered) Split spoon driven 33-35 feet following testing (blows:WH,1/1.5') Lean CLAY - very soft, wet, black - organic odor					47	95	43	23	
	35														
					CH	Fat CLAY - very soft, wet, black - organic odor	WR/2'	0			70	99	59	33	
4180					CH	Fat CLAY - very soft, wet, gray									
							WR/2'	0							

N - OBSERVED UNCORRECTED BLOW COUNT
N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-3b

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

DATE
STARTED: 8/22/19
COMPLETED: 8/22/19
BACKFILLED: 8/22/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-1
Sheet 3 of 3

LOCATION
NORTHING 7,463,380.90 EASTING 1,519,640.34 ELEVATION 4,216.8

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4175	40				CH	Fat CLAY - very soft, wet, gray	WR/1'								
							1	1	●						
					SP	Poorly Graded SAND - very loose, wet, gray - fine sand, mica	1								
					CL	CLAY - very soft, wet, black - organic odor									
					SP	Poorly Graded SAND - very loose, wet, gray - fine sand, brown at 43 feet	1								
					CL	CLAY - very soft, wet, gray, dark gray	1	3	●						
							2								
							1								
	45				CL	CLAY - very soft, wet, black-gray to gray, occasional 1/4 inch thick fine sand seam									
4170							WR/2'	0	●						
	50				CL	CLAY - very soft, wet, gray									
4165							WR/2'	0	●						
						-Groundwater not observed due to mud rotary drilling -Exploration backfilled with cement grout and bentonite chips at surface -PZ19-ITW-1 installed adjacent to borehole. Screened ~ 19 - 29 feet									
	55					Bottom of Boring @ 52 Feet									
4160															

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-3c

DATE
STARTED: 4/25/19
COMPLETED: 4/26/19
BACKFILLED: 4/26/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BF
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 3.875" Drag Bit Mud Rotary

BORING NO:
BH19-ITW-2
Sheet 1 of 3

LOCATION
NORTHING 7,463,095.17 EASTING 1,520,168.62 ELEVATION 4,217.0

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4215	0					Casing driven to ± 8 feet below existing ground surface (b.e.g.s.). Vacuum extraction utility clearance performed to ± 7.5 feet b.e.g.s. prior to drilling.									
4210	5														
4205	10				CL	NO RECOVERY Lean CLAY - very soft, wet, gray - sand seam at top of sample	WH/1' 1 1	1			41	91	32	14	
4200	15				CL	TOP / BOTTOM: Lean CLAY - soft, wet, gray					54	96	42	20	
					CL	Lean CLAY - very soft, wet, gray - interminant sand lenses less than 1 inch in thick	1 1/1' 1	1			48	96	37	15	

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-4a

DATE
STARTED: 4/25/19
COMPLETED: 4/26/19
BACKFILLED: 4/26/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BF
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 3.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-2
Sheet 2 of 3

LOCATION
NORTHING 7,463,095.17 EASTING 1,520,168.62 ELEVATION 4,217.0

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4195	20					NO RECOVERY									
					CL	Lean CLAY - soft, wet, gray	1 1 1 1	2	●		43	96	28	8	
	25				CH	Fat CLAY - very soft, wet, gray	WH/2'	0	●		72	99	54	29	
4190					CL	Lean CLAY - soft, wet, gray	WH 1 1 1	2	●						
	30				CL	Lean CLAY with sand - medium stiff, wet, gray to blackish gray - 3 inch fine sand seam at ± 31 feet, fine sand seam at tip	1 2 1 1	4	●						
4185					CL	Lean CLAY - medium stiff, wet, gray	WH/1' 4 2	5	●						
	35				CL	Lean CLAY - soft, wet, gray - interminant silty fine sand seams 1 to 2 inches in thickness	1 1 1 1	2	●						
4180					CL	Lean CLAY with sand - very stiff, wet, gray	2 8 5 4	17	●						
					SM	Silty sand layer - medium dense									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-4b

DATE
STARTED: 4/25/19
COMPLETED: 4/26/19
BACKFILLED: 4/26/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BF
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 3.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-2
Sheet 3 of 3

LOCATION
NORTHING 7,463,095.17 EASTING 1,520,168.62 ELEVATION 4,217.0

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4175	40					NO RECOVERY									
					CL	Sandy Lean CLAY - medium stiff, wet, gray	WH 2 1 1	3							
	45				CL	Lean CLAY with sand - stiff, wet, gray - fine sand seams throughout sample	3 4 6 5	12							
4170					CL	Lean CLAY with sand - very stiff, wet, gray - fine to medium sand	5 7 4 2	12							
	50				CL	TOP / BOTTOM : Lean CLAY - soft, wet, gray									
4165						-Groundwater not observed due to mud rotary drilling -Exploration backfilled with cement grout and bentonite chips at surface									
						Bottom of Boring @ 52 Feet									
4160	55														

N - OBSERVED UNCORRECTED BLOW COUNT
N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
- MEASURED - ESTIMATED

Figure A-4c

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

DATE
STARTED: 8/1/19
COMPLETED: 8/2/19
BACKFILLED: 8/2/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 3.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-3N
Sheet 1 of 3

LOCATION
NORTHING 7,462,719.25 EASTING 1,520,339.76 ELEVATION 4,218.0

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4215	0					Casing driven to ± 8.5 feet below existing ground surface (b.e.g.s.). Vacuum extraction utility clearance performed to ± 7.5 feet b.e.g.s. prior to drilling.									
4210	5														
	10				CL	Lean CLAY with sand - medium stiff, wet, light gray - fine sand	1 1 2 1	4	●						
4205					CL	Lean CLAY - very soft, wet, gray, dark gray - slight organic odor, frequent fine sand laminae	WH/2'	0	●						
	15				CL	Lean CLAY - very soft, wet, gray, dark gray - slight organic odor, slightly below liquid limit, highly plastic	WH/1.5' 1	0	●						
					ML	± 3 inch SILT seam - organic odor									
4200					SM	Silty SAND - very loose, wet, gray - fine to medium sand, organic odor	2 1 1	3	●						
					CL	Lean CLAY - soft, wet, gray Vane Shear Test tip at 20.5 feet (60mmx120mm double tapered); Split Spoon driven 19-21 feet following testing (blows:WH/2'); Lean CLAY - very soft, wet, gray -									
					CL										

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-5a

DATE
STARTED: 8/1/19
COMPLETED: 8/2/19
BACKFILLED: 8/2/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 3.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-3N

LOCATION
NORTHING 7,462,719.25 EASTING 1,520,339.76 ELEVATION 4,218.0

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
	20					occasional 1/8 inch clayey sand seams, slight organic odor					49	97	43	20	
4195					SP-SM	Poorly Graded SAND with silt - loose, moist, gray - fine grading to medium sand, occasional organics (± 1/16 inch wood)	4								
					CL	CLAY - medium stiff, wet, gray	2	4							
					SP	± 1 inch Poorly Graded SAND with silt seam	1								
	25				CH	Fat CLAY - very soft, wet, gray	1								
					CH	Vane Shear Test tip at 28 feet (60mmx120mm double tapered); Split Spoon driven 27-29 feet following testing (blows:WH/2'); Fat CLAY - very soft, wet, gray, black - highly plastic				61	65	100	54	30	
4190											61	99	54	29	
	30				CH	Fat CLAY - soft, wet, gray									
										66	59	99	51	29	
					SM	Silty SAND - very loose, wet, gray - fine sand, low plasticity fines									
4185					CL	Lean CLAY - very soft, wet, gray	2	1			26	40			
					SP	Fine sand laminae at ± 33.6 feet	1/1'								
					CL		1								
	35				SM	TRACE RECOVERY - Silty SAND - loose, moist, gray - fine sand	2	3							
							1								
							2								
4180					CL	Lean CLAY - very soft, wet, gray - occasional 1/8 inch fine sand seams, at or above liquid limit	1								
							WH/2'	0			44	98	37	17	

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-5b

DATE
STARTED: 8/1/19
COMPLETED: 8/2/19
BACKFILLED: 8/2/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 3.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-3N
Sheet 3 of 3

LOCATION
NORTHING 7,462,719.25 EASTING 1,520,339.76 ELEVATION 4,218.0

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4175	40				CL	Lean CLAY - stiff, wet, gray	8								
					ML	Sandy SILT - stiff, moist, gray - fine sand, slightly micaceous	5 3 3	10			18	55	NP	NP	
					CL	Lean CLAY - stiff, wet, gray									
	45				ML	Sandy SILT - stiff, moist, gray	3 9								
4170					SP	Poorly Graded SAND - medium dense, moist, gray - fine sand	5 7	16							
	50				CL	Lean CLAY - medium stiff, wet, gray									
					SP	± 1 inch fine sand seam	1								
					CL		2 1	3							
					SP	± 1.5 inch fine sand seam	1								
4165					CL										
	55					-Groundwater not observed due to mud rotary drilling -Exploration backfilled with cement grout and bentonite chips at surface -PZ19-ITW-3N installed adjacent to borehole. Screened ~ 18.9 - 28.9 feet -During installation of PZ19-ITW-3N upon removal of the rods and drill bit ConeTec observed that a possible gas pocket had been penetrated as indicated by an organic odor (max PID reading of 0.4ppm, typical 0.0 - 0.1 ppm) and gurgling sound. The rig was shut down to allow for gas to dissipate. The gas pocket indications continued when removing the 30, 25 and 20 foot augers of the drill string and appeared to subside once additional well sand was placed. Bottom of Boring @ 52 Feet									
4160															

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-5c

DATE
STARTED: 8/19/19
COMPLETED: 8/19/19
BACKFILLED: 8/19/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO:
BH19-ITW-3S
Sheet 1 of 3

LOCATION
NORTHING 7,462,074.71 EASTING 1,520,652.21 ELEVATION 4,214.8

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4210	0					Casing driven to ± 3 feet below existing ground surface. PID monitoring performed on each sample and was observed to be 0.0 ppm unless otherwise noted									
	5				CL	Lean CLAY with sand - very soft, wet, light gray - fine sand, oxidation staining	1 1 1 1	3							
					CL	Lean CLAY - very soft, wet, gray, light gray - occasional 1/4 inch fine sand lenses	1 1 1 1	3							
4205	10				CL	Lean CLAY - very soft, wet, gray - occasional fine sand lamina	WH/2'	0							
					CL	Lean CLAY - very soft, wet, gray to brown at ± 13.5 feet- with medium sand at ± 13.5 feet	WH/1.5'	0							
4200	15				CL	Lean CLAY - soft, wet, gray - occasional silt and sand lamina									
					CL	Vane Shear Test at 18 feet (50x100 double tapered) Split spoon driven 17-19 feet following testing (blows:WH/1.5',6) Lean CLAY - very soft, wet, gray - decreasing plasticity with depth, occasional silt and fine sand seams				91	33	96	30	9	
					ML	SILT - stiff, wet, gray - fine sand					30	86	NP	NP	
4195															

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-6a

DATE
STARTED: 8/19/19
COMPLETED: 8/19/19
BACKFILLED: 8/19/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-3S

LOCATION
NORTHING 7,462,074.71 EASTING 1,520,652.21 ELEVATION 4,214.8

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4190	20				CH	Fat CLAY- very soft, wet, gray	WH/2'	0			61	99	51	26	
					CH	Fat CLAY - soft, wet, gray				65	62	100	52	28	
	25				CH	Vane Shear Test at 26 feet (50x100 double tapered) Split spoon driven 25-27 feet following testing (blows:WH/1',1,1) Fat CLAY - very soft, wet, gray					63	96	53	28	
					CH	Fat CLAY - soft, wet, black, dark gray - heavy organic odor					63	94	54	30	
					CH	Fat CLAY - soft, wet, black, dark gray - heavy organic odor									
					SP	Poorly Graded SAND - loose, wet, gray - fine sand	1								
					CL	Lean CLAY - soft, wet, light gray - at liquid limit, faint organic odor	3 1 1	5							
4185	30				CL	Lean CLAY - soft, wet, gray increasing moisture with depth									
							WH/1' 3 2	3							
					ML	SILT - medium stiff, moist, gray									
					CL	Lean CLAY - very soft, wet, gray - occasional silty sand seams									
							WH/2'	0			40	95	35	16	
4180	35				CL	Lean CLAY - very soft, wet, gray - occasional silt lamina									
							WH/1.5' 1	0							
					ML	Sandy SILT - medium stiff, moist, gray - fine sand	7 3								
					CL	CLAY - medium stiff, wet, gray - at liquid limit	2 2	5			21	62	18	2	
4175															

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-6b

DATE
STARTED: 8/19/19
COMPLETED: 8/19/19
BACKFILLED: 8/19/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-3S
Sheet 3 of 3

LOCATION
NORTHING 7,462,074.71 EASTING 1,520,652.21 ELEVATION 4,214.8

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4170	40				CL	CLAY - medium stiff, wet, gray	WH 2 3 6	5							
					SM	Silty SAND - medium dense, moist, gray - fine sand, low plasticity fines									
	45				SC	Clayey SAND - very loose, moist, gray	3 2 1 1	3							
					CL	Sandy CLAY - soft, wet, gray - occasional 1 inch fine sand layers									
4165	50				CL	CLAY - soft, wet, gray	1 1 15 12	16							
					ML	Sandy SILT - very stiff, moist, gray - fine sand									
						-Groundwater not observed due to mud rotary drilling -Exploration backfilled with cement grout and bentonite chips at surface									
4160	55					Bottom of Boring @ 52 Feet									
4155															

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-6c

DATE
STARTED: 4/24/19
COMPLETED: 4/25/19
BACKFILLED: 4/25/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL/BF
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 3.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-4
Sheet 1 of 3

LOCATION
NORTHING 7,461,641.19 EASTING 1,520,745.31 ELEVATION 4,216.1

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4215	0					Casing driven to ± 9 feet below existing ground surface (b.e.g.s.). Vacuum extraction utility clearance performed to ± 7.5 feet b.e.g.s. prior to drilling.									
4210	5														
4205	10				CL	TOP: Sandy Lean CLAY - wet, brown-gray - fine sand, mica BOTTOM: CLAY with sand									
					CL	Lean CLAY - very soft, wet, 1/4 inch alternating layers of gray and dark gray - occasional organics (peat, roots), clayey sand lense ± 12.8-13.0 feet	WH/1"								
					SC		1	1	•		55	90	47	24	
					CL		1								
4200	15				CL-ML	TOP / BOTTOM: SILTY CLAY - soft, wet, gray - mica					34	91	26	7	
					CL	Lean CLAY - soft, wet, gray - fine sand and mica laminae 1/2 to 3/4 inch in thickness	3	3	•		41	90	32	13	
							1								
							1								
							1								
						TOP / BOTTOM: Sandy SILT - soft,									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-7a

DATE
STARTED: 4/24/19
COMPLETED: 4/25/19
BACKFILLED: 4/25/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL/BF
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 3.875" Drag Bit Mud Rotary

BORING NO:
BH19-ITW-4
Sheet 2 of 3

LOCATION
NORTHING 7,461,641.19 EASTING 1,520,745.31 ELEVATION 4,216.1

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4195	20				ML	wet, gray					30	55	NP	NP	
					CL	Lean CLAY with sand - soft, wet, gray - fine sand in 1 inch lenses	1 1 1 1	2			52	88	42	19	
4190	25				CH	Fat CLAY - very soft, wet, gray - occasional sand seam < 1/2 inch	WH/2'	0			64	99	53	28	
					CL	Lean CLAY with sand - medium stiff, wet, grayish-black - fine to medium sand in 1 inch lenses	WH 1 3 1	5							
4185	30				CL	- very soft - frequent 1 to 4 inch sand lenses	1/1' 1 1	1							
					CL	- medium stiff - frequent 1 inch sand lenses	3 2 3 2	6							
4180	35				CL	- very soft - frequent 1 to 2 inch sand lenses	WOH/2'	0							
					CL	- very soft - occasional sand lenses	WOH/1.5' 1	0							
						TOP / BOTTOM - Lean CLAY with									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-7b

DATE
STARTED: 4/24/19
COMPLETED: 4/25/19
BACKFILLED: 4/25/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL/BF
Rig Type: Truck Mounted CME-75 (D-9)
Boring Type: 3.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-4
Sheet 3 of 3

LOCATION
NORTHING 7,461,641.19 EASTING 1,520,745.31 ELEVATION 4,216.1

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4175	40				CL	sand - soft, wet, gray									
					CL	Lean CLAY with sand - very stiff, wet, gray - fine to medium sand	5 6 7 4	16							
4170	45				SC	Clayey SAND - medium dense, wet, gray	13 6 9 4	18							
					CL	Sandy Lean CLAY to Lean CLAY - medium stiff, wet, gray - fine sand	1 2 1 1	3							
4165	50				CL	Lean CLAY with sand - stiff, wet, gray - fine sand lenses < 2 inches in thickness	1 1 7 7	9							
						-Monitoring well installed following sampling. Screened ~ 39.1 - 49.1 feet -Groundwater not observed due to mud rotary drilling									
4160	55					Bottom of Boring @ 52 Feet									

N - OBSERVED UNCORRECTED BLOW COUNT

N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 87.4%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-7c

DATE
STARTED: 8/15/19
COMPLETED: 8/16/19
BACKFILLED: 8/16/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah
Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO:
BH19-ITW-5
Sheet 1 of 3

LOCATION
NORTHING 7,460,933.50 EASTING 1,521,704.23 ELEVATION 4,215.1

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4210	0					Casing driven to ± 3 feet below existing ground surface. PID monitoring performed on each sample and was observed to be 0.0 ppm unless otherwise noted									
	5				CL-ML	Silty CLAY with sand - very soft, moist, brown-gray - occasional oxidation staining, medium to fine sand	1 1 1 2	3							
						NO RECOVERY	1 1 1 1								
4205	10				CL	Lean CLAY with sand - very soft, wet, gray - fine sand fraction decreasing with depth, at liquid limit	WH 1 1 1	2							
					CH	Fat CLAY - soft, wet, gray				69	55	98	52	29	
4200	15				CL	- increased silt content Vane Shear Test at 16 feet (50x100 double tapered) Split spoon driven 14.5-16.5 feet following testing (blows:WH,2,2,6) Lean CLAY with sand - medium stiff, wet, gray - fine to medium sand seams 1 inch in thickness									
					CL	Lean CLAY - soft, wet, gray - at liquid limit	3 2 1 1	4							
					CL	Sandy Lean CLAY - very soft, wet gray - fine sand, heavy marsh odor									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-8a

DATE
STARTED: 8/15/19
COMPLETED: 8/16/19
BACKFILLED: 8/16/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-5
Sheet 2 of 3

LOCATION
NORTHING 7,460,933.50 EASTING 1,521,704.23 ELEVATION 4,215.1

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4190	20				CL	Lean CLAY - very soft, wet gray, dark gray - frequent fine sand lamina, heavy organic odor, at liquid limit	WH/2'	0			57	94	48	24	
					CL	Lean CLAY - very soft, wet gray, dark gray - frequent fine sand lamina, heavy organic odor, at liquid limit	WH/2'	0							
	25				CL	Vane Shear Test at 26 feet (50x100 double tapered) Split spoon driven 25-27 feet following testing (blows:WH/2') Lean CLAY - very soft, wet, gray - frequent fine sand lamina, organic odor					57	99	49	26	
					CL	Lean CLAY - medium stiff, wet, gray									
						Sand Lense					38	86	35	16	
4185	30				CL	Lean CLAY with sand - very soft, wet, gray - occasional fine sand lense, increasing granular fraction with depth, singular piece of 1/4 inch subrounded gravel at ± 31.25 feet	WH/2'	0			33	81	36	17	
					CL	Lean CLAY - very soft, wet gray, dark gray - frequent fine sand lamina, heavy organic odor, at liquid limit									
						CLAY - very soft, wet, gray, black	1 1/1.5'	0							
					ML	1 inch Sandy SILT seam									
					CL	1 inch Sandy SILT seam									
4180	35				ML CL	Lean CLAY - medium stiff, wet, gray - at liquid limit									
					ML	SILT - medium stiff, moist, gray - nonplastic, trace fine sand									
					CL	Lean CLAY - very soft, wet,									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-8b

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

DATE
STARTED: 8/15/19
COMPLETED: 8/16/19
BACKFILLED: 8/16/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-5
Sheet 3 of 3

LOCATION
NORTHING 7,460,933.50 EASTING 1,521,704.23 ELEVATION 4,215.1

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4170	40				CL	gray-black to gray - at liquid limit	WR/2'	0							
	45				ML	SILT with sand - stiff, moist, gray - fine sand, mica	2 2 7 8	9			21	81	NP	NP	
					SP	1/2 inch poorly graded sand lense in shoe									
4165	50				CL	Lean CLAY - very soft, wet, gray, occasional black - occasional silt and fine sand lamina	1 1 1 5	2							
						- Groundwater not observed due to mud rotary drilling -Exploration backfilled with cement grout and bentonite chips at surface									
4160	55					Bottom of Boring @ 52 Feet									

N - OBSERVED UNCORRECTED BLOW COUNT
N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-8c

DATE
STARTED: 8/12/19
COMPLETED: 8/13/19
BACKFILLED: 8/13/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-6

LOCATION
NORTHING 7,460,647.58 EASTING 1,522,509.21 ELEVATION 4,216.5

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4215	0					Casing driven to ± 3.5 feet below existing ground surface. PID monitoring performed on each sample and was observed to be 0.0 ppm unless otherwise noted									
	5					NO RECOVERY	3 4 3 1								
4210					CL	Lean CLAY - very soft, wet, gray, brown									
					CL	Sandy Lean CLAY and Clayey SAND - loose/soft, wet, gray, brown, dark brown - medium to fine sand	WH/1' 2 2	3	●						
4205	10				CL	Lean CLAY - very soft, wet, gray, dark gray - at liquid limit, occasional fine sand lamina in first 6 inches of sample	WH/1.5'	0	●						
					CL	TOP/BOTTOM: Lean CLAY - soft, wet, gray				55	62	90	31	10	●
	15				ML	Vane Shear Test at 15.5 feet (50x100 double tapered) Split spoon driven 14-16 feet following testing (blows:1,2,1,1) Sandy SILT - medium stiff, moist, gray - fine sand, mica, nonplastic, sample collected from PZ19-ITW-6					34	56	NP	NP	●
4200					SM	Silty SAND - medium dense, wet, gray - fine sand, nonplastic fines	1 4 10 10	19	●						

N - OBSERVED UNCORRECTED BLOW COUNT
N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

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SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-9a

DATE
STARTED: 8/12/19
COMPLETED: 8/13/19
BACKFILLED: 8/13/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-6
Sheet 2 of 3

LOCATION
NORTHING 7,460,647.58 EASTING 1,522,509.21 ELEVATION 4,216.5

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4195	20				SP-SM	Poorly Graded SAND with silt - medium dense, moist, gray - fine sand	7 8 9 7	22							
					CL	Lean CLAY with sand - soft, wet, gray - occasional fine sand seams 1/2 inch in thickness	1 2 1 2	3							
4190	25				CL	Vane Shear Test at 26 feet (50x100 double tapered) Split spoon driven 25-27 feet following testing (blows:WH/1',1,1) Lean CLAY with sand - very soft, wet, gray, dark gray - fine sand seams throughout, mica					44	93	42	19
					CL	TOP/BOTTOM: Lean CLAY - medium stiff, wet, gray					50	94	33	12	
4185	30				CL	Lean CLAY - very soft, wet, gray	1/1.5' 3	0							
					SM	Silty SAND - loose, wet, gray									
					CL	Lean CLAY - very soft, wet, dark gray to gray - occasional fine sand and silt lamina	WH/2'	0			40	85	38	18	
4180	35				CL	Lean CLAY - stiff, wet, dark gray to gray - occasional fine sand and silt lamina	WH 2 8 11	11							
					GC	Clayey GRAVEL - medium dense, wet, gray - subangular gravel up top 1 inch in diameter, average size 1/4 inch									
						Driller noted decreased drilling resistance at ± 38 feet									

N - OBSERVED UNCORRECTED BLOW COUNT N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES

Copyright (c) 2020, IGES, INC.

SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-9b

DATE
STARTED: 8/12/19
COMPLETED: 8/13/19
BACKFILLED: 8/13/19

Geotechnical Investigation
SLCWRF Influent Sewer Conveyance Design
Salt Lake City, Utah

Project Number 00100-015

IGES Rep: BTL
Rig Type: Track Mounted CME-850
Boring Type: 4.875" Drag Bit Mud Rotary

BORING NO: BH19-ITW-6
Sheet 3 of 3

LOCATION
NORTHING 7,460,647.58 EASTING 1,522,509.21 ELEVATION 4,216.5

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	N1(60)	SPT BLOW COUNT 10 20 30 40 50 60 70 80 90	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits: Plastic Limit / Moisture Content / Liquid Limit 10 20 30 40 50 60 70 80 90
4175	40				CL	CLAY - stiff, wet, gray	4 4 4 4	9							
					ML	SILT - medium stiff, moist, brown-gray									
					CL										
4170	45				CL	CLAY - very soft, wet, gray - above liquid limit	WR/1.5' WH/0.5'	0			43	95	38	17	
4165	50				ML	SILT with sand - stiff, moist, gray - nonplastic fines, fine to medium sand	2 2 5 10	7			22	78	NP	NP	
4160	55					- Groundwater not observed due to mud rotary drilling -Exploration backfilled with cement grout and bentonite chips at surface -PZ19-ITW-6 installed adjacent to borehole. Screened ~ 19.2 - 29.2 feet Bottom of Boring @ 52 Feet									

N - OBSERVED UNCORRECTED BLOW COUNT
N1(60) - NORMALIZED, CORRECTED, EQUIVALENT BLOW COUNT (BPF)

BORING LOG NORTH EAST N160 00100-015 SCLWRF TUNNEL BORING LOGS 20200204.GPJ IGES.GDT 2/4/20

IGES®

Copyright (c) 2020, IGES, INC.

SAMPLE TYPE
- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3.25" O.D./2.42" I.D. U SAMPLER
- 3" O.D. THIN-WALLED SHELBY TUBE
- GRAB SAMPLE
- 3" O.D./2.38" I.D. CALIFORNIA SAMPLER
- 2.5" O.D./1.88" I.D. MOD. CAL. SAMPLER

NOTES:
- Latitude, Longitude and Elevation Provided by AECOM (H: NAD 83; V: NAVD 88) in feet
- ConeTec Reported Hammer E: 79.2%

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A-9c

Appendix C Cone Penetration Test Results

The cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd. of Richmond, British Columbia, Canada.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and a geophone sensor for recording seismic signals. All signals are amplified down hole within the cone body and the analog signals are sent to the surface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in both 10 cm^2 and 15 cm^2 tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first Appendix. The 15 cm^2 penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm^2 piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 mm diameter over a length of 32 mm with tapered leading and trailing edges) located at a distance of 585 mm above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All ConeTec piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u_2" position (ASTM Type 2). The filter is 6 mm thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. ConeTec's calibration criteria also meet or exceed those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.

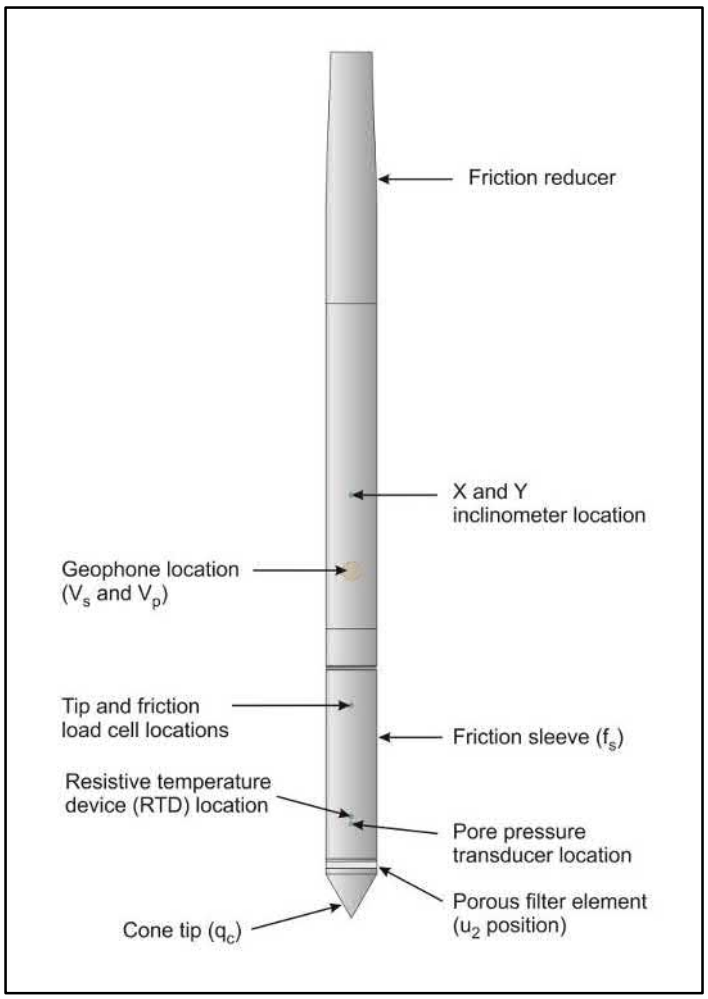


Figure CPTu. Piezocone Penetrometer (15 cm^2)

The ConeTec data acquisition systems consist of a Windows based computer and a signal conditioner and power supply interface box with a 16 bit (or greater) analog to digital (A/D) converter. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording intervals are either 2.5 cm or 5.0 cm depending on project requirements; custom recording intervals are possible. The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to ConeTec's CPT operating procedures which are in general accordance with the current ASTM D5778 standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with either glycerin or silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of 2 cm/s, within acceptable tolerances. Typically one meter length rods with an outer diameter of 1.5 inches are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to ConeTec's cone penetration testing procedures:

- Each filter is saturated in silicone oil or glycerin under vacuum pressure prior to use
- Recorded baselines are checked with an independent multi-meter
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of piezocone data for this report is based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson (1990) and Robertson (2009). It should be noted that it is not always possible to accurately identify a soil type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behavior type.

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in Robertson et al, 1986:

$$q_t = q_c + (1\text{-}a) \bullet u_2$$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all ConeTec piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (Rf) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high

friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of interpretation files were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the interpretation methods used is also included in the data release folder.

For additional information on CPTu interpretations, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

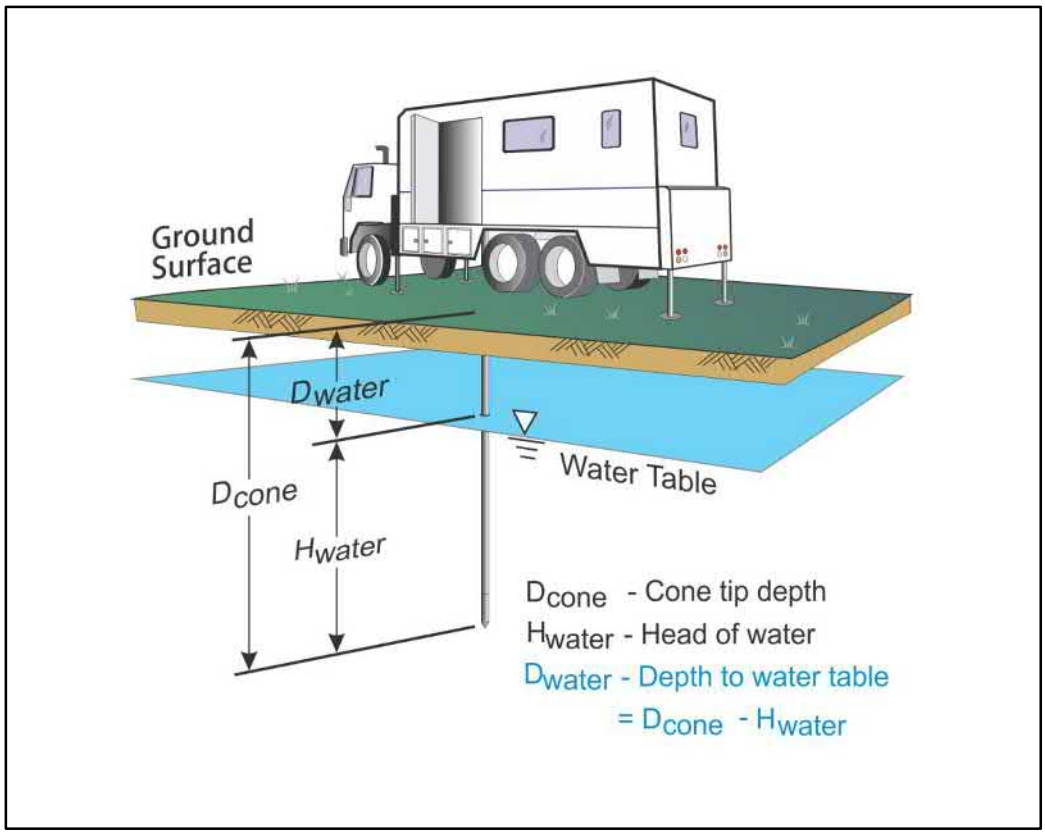


Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behavior.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.

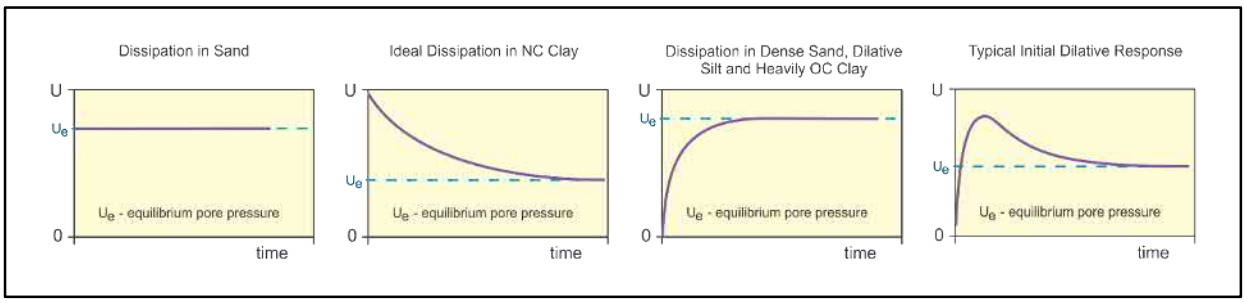


Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve of Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as t_{100}. In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to t_{100}. A theoretical analysis of pore pressure dissipations by Teh and Houlsby (1991) showed that a single curve relating degree of dissipation versus theoretical time factor (T*) may be used to calculate the coefficient of consolidation (c_h) at various degrees of dissipation resulting in the expression for c_h shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:

T* is the dimensionless time factor (Table Time Factor)
a is the radius of the cone
I_r is the rigidity index
t is the time at the degree of consolidation

Table Time Factor. T* versus degree of dissipation (Teh and Houlsby, 1991)

Degree of Dissipation (%)	20	30	40	50	60	70	80
T* (u_2)	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time (t_{50}) corresponding to a degree of dissipation of 50% (u_{50}). In order to determine t_{50}, dissipation tests must be taken to a pressure less than u_{50}. The u_{50} value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as u_{100}. To estimate u_{50}, both the initial maximum pore pressure and u_{100} must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at t_{100}) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly (u_{100}), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.

For calculations of c_h (Teh and Houlsby, 1991), t_{50} values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I_r) is assumed. For curves having an initial dilatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining t_{50}. In cases where the time to peak is excessive, t_{50} values are not calculated.

Due to possible inherent uncertainties in estimating I_r, the equilibrium pore pressure and the effect of an initial dilatory response on calculating t_{50}, other methods should be applied to confirm the results for c_h.

Additional published methods for estimating the coefficient of consolidation from a piezocone test are described in Burns and Mayne (1998, 2002), Jones and Van Zyl (1981), Robertson et al. (1992) and Sully et al. (1999).

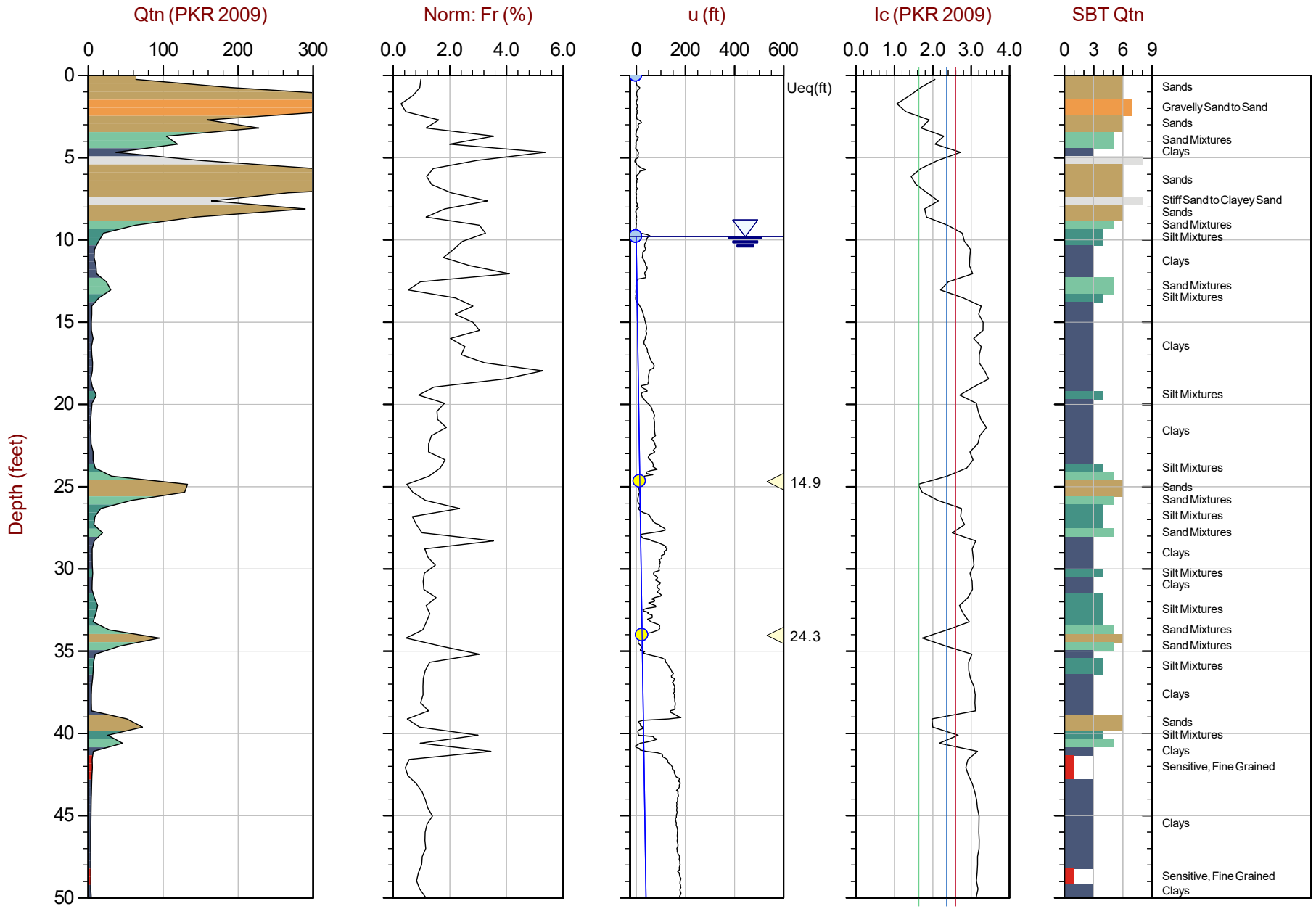
A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.

CONETEC

AECOM

Job No: 18-52099
Date: 2018-07-13 08:19
Site: SLC WWTP

Sounding: CP18-PC-1
Cone: 430:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 18-52099_CP-PC-1.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.809869 Long: -111.935280

00 31 32-154

Overplot Item: Ueq Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

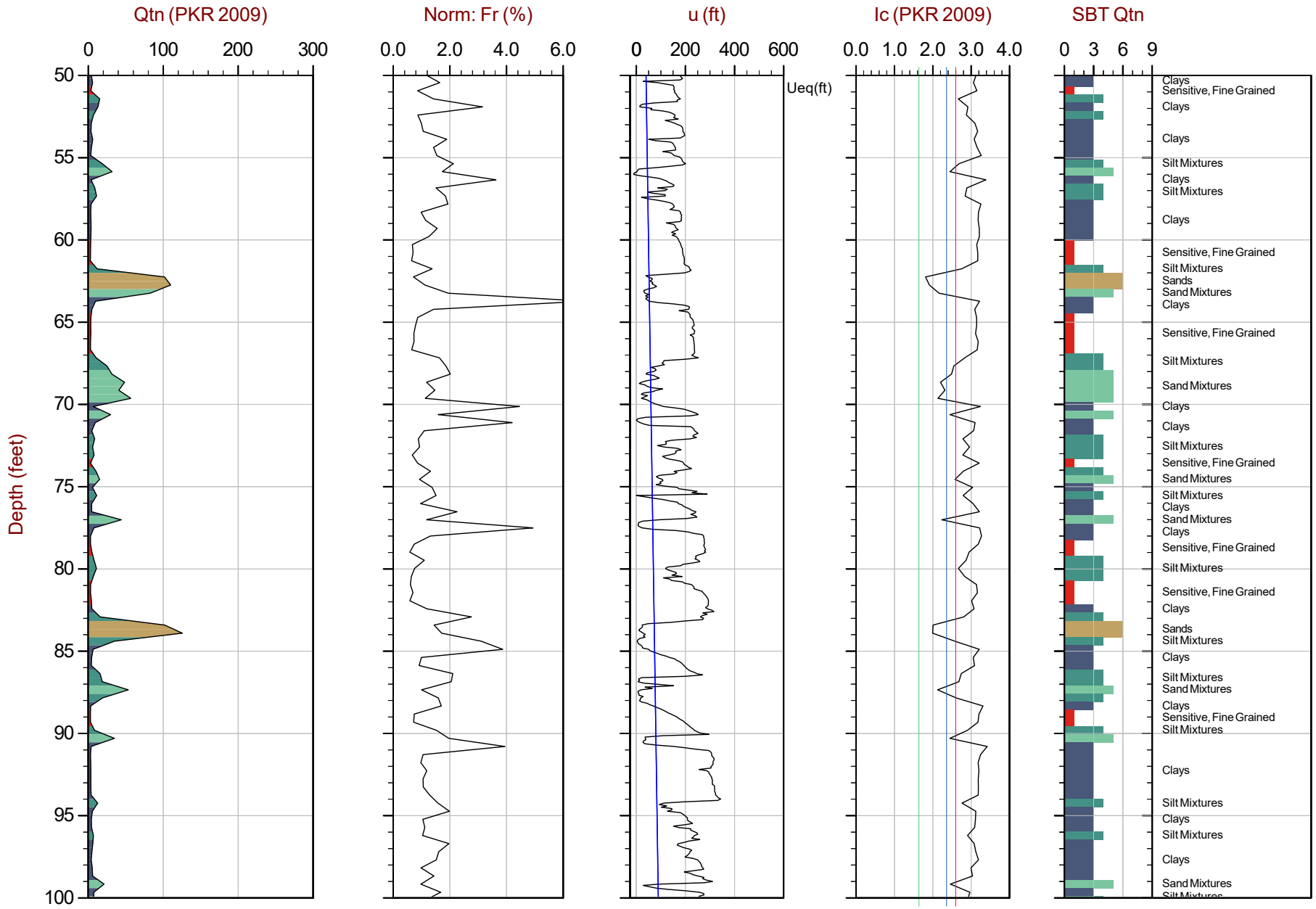
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 18-52099
Date: 2018-07-13 08:19
Site: SLC WWTP

Sounding: CP18-PC-1
Cone: 430:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 18-52099_CP-PC-1.COR
Unit Wt: SBTQtn (PKR2009)

00 31 32-155

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.809869 Long: -111.935280

Overplot Item: Ueq Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

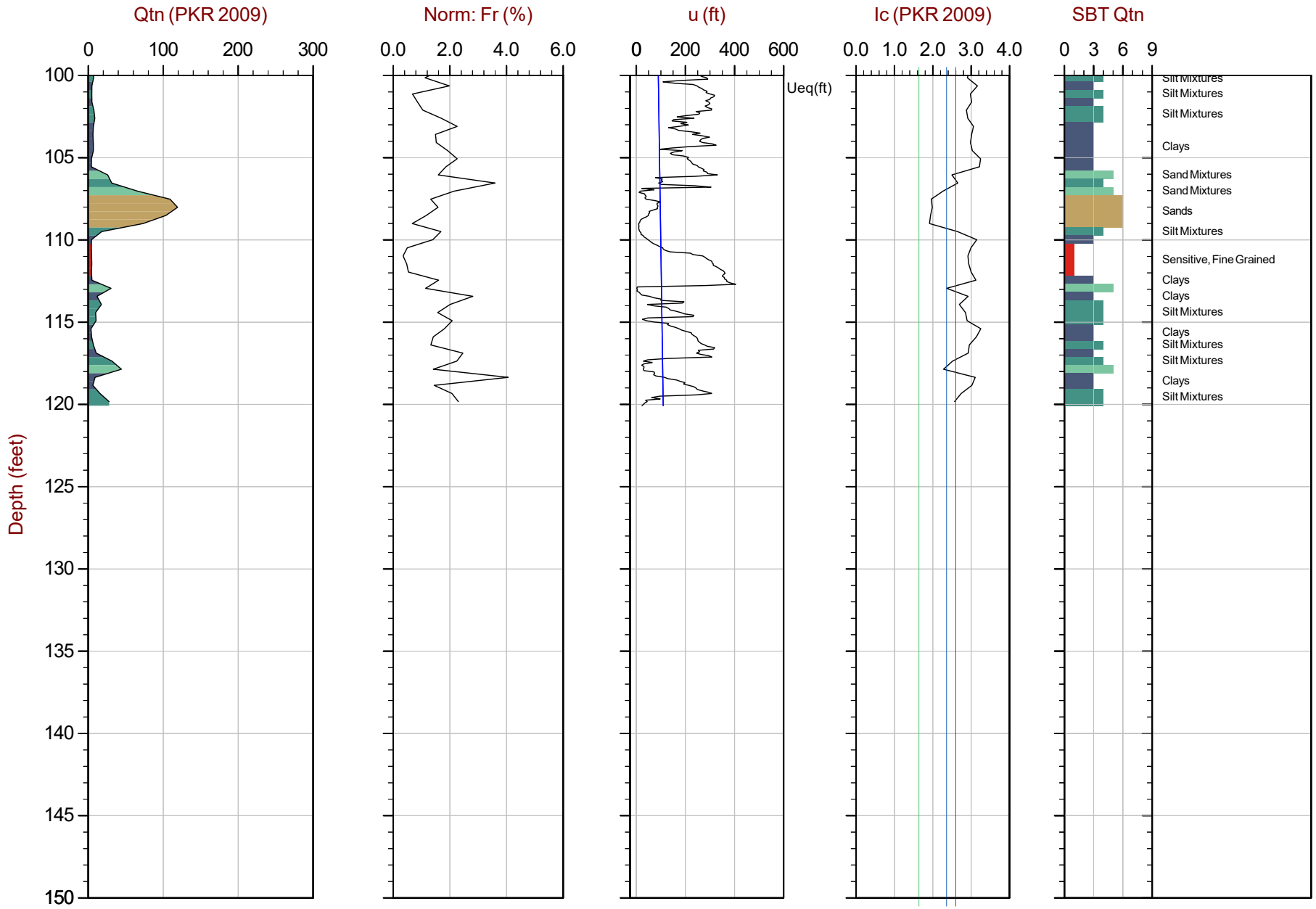
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 18-52099
Date: 2018-07-13 08:19
Site: SLC WWTP

Sounding: CP18-PC-1
Cone: 430:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 18-52099_CP-PC-1.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.809869 Long: -111.935280

00 31 32-156

Overplot Item: Ueq Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

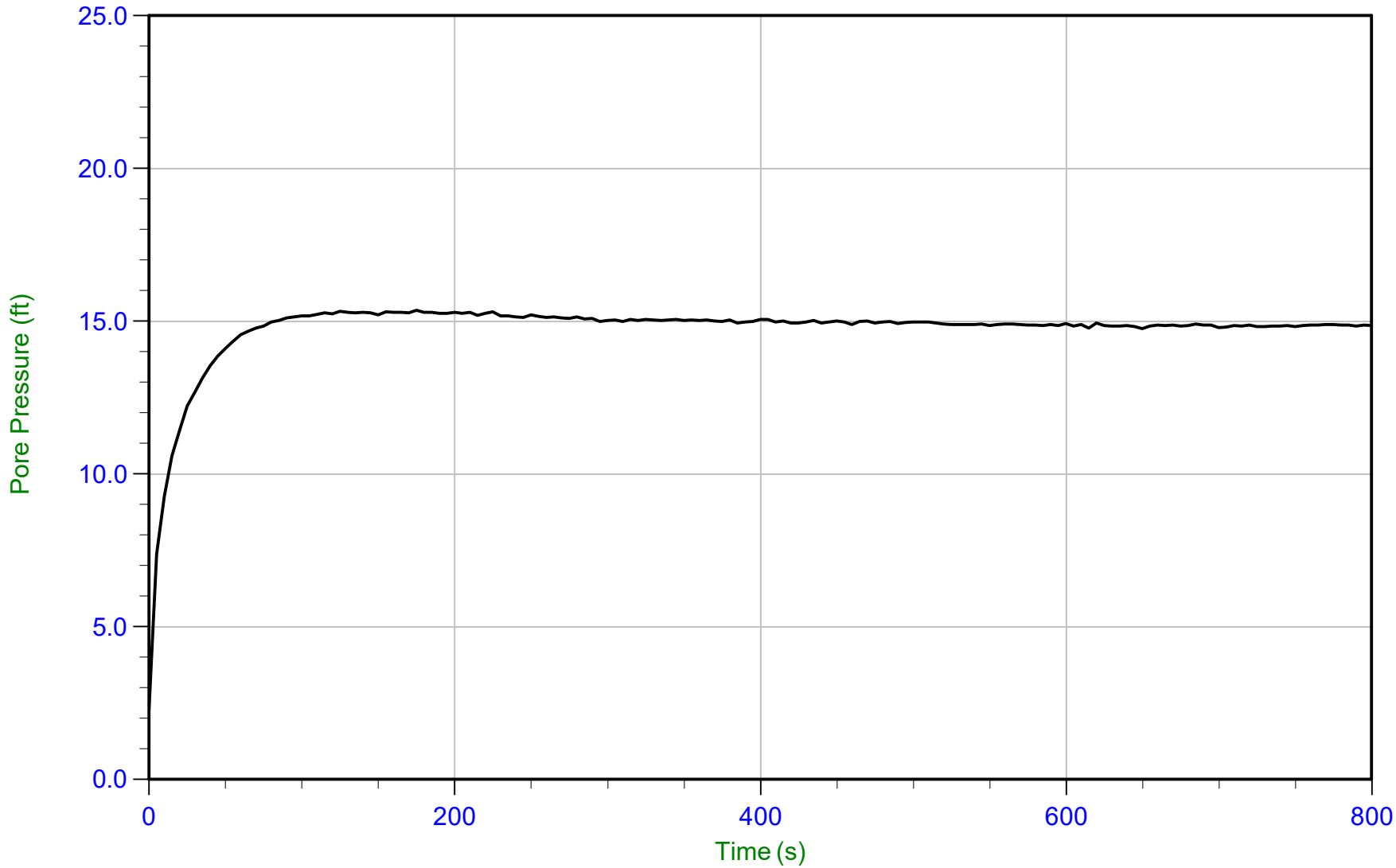
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 18-52099
Date: 07/13/2018 08:19
Site: SLC WWTP

Sounding: CP18-PC-1
Cone: 430:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 18-52099_CP-PC-1.PPD
Depth: 7.525 m / 24.688 ft
Duration: 800.0 s

U Min: 2.3 ft
U Max: 15.4 ft

WT: 2.989 m / 9.806 ft
Ueq: 14.9 ft

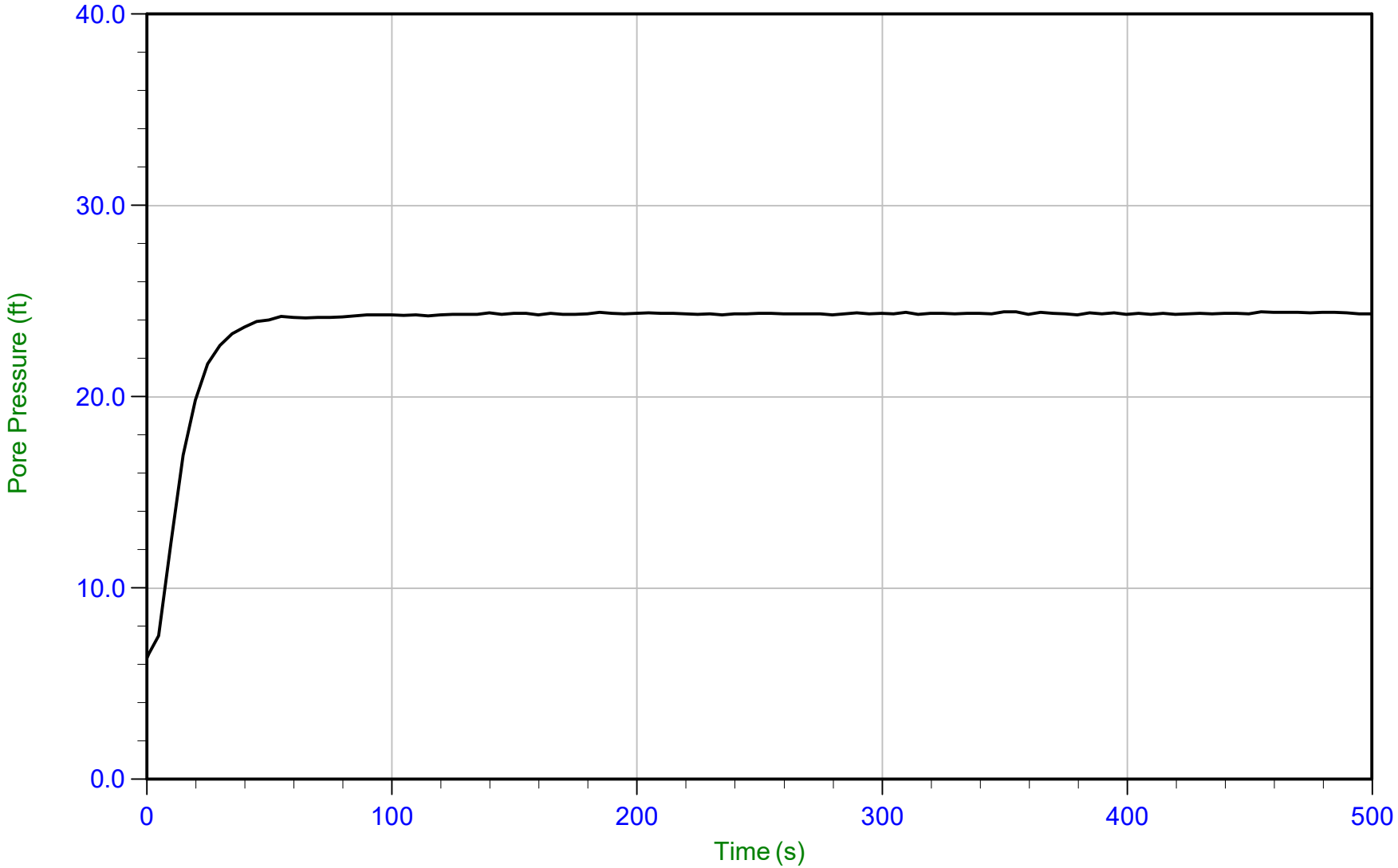
09-31 32-157

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AECOM

Job No: 18-52099
Date: 07/13/2018 08:19
Site: SLC WWTP

Sounding: CP18-PC-1
Cone: 430:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 18-52099_CP-PC-1.PPD
Depth: 10.375 m / 34.038 ft
Duration: 500.0 s

U Min: 6.3 ft
U Max: 24.4 ft

WT: 2.962 m / 9.718 ft
Ueq: 24.3 ft

09-31 32-158

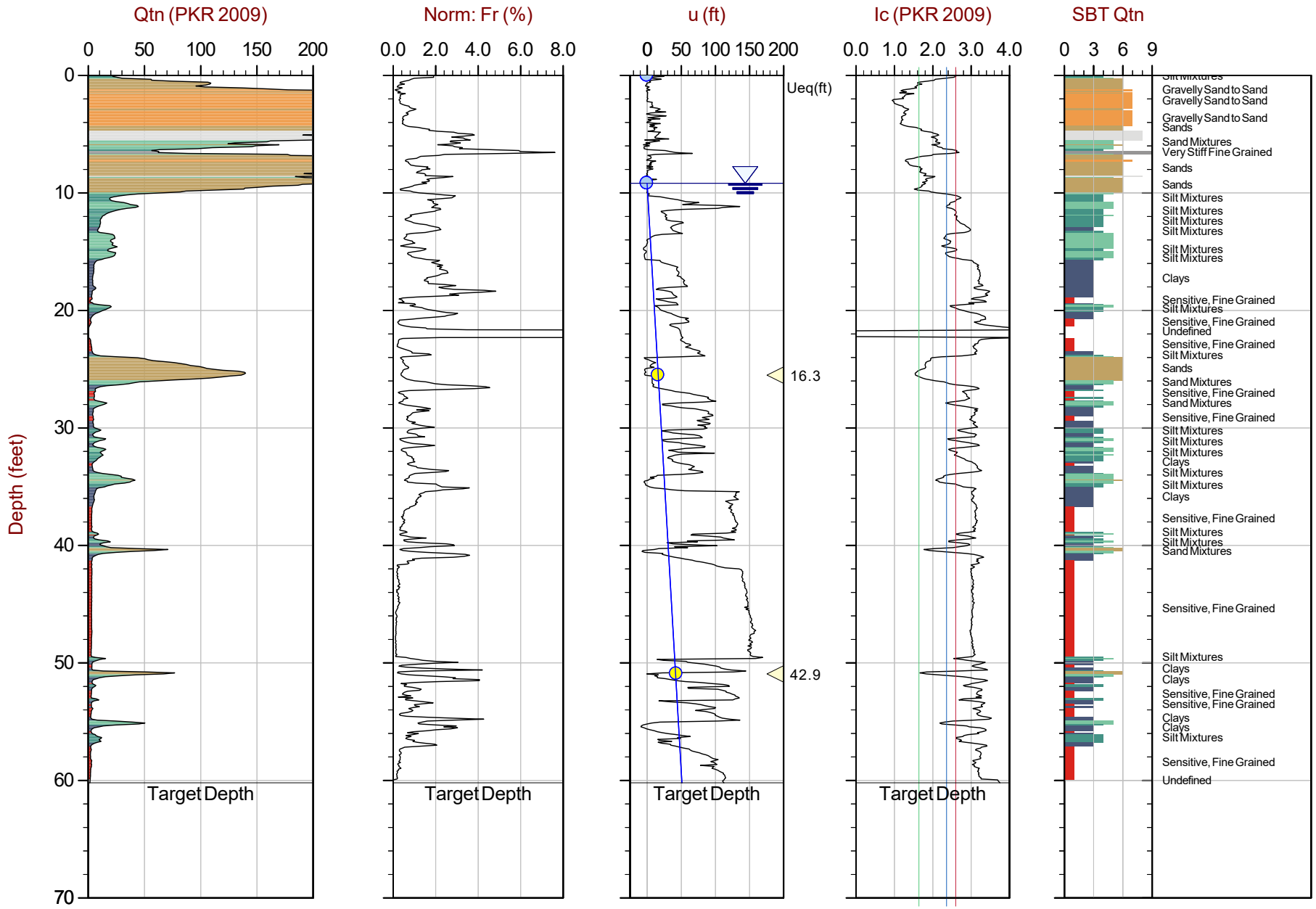
© 2016 ConeTec Investigations Ltd.

CONETEC

AECOM

Job No: 20-52-21547
Date: 2020-10-28 17:03
Site: Influent Pump Station Electrical

Sounding: CPT20-IPSEL-01
Cone: 553:T1500F15U500



Max Depth: 18.350 m / 60.20 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21547_CP-IPSEL-01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.80999 Long: -111.93557

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

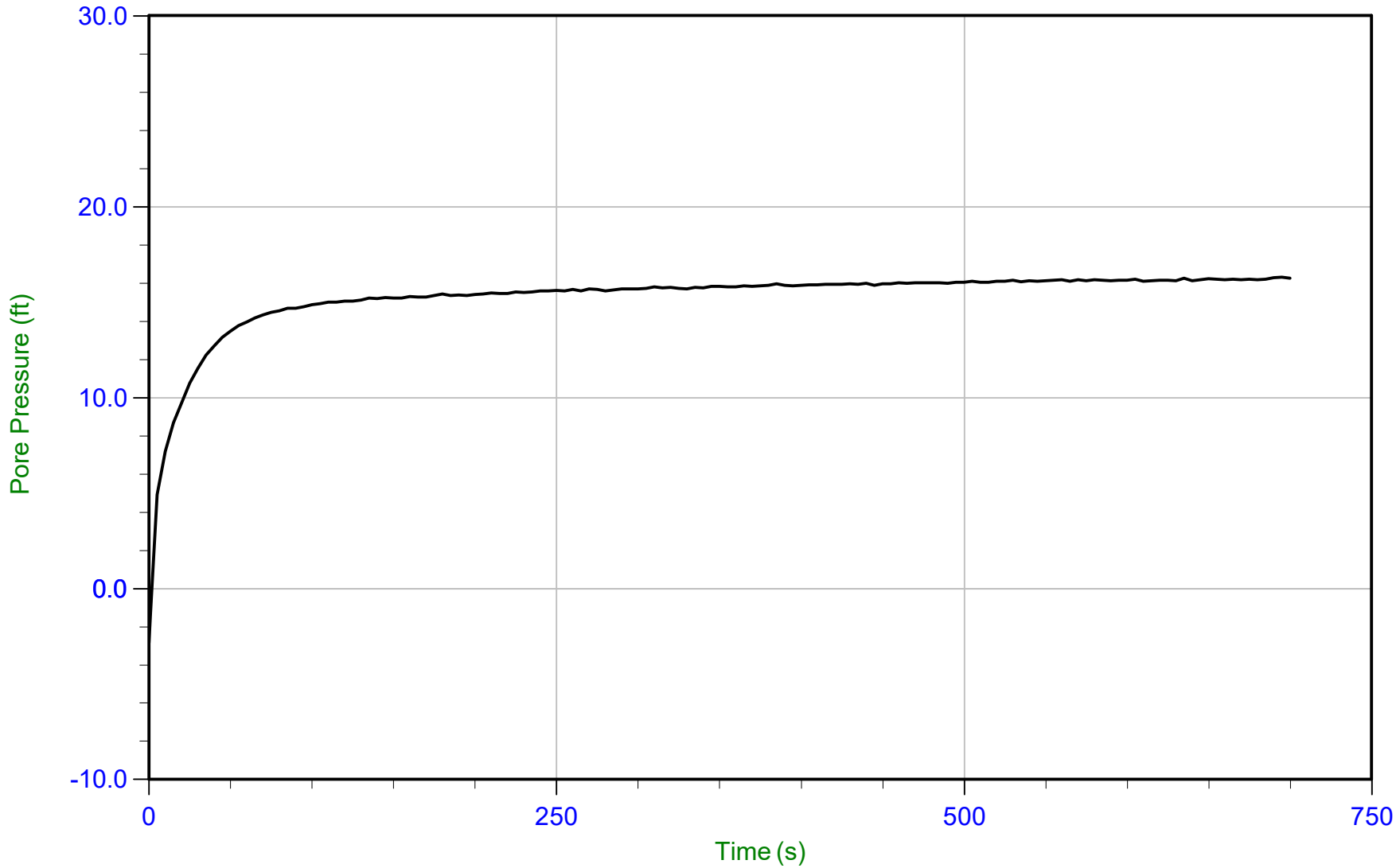
00 31 32-159

CONETEC

AECOM

Job No: 20-52-21547
Date: 10/28/2020 17:03
Site: Influent Pump Station Electrical

Sounding: CPT20-IPSEL-01
Cone: 553:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21547_CP-IPSEL-01.PPF
Depth: 7.775 m / 25.508 ft
Duration: 700.0 s

u Min: -2.8 ft
u Max: 16.3 ft
u Final: 16.3 ft

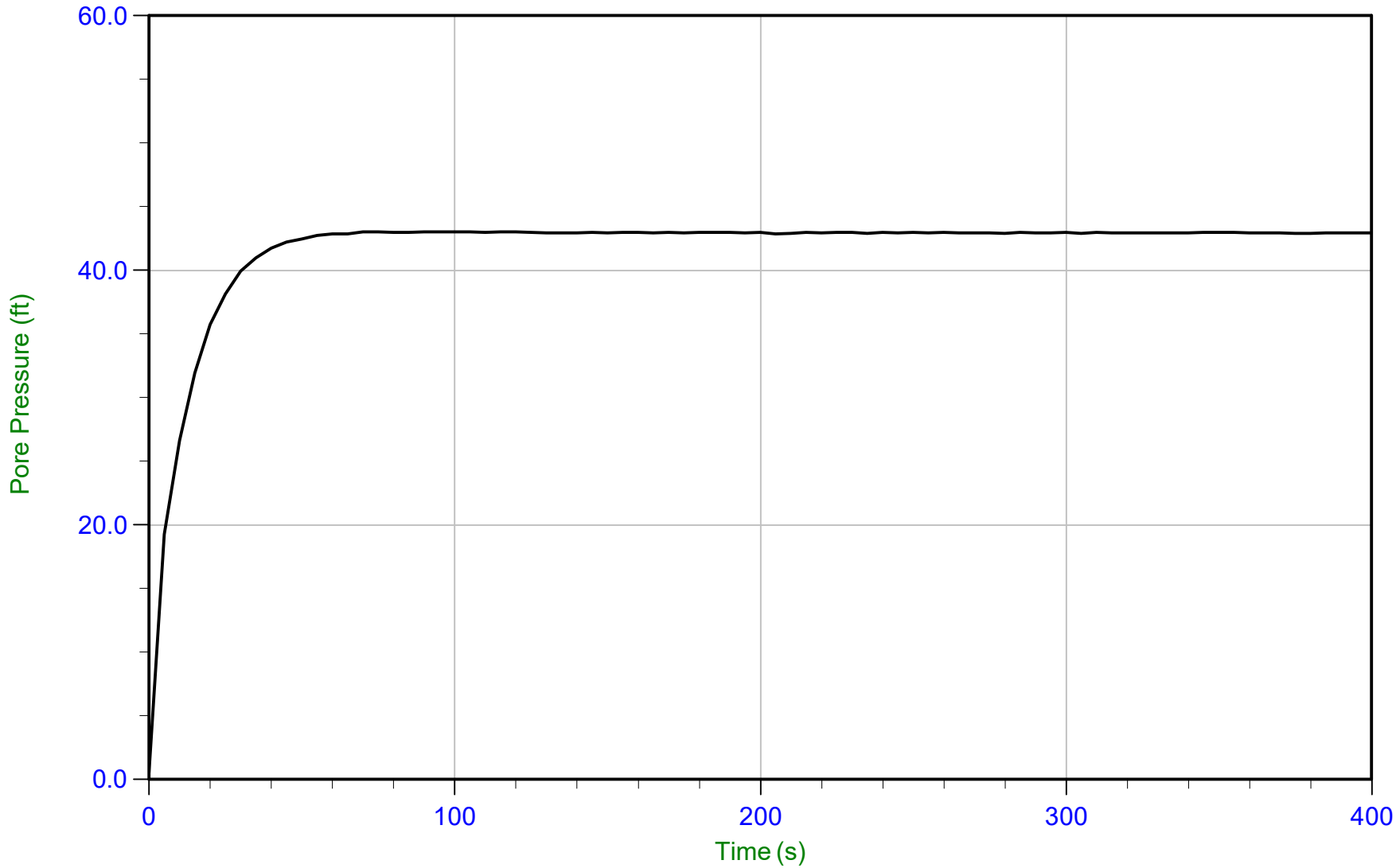
WT: 2.799 m / 9.183 ft
Ueq: 16.3 ft

CONETEC

AECOM

Job No: 20-52-21547
Date: 10/28/2020 17:03
Site: Influent Pump Station Electrical

Sounding: CPT20-IPSEL-01
Cone: 553:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21547_CP-IPSEL-01.PPF
Depth: 15.525 m / 50.934 ft
Duration: 400.0 s

u Min: 0.5 ft
u Max: 43.0 ft
u Final: 42.9 ft

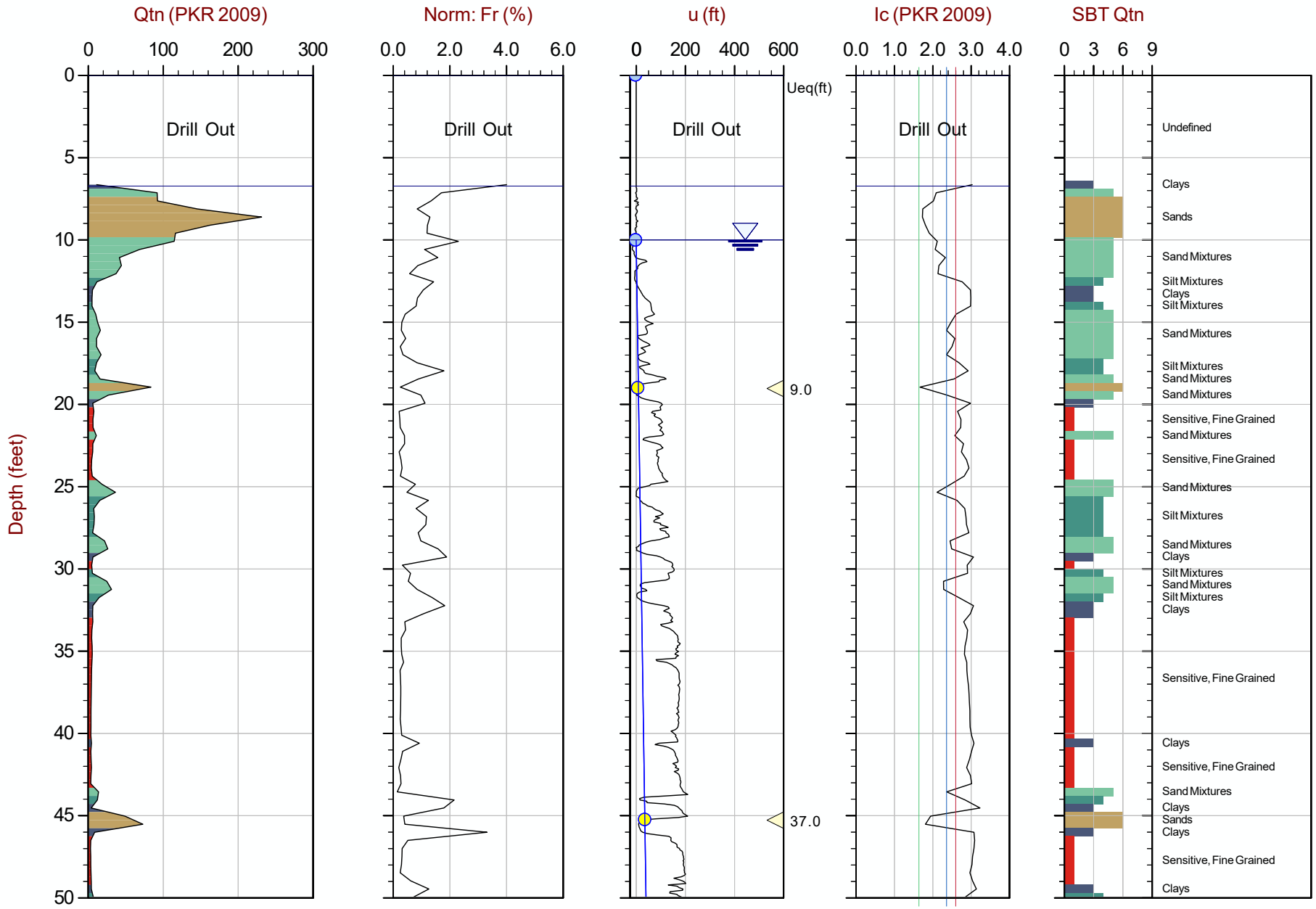
WT: 2.446 m / 8.025 ft
Ueq: 42.9 ft

CONETEC

AECOM

Job No: 19-52037
Date: 2019-06-25 11:25
Site: SLC WRF

Sounding: CP19-ES-1
Cone: 418:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 19-52037_CP19-ES-1.COR
Unit Wt: SBTQtn (PKR2009)

00 31 32-162

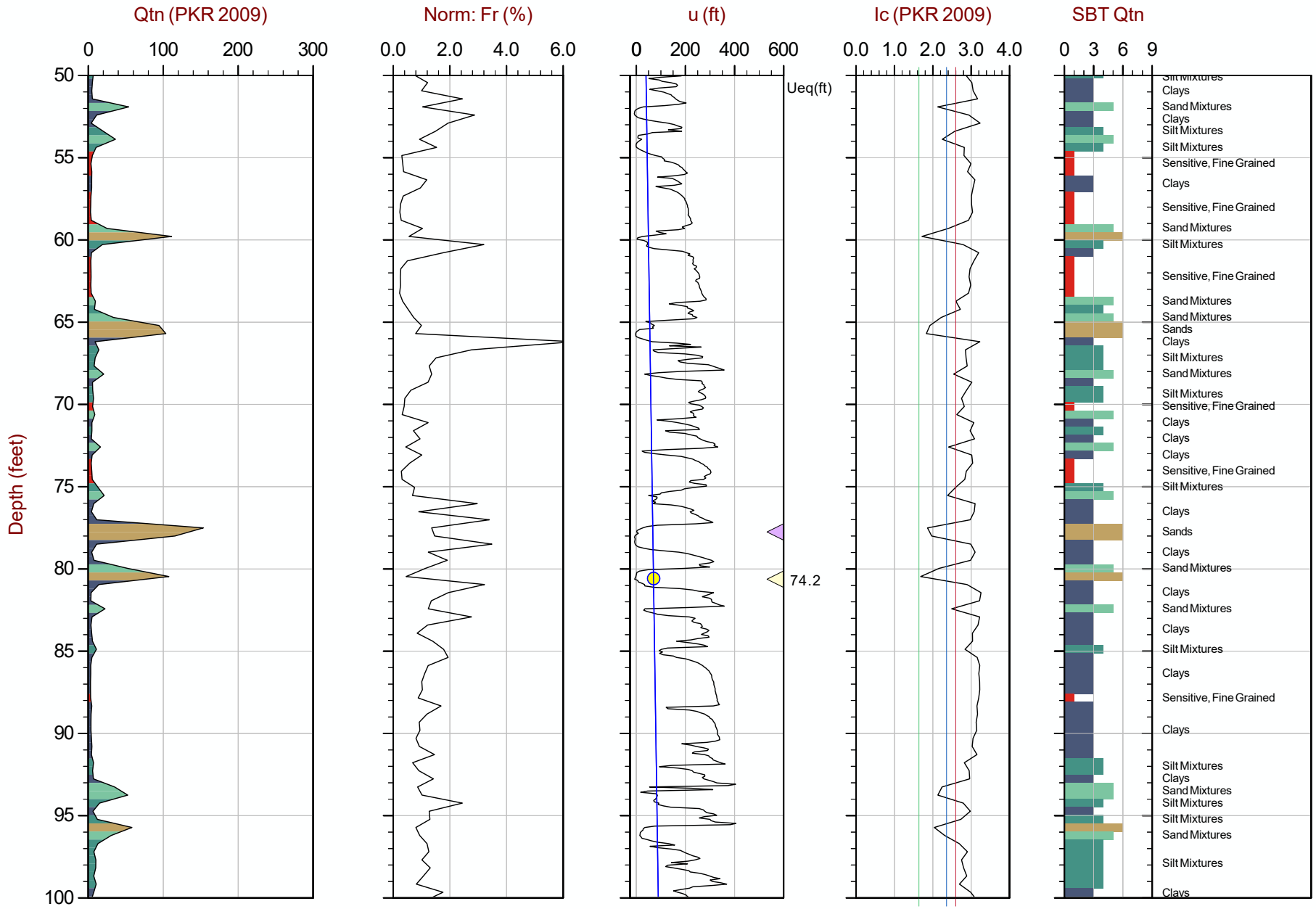
SBT: Robertson, 2009 and 2010
Coords: Lat: 40.810623 Long: -111.929526

CONETEC

AECOM

Job No: 19-52037
Date: 2019-06-25 11:25
Site: SLC WRF

Sounding: CP19-ES-1
Cone: 418:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 19-52037_CP19-ES-1.COR
Unit Wt: SBTQtn (PKR2009)

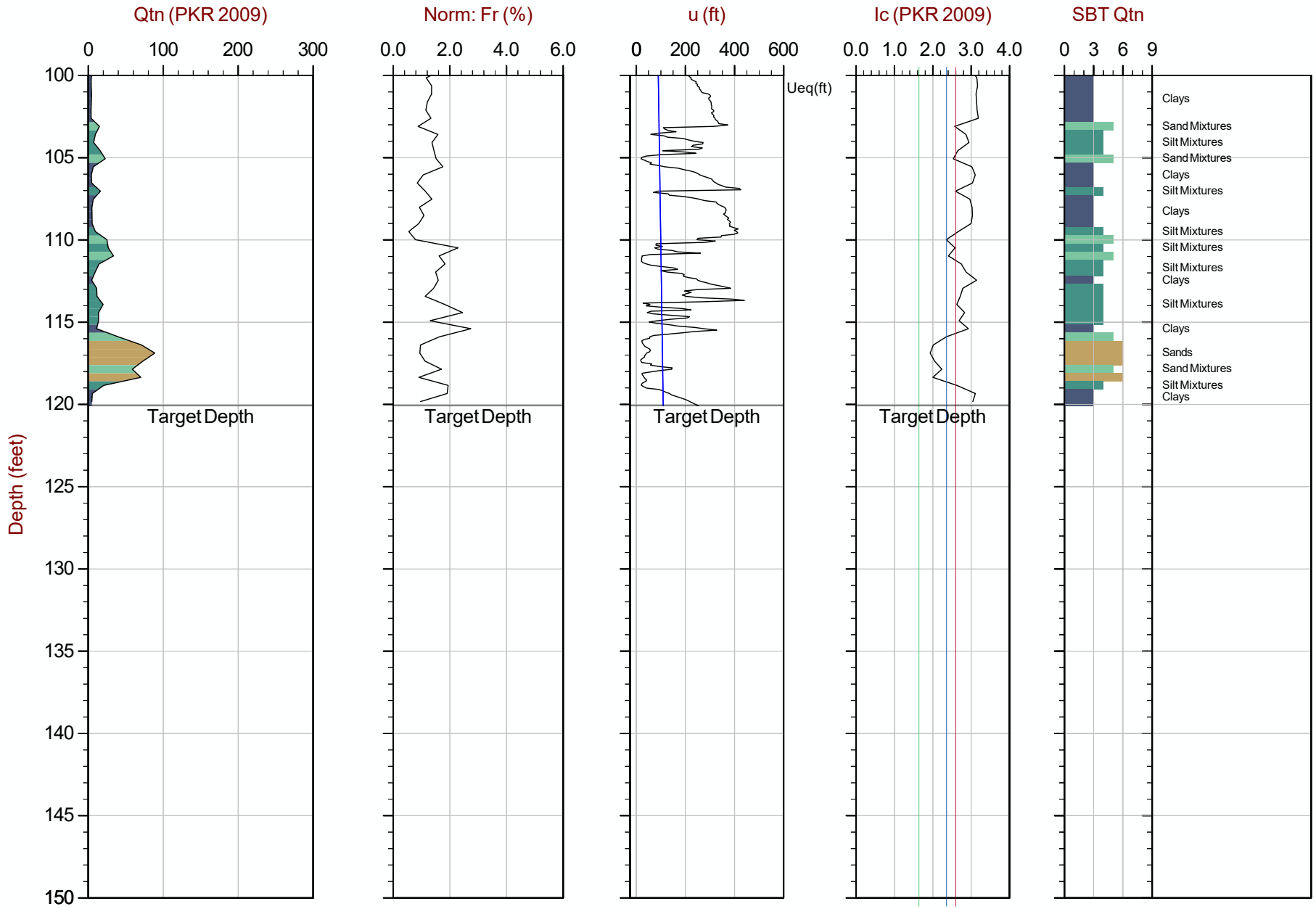
SBT: Robertson, 2009 and 2010
Coords: Lat: 40.810623 Long: -111.929526

CONETEC

AECOM

Job No: 19-52037
Date: 2019-06-25 11:25
Site: SLC WRF

Sounding: CP19-ES-1
Cone: 418:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 19-52037_CP19-ES-1.COR
Unit Wt: SBTQtn (PKR2009)

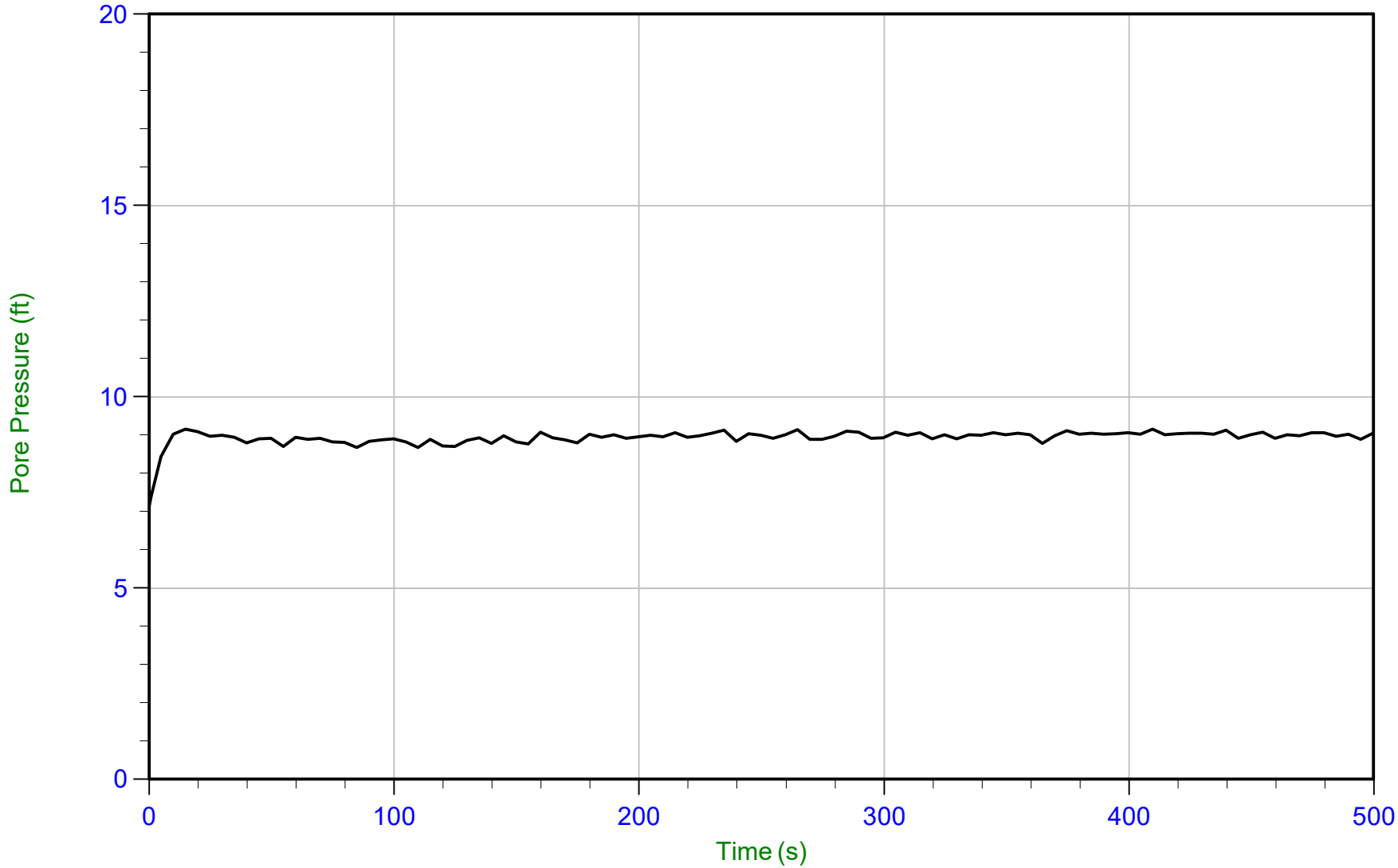
SBT: Robertson, 2009 and 2010
Coords: Lat: 40.810623 Long: -111.929526

CONETEC

AECOM

Job No: 19-52037
Date: 06/25/2019 11:25
Site: SLC WRF

Sounding: CP19-ES-1
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 19-52037_CP19-ES-1.PPD
Depth: 5.800 m / 19.029 ft
Duration: 500.0 s

u Min: 7.1 ft
u Max: 9.2 ft
u Final: 9.0 ft

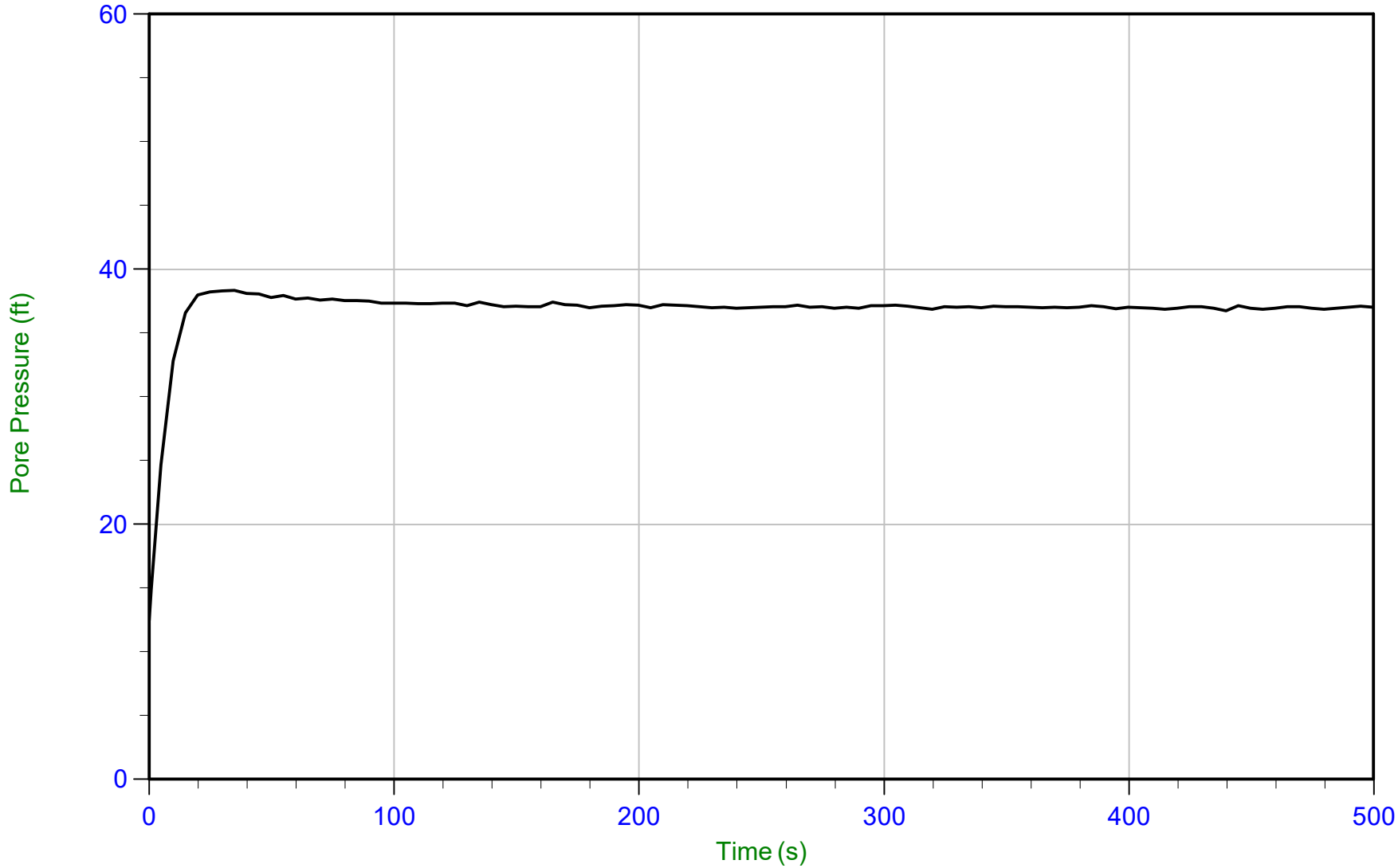
WT: 3.062 m / 10.046 ft
Ueq: 9.0 ft

CONETEC

AECOM

Job No: 19-52037
Date: 06/25/2019 11:25
Site: SLC WRF

Sounding: CP19-ES-1
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 19-52037_CP19-ES-1.PPD
Depth: 13.800 m / 45.275 ft
Duration: 500.0 s

u Min: 12.4 ft
u Max: 38.3 ft
u Final: 37.0 ft

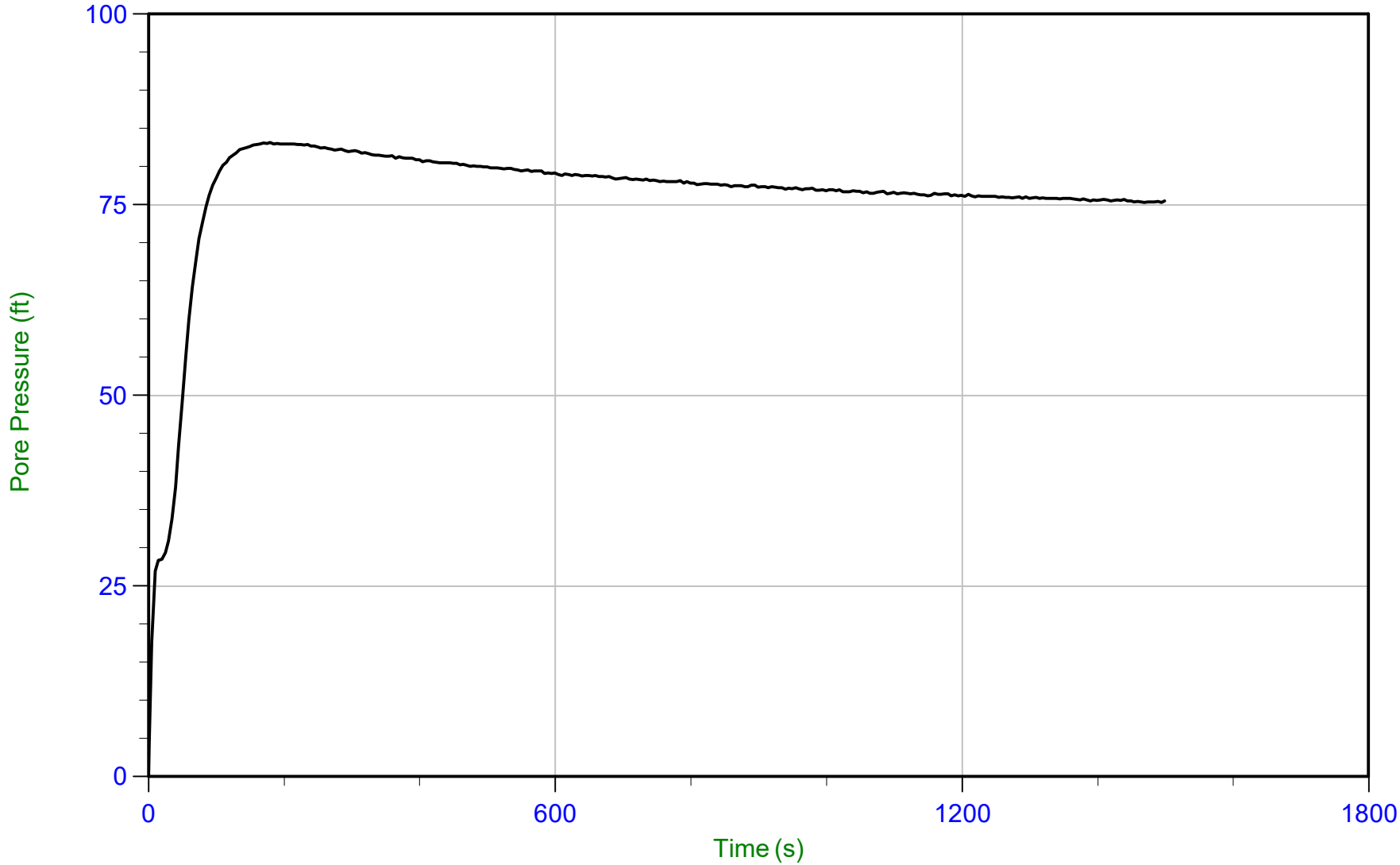
WT: 2.529 m / 8.297 ft
Ueq: 37.0 ft

CONETEC

AECOM

Job No: 19-52037
Date: 06/25/2019 11:25
Site: SLC WRF

Sounding: CP19-ES-1
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 19-52037_CP19-ES-1.PPD
Depth: 23.700 m / 77.755 ft
Duration: 1500.0 s

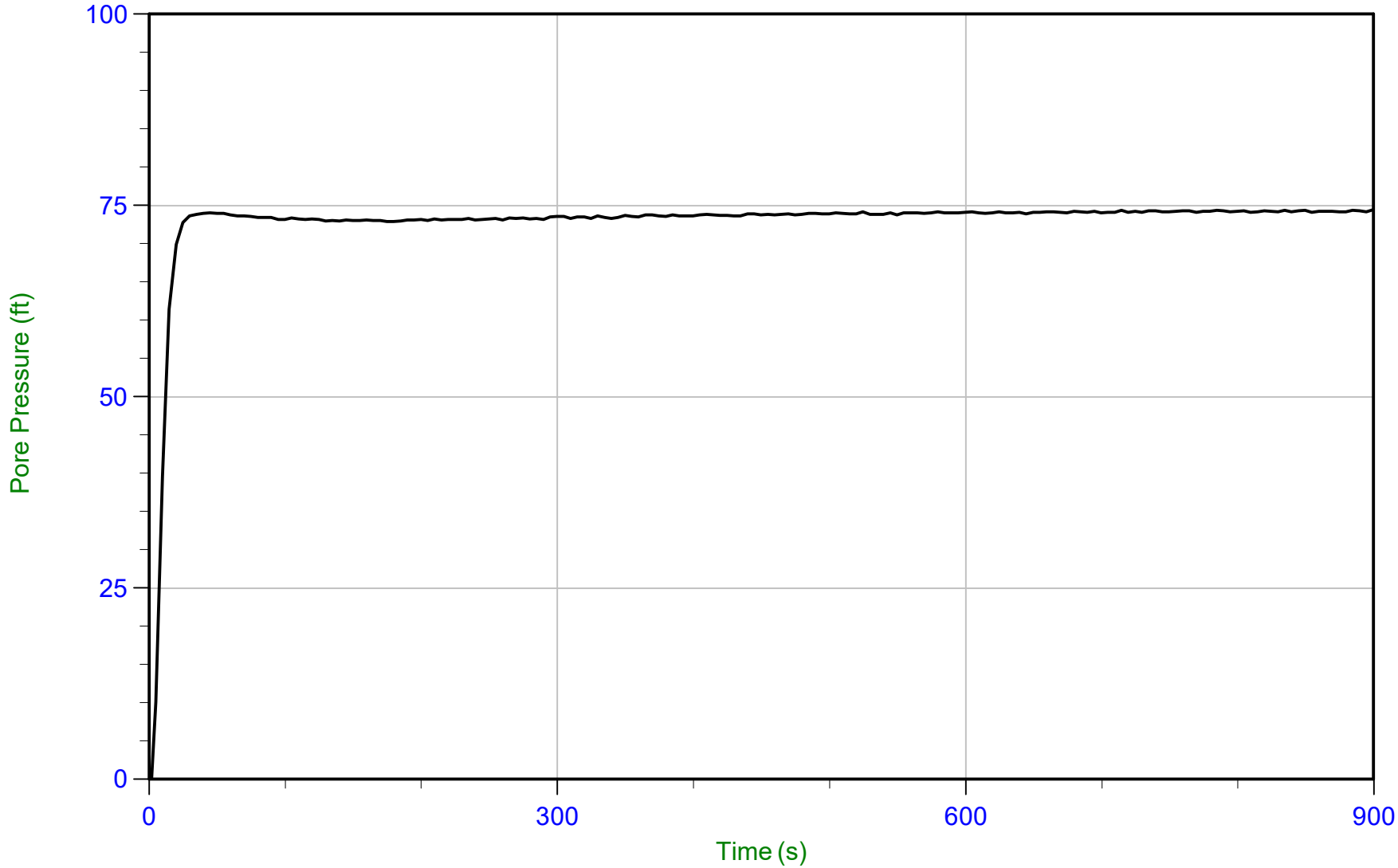
u Min: 0.7 ft
u Max: 83.2 ft
u Final: 75.5 ft

CONETEC

AECOM

Job No: 19-52037
Date: 06/25/2019 11:25
Site: SLC WRF

Sounding: CP19-ES-1
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 19-52037_CP19-ES-1.PPD
Depth: 24.575 m / 80.626 ft
Duration: 900.0 s

u Min: -6.7 ft
u Max: 74.4 ft
u Final: 74.4 ft

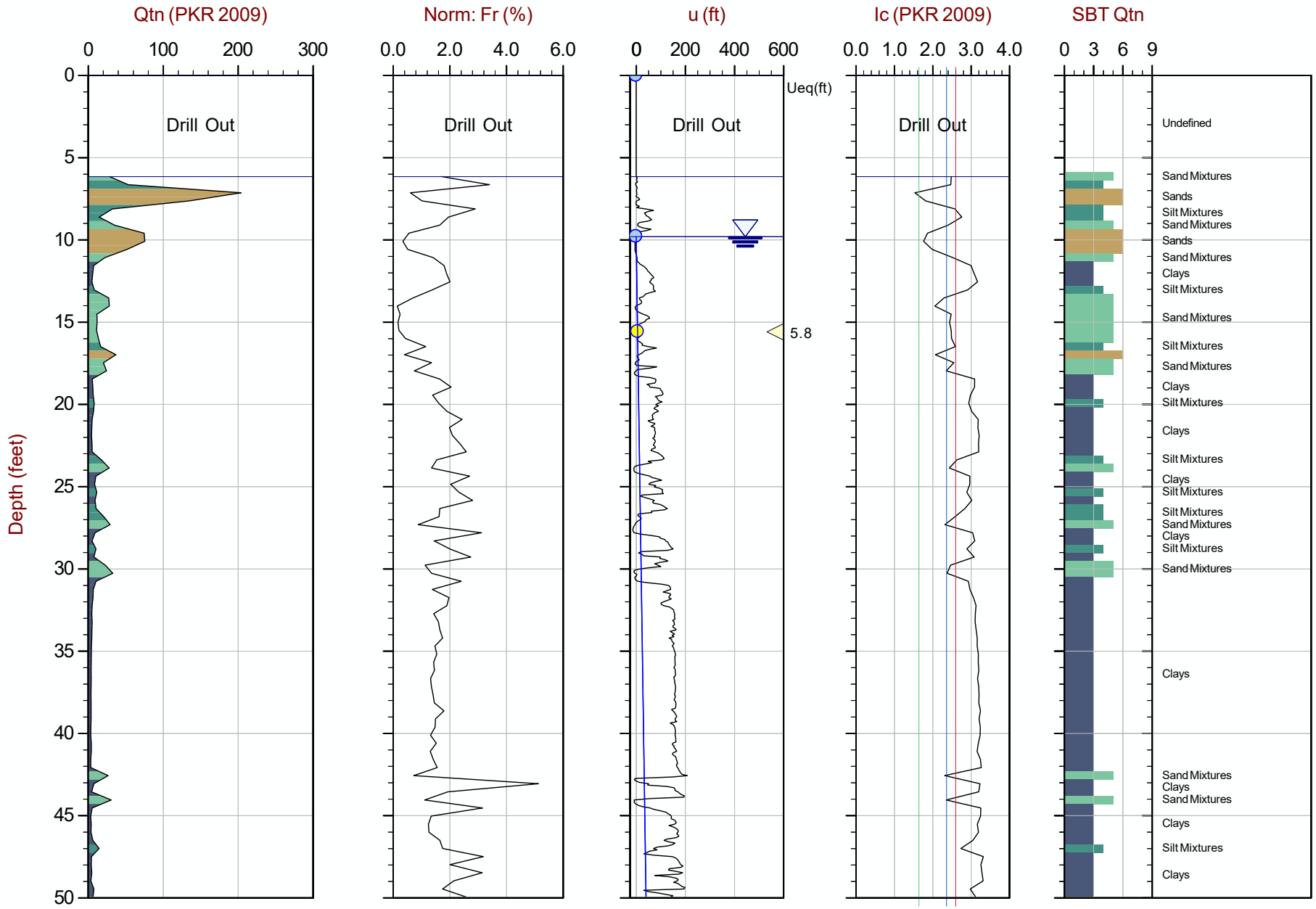
WT: 1.954 m / 6.411 ft
Ueq: 74.2 ft

CONETEC

AECOM

Job No: 19-52037
Date: 2019-06-25 09:14
Site: SLC WRF

Sounding: CP19-ES-2
Cone: 418:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 19-52037_CP19-ES-2.COR
Unit Wt: SBTQtn (PKR2009)

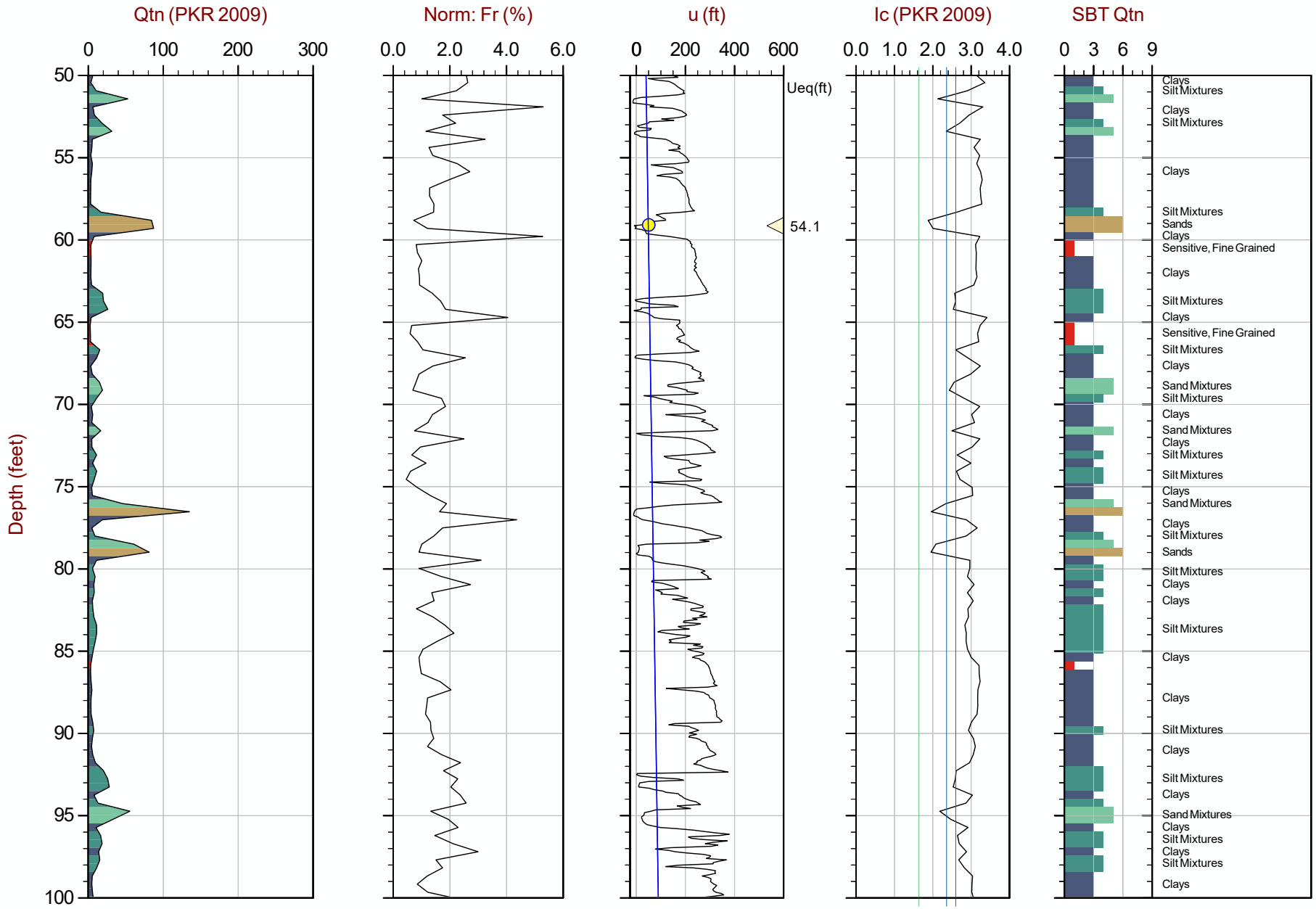
SBT: Robertson, 2009 and 2010
Coords: Lat: 40.810148 Long: -111.929153

CONETEC

AECOM

Job No: 19-52037
Date: 2019-06-25 09:14
Site: SLC WRF

Sounding: CP19-ES-2
Cone: 418:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 19-52037_CP19-ES-2.COR
Unit Wt: SBTQtn (PKR2009)

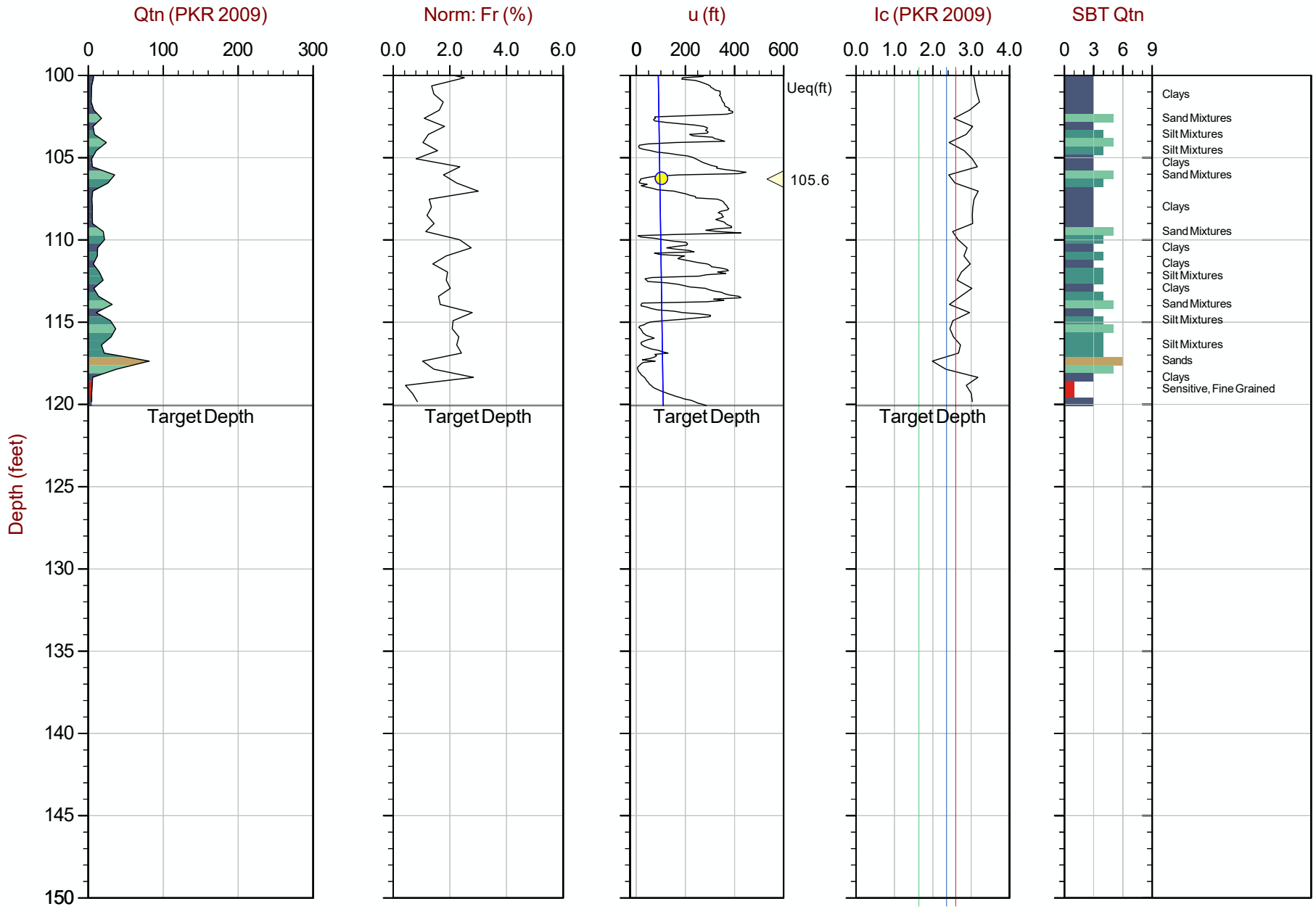
SBT: Robertson, 2009 and 2010
Coords: Lat: 40.810148 Long: -111.929153

CONETEC

AECOM

Job No: 19-52037
Date: 2019-06-25 09:14
Site: SLC WRF

Sounding: CP19-ES-2
Cone: 418:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 19-52037_CP19-ES-2.COR
Unit Wt: SBTQtn (PKR2009)

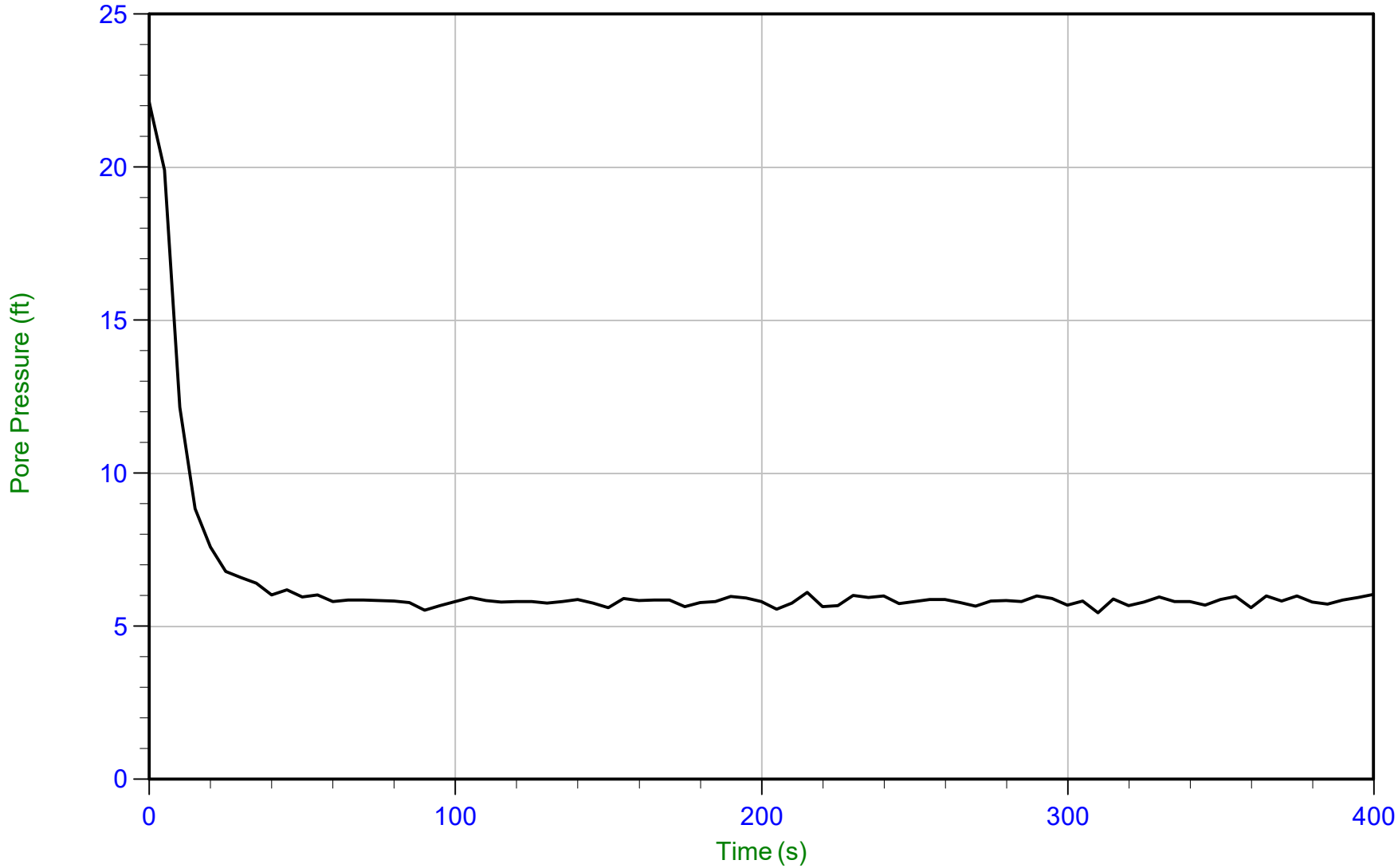
SBT: Robertson, 2009 and 2010
Coords: Lat: 40.810148 Long: -111.929153

CONETEC

AECOM

Job No: 19-52037
Date: 06/25/2019 09:14
Site: SLC WRF

Sounding: CP19-ES-2
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 19-52037_CP19-ES-2.PPD
Depth: 4.750 m / 15.584 ft
Duration: 400.0 s

u Min: 5.4 ft
u Max: 22.1 ft
u Final: 6.0 ft

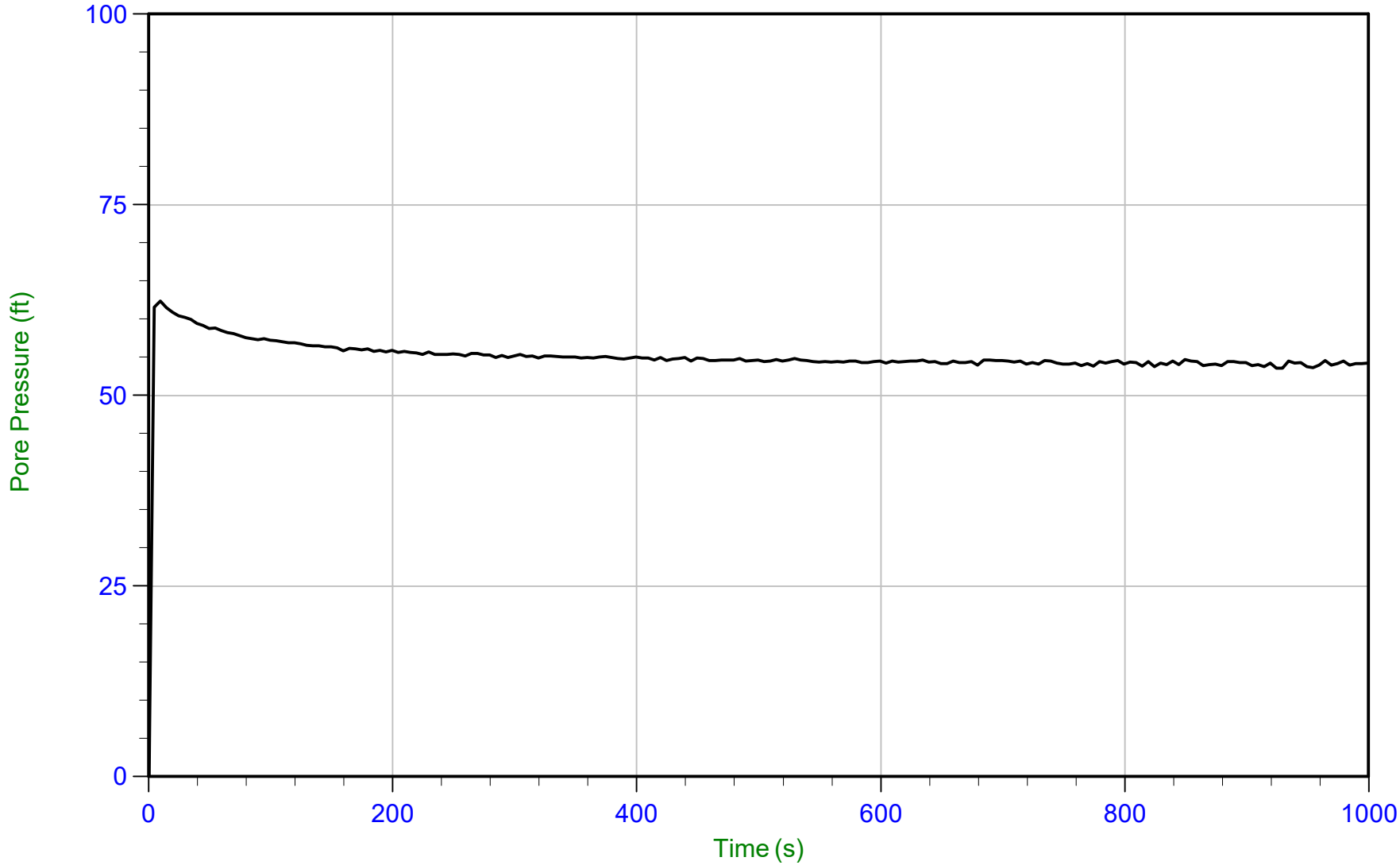
WT: 2.987 m / 9.800 ft
Ueq: 5.8 ft

CONETEC

AECOM

Job No: 19-52037
Date: 06/25/2019 09:14
Site: SLC WRF

Sounding: CP19-ES-2
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 19-52037_CP19-ES-2.PPD
Depth: 18.025 m / 59.136 ft
Duration: 1000.0 s

u Min: -6.6 ft
u Max: 62.3 ft
u Final: 54.2 ft

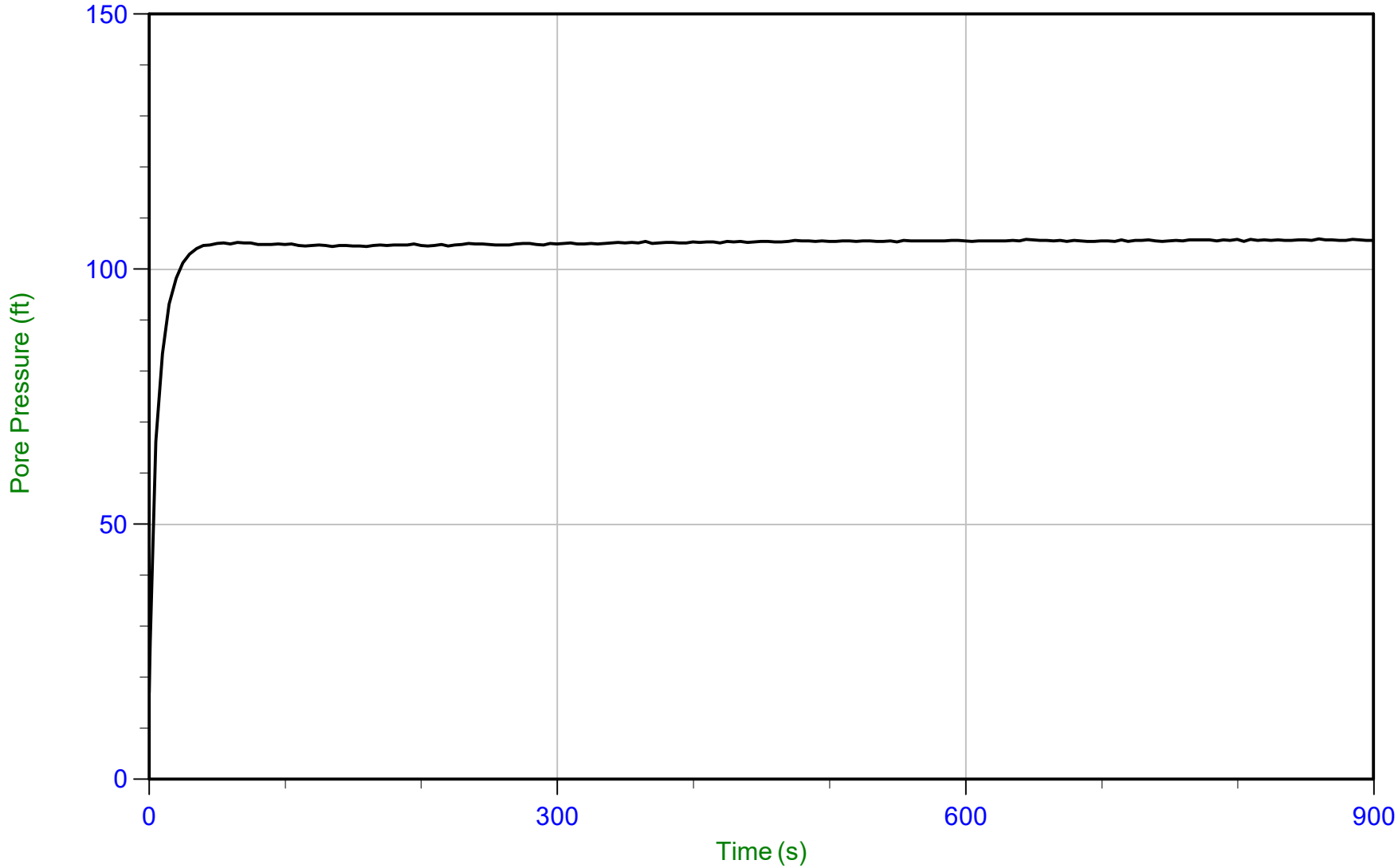
WT: 1.536 m / 5.039 ft
Ueq: 54.1 ft

CONETEC

AECOM

Job No: 19-52037
Date: 06/25/2019 09:14
Site: SLC WRF

Sounding: CP19-ES-2
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 19-52037_CP19-ES-2.PPD
Depth: 32.400 m / 106.298 ft
Duration: 900.0 s

u Min: 17.1 ft
u Max: 105.9 ft
u Final: 105.7 ft

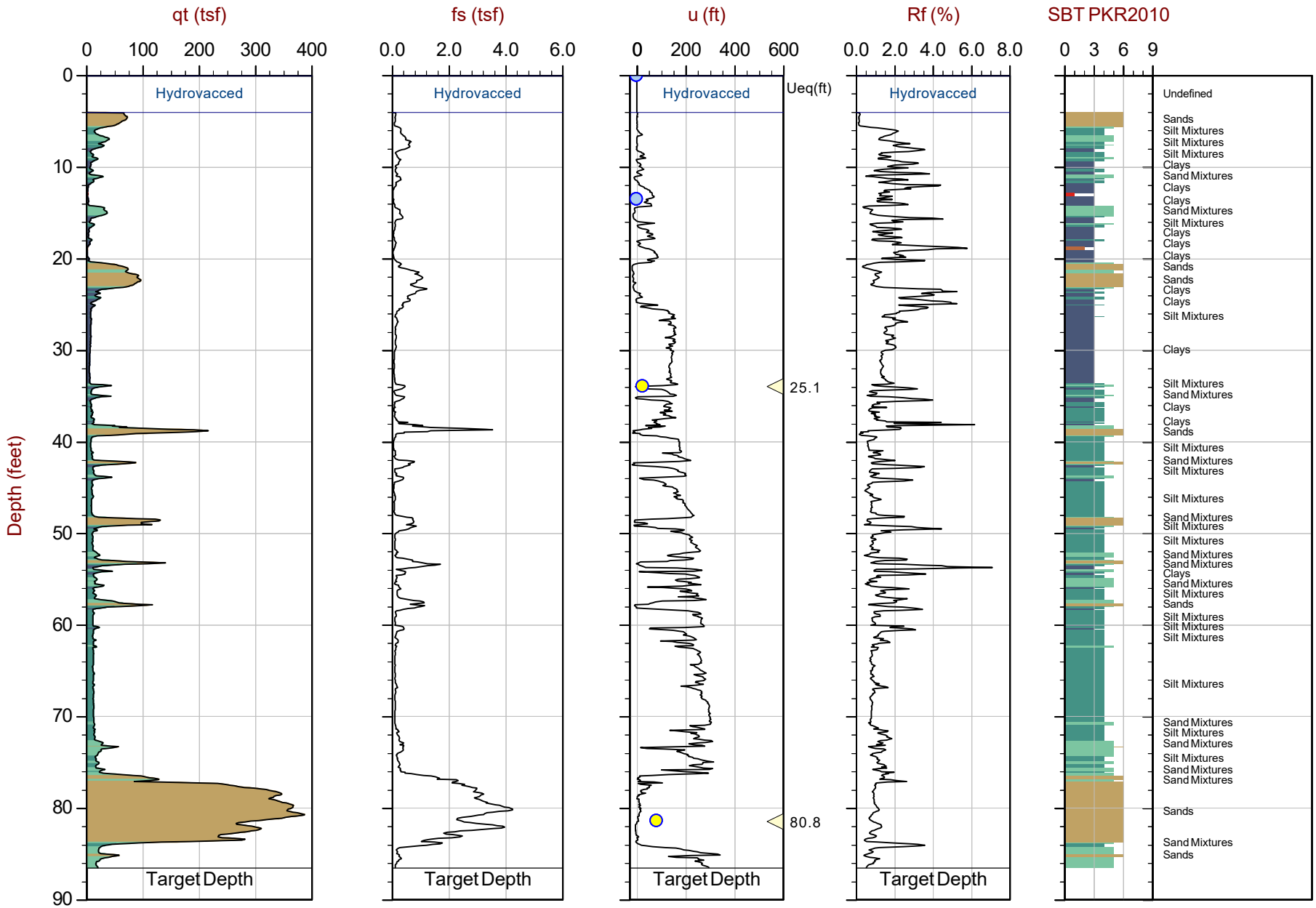
WT: 0.192 m / 0.630 ft
Ueq: 105.7 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-05 08:25
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-01
Cone: 794:T1500F15U35



Max Depth: 26.375 m / 86.53 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP01.COR

00 31 32-175

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.801267 Long: -111.926425
Sheet No: 1 of 1

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

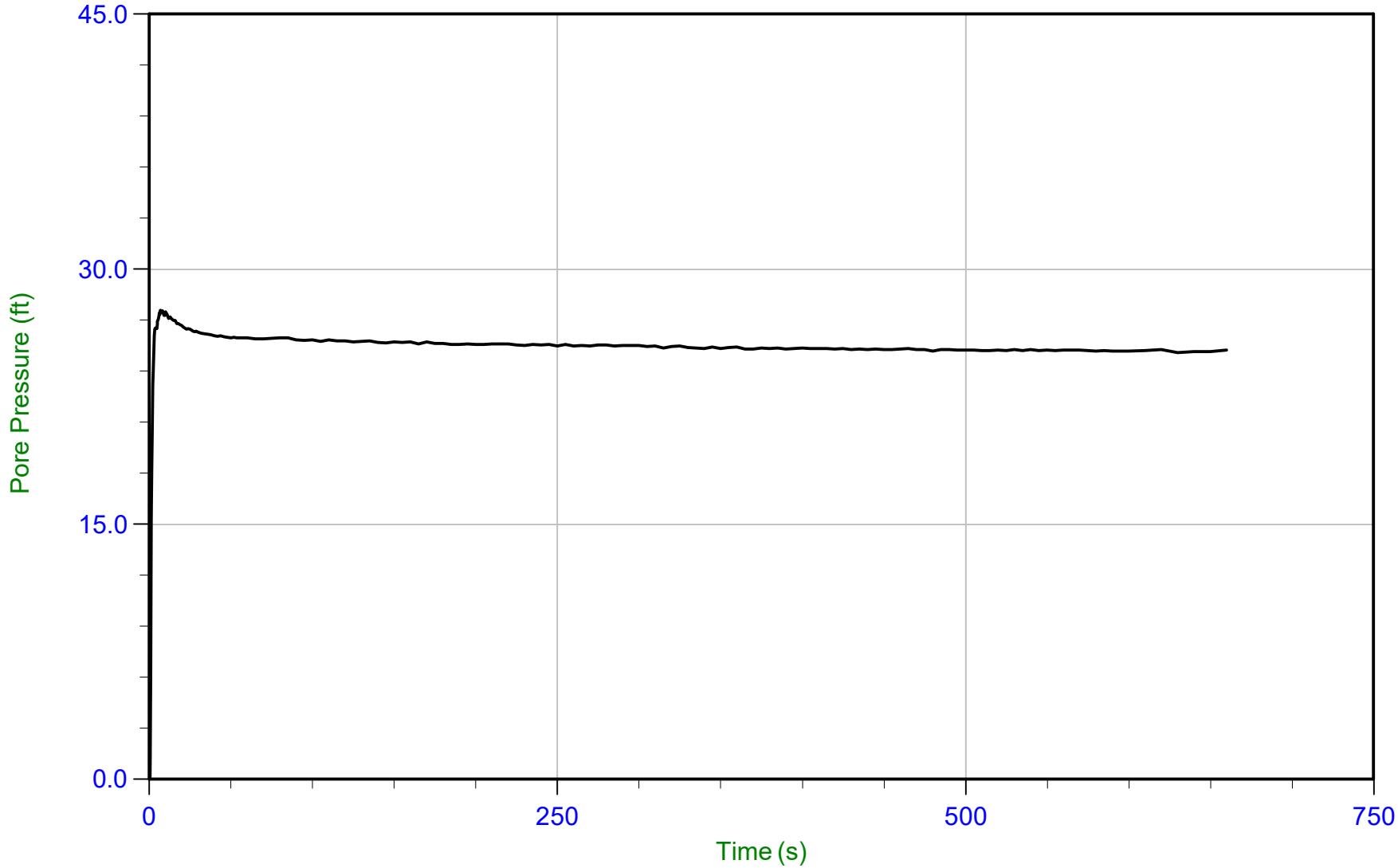
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/05/2021 08:25
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-01
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP01.ppd2
Depth: 10.350 m / 33.956 ft
Duration: 660.0 s

u Min: -7.5 ft
u Max: 27.6 ft
u Final: 25.2 ft

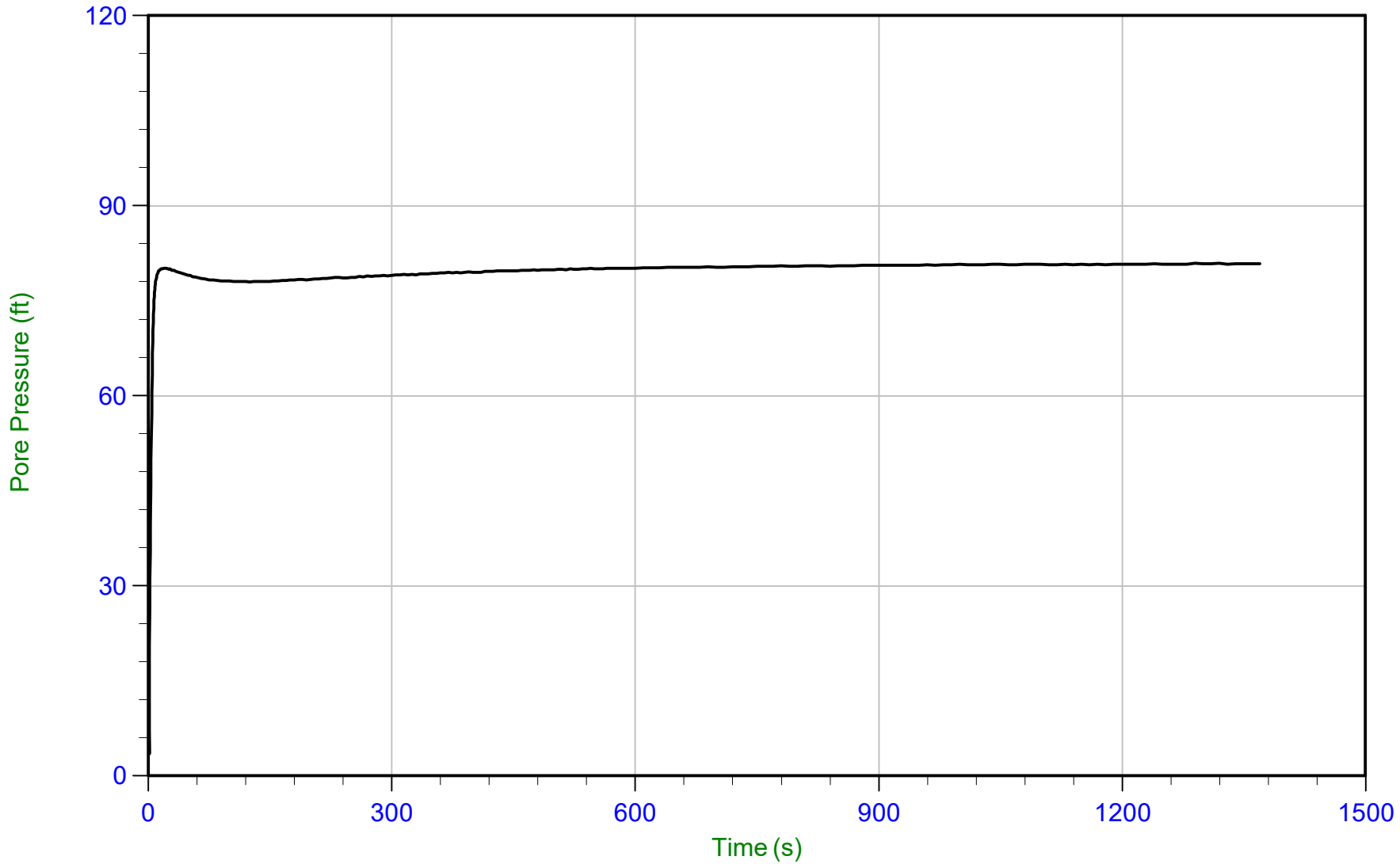
WT: 2.681 m / 8.796 ft
Ueq: 25.2 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/05/2021 08:25
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-01
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP01.ppd2
Depth: 24.825 m / 81.446 ft
Duration: 1370.0 s

u Min: 3.4 ft
u Max: 80.9 ft
u Final: 80.8 ft

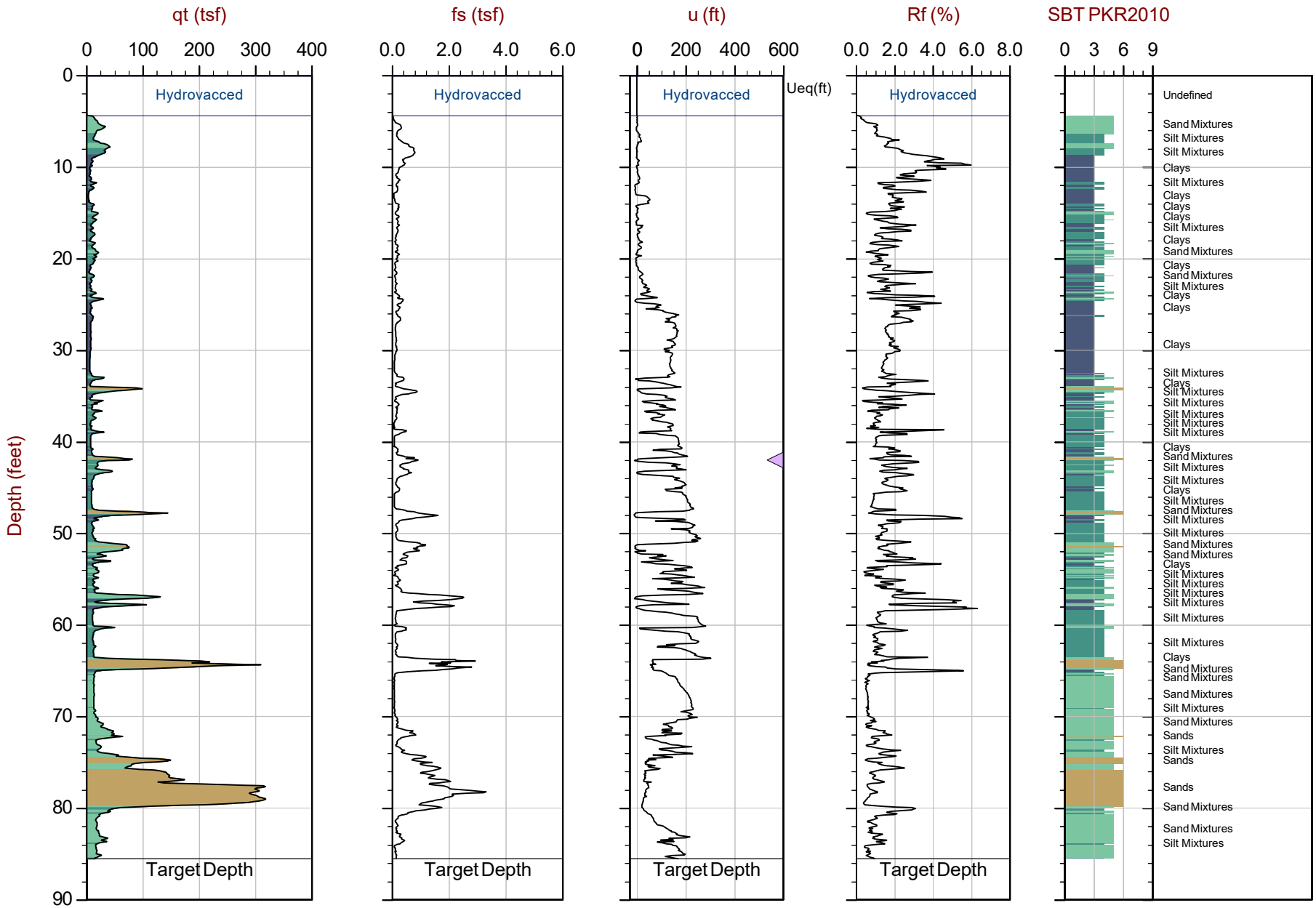
WT: 0.172 m / 0.564 ft
Ueq: 80.9 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-04 14:09
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-02
Cone: 794:T1500F15U35



Max Depth: 26.075 m / 85.55 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP02.COR

00 31 32-178

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.801238 Long: -111.927454
Sheet No: 1 of 1

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

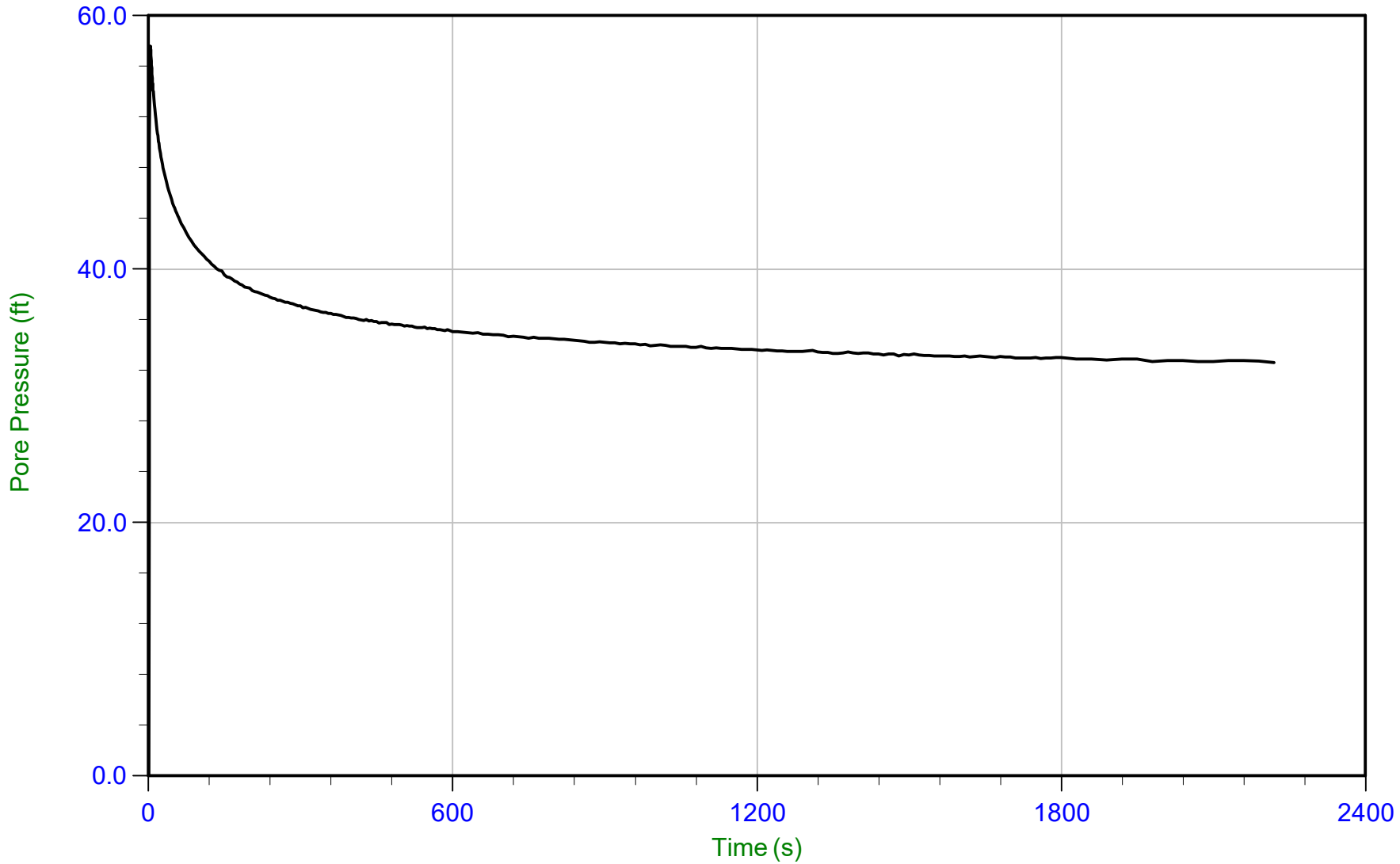
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/04/2021 14:09
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-02
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP02.ppd2
Depth: 12.800 m / 41.994 ft
Duration: 2220.0 s

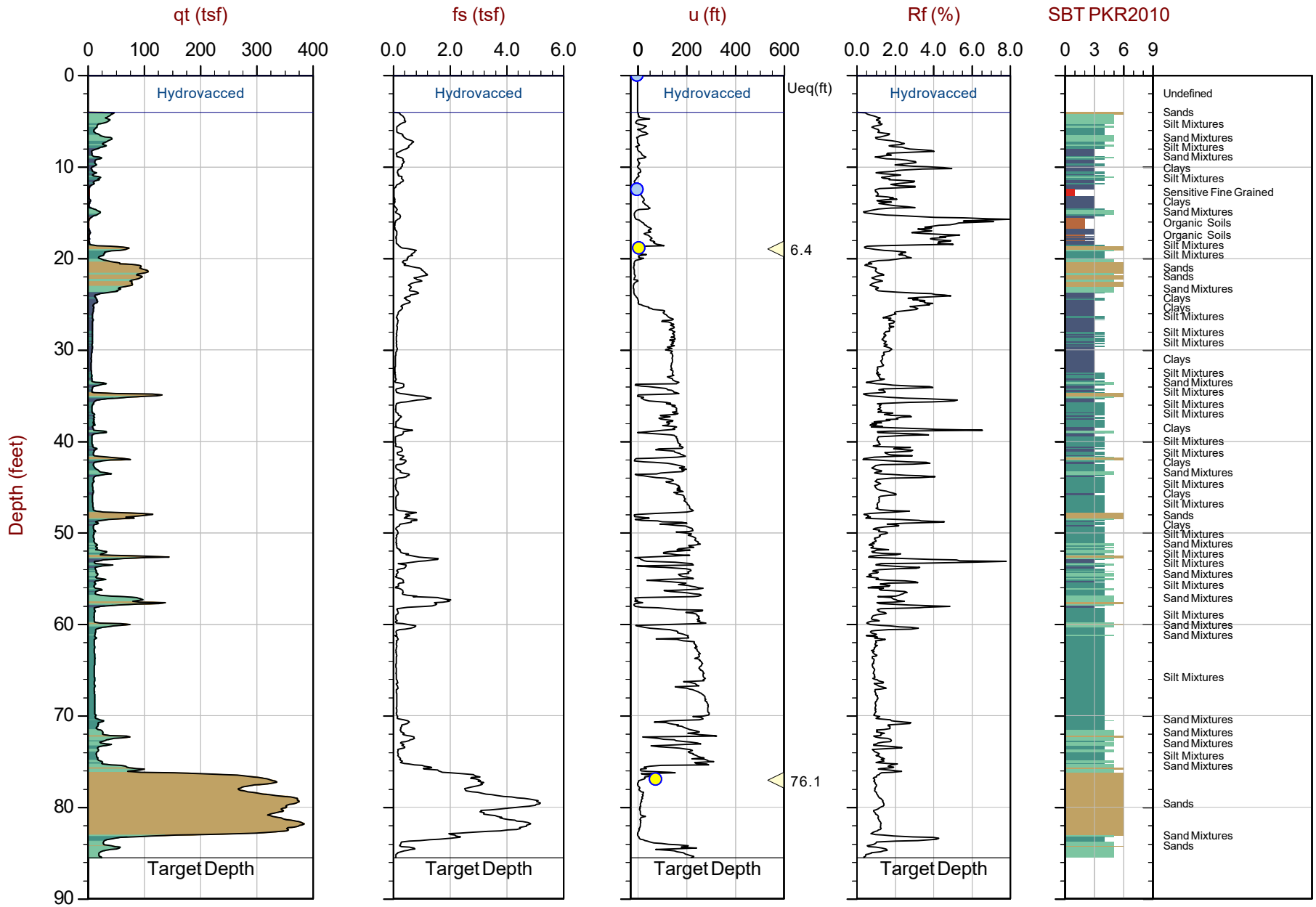
u Min: -11.1 ft
u Max: 57.6 ft
u Final: 32.6 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-03 08:29
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-03
Cone: 794:T1500F15U35



Max Depth: 26.075 m / 85.55 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP03.COR

00 31 32-180

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.801095 Long: -111.926527
Sheet No: 1 of 1

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

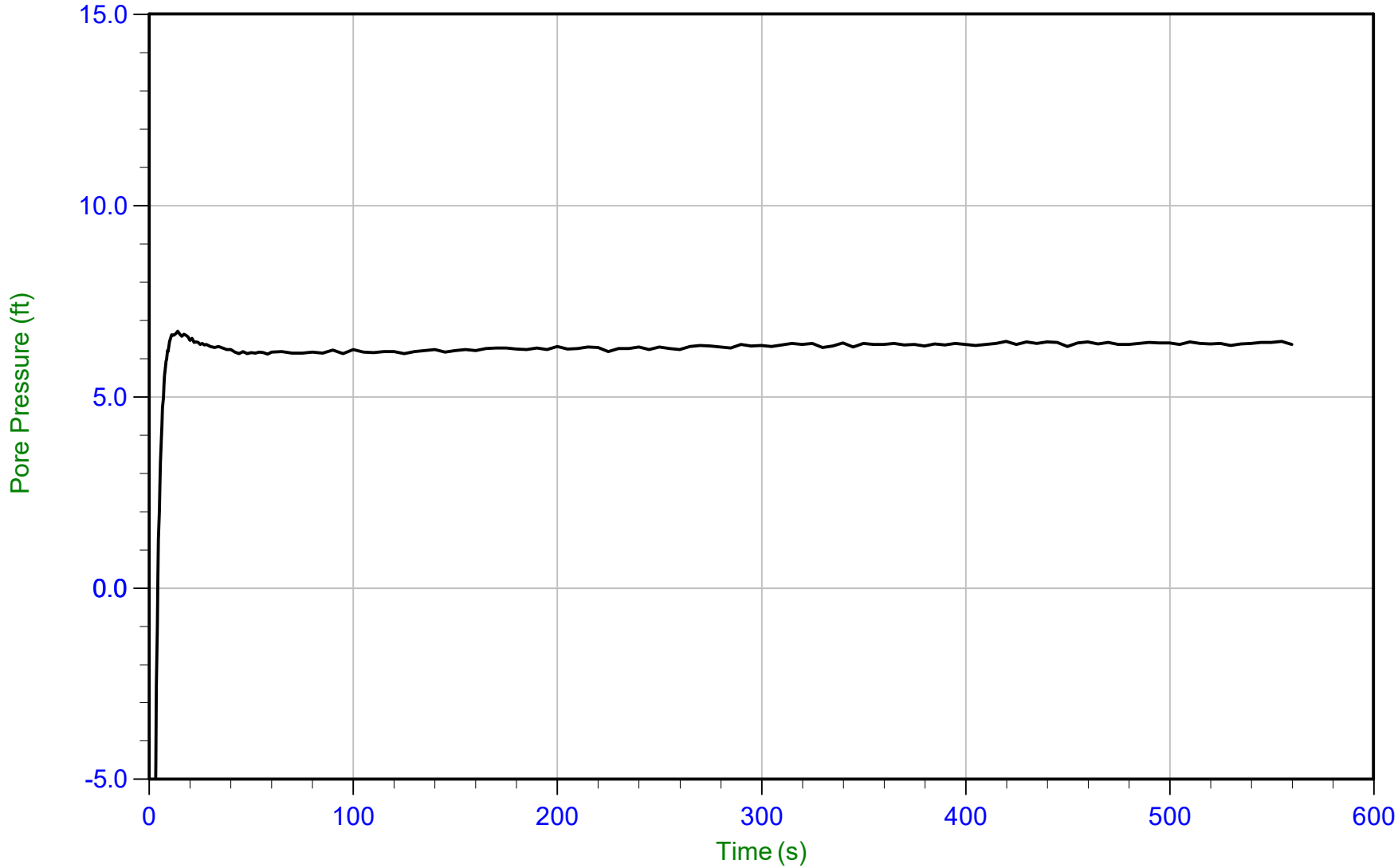
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/03/2021 08:29
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-03
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP03.ppd2
Depth: 5.775 m / 18.947 ft
Duration: 560.0 s

u Min: -16.0 ft
u Max: 6.7 ft
u Final: 6.4 ft

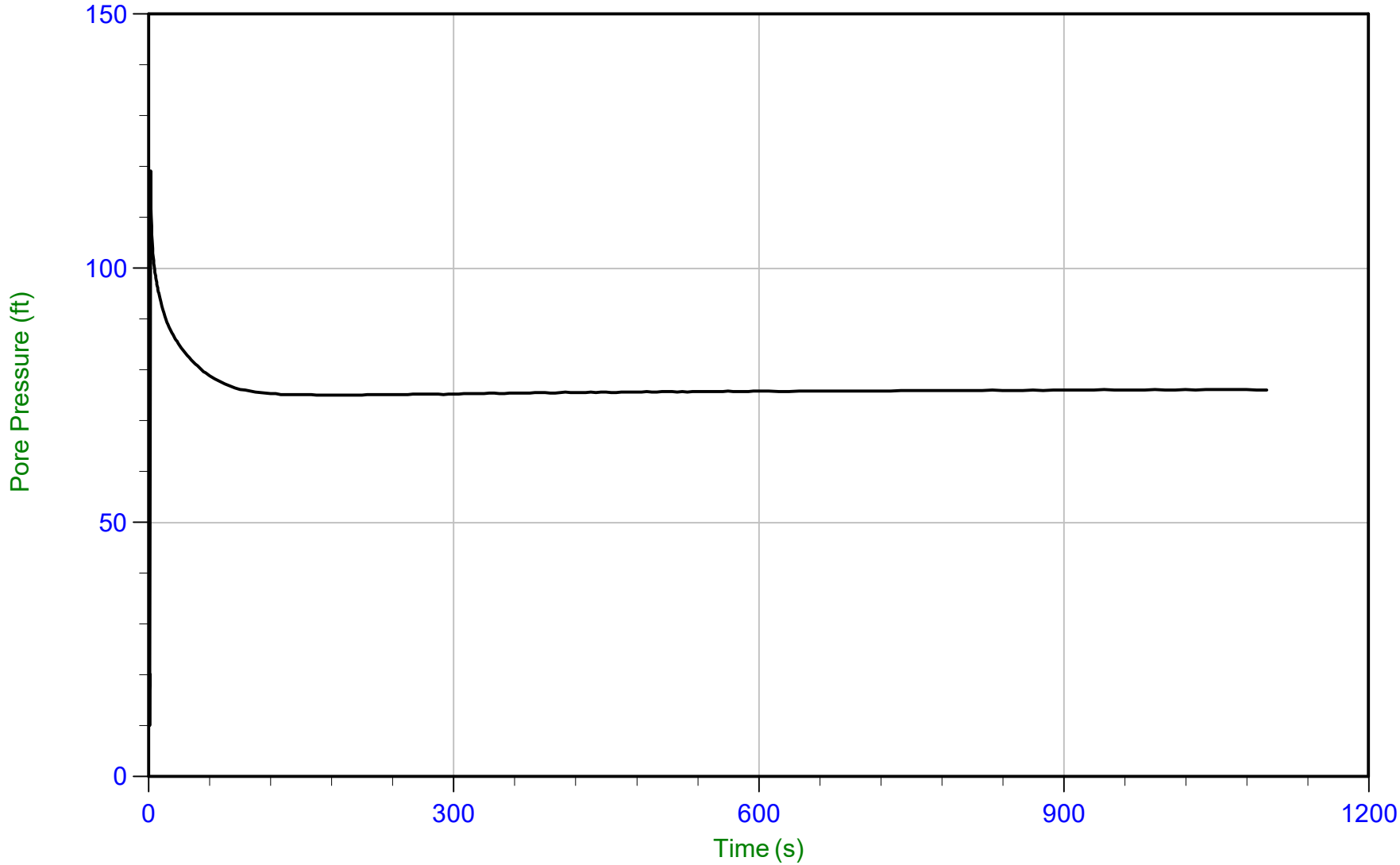
WT: 3.821 m / 12.536 ft
Ueq: 6.4 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/03/2021 08:29
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-03
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP03.ppd2
Depth: 23.475 m / 77.017 ft
Duration: 1100.0 s

u Min: 10.1 ft
u Max: 119.1 ft
u Final: 76.1 ft

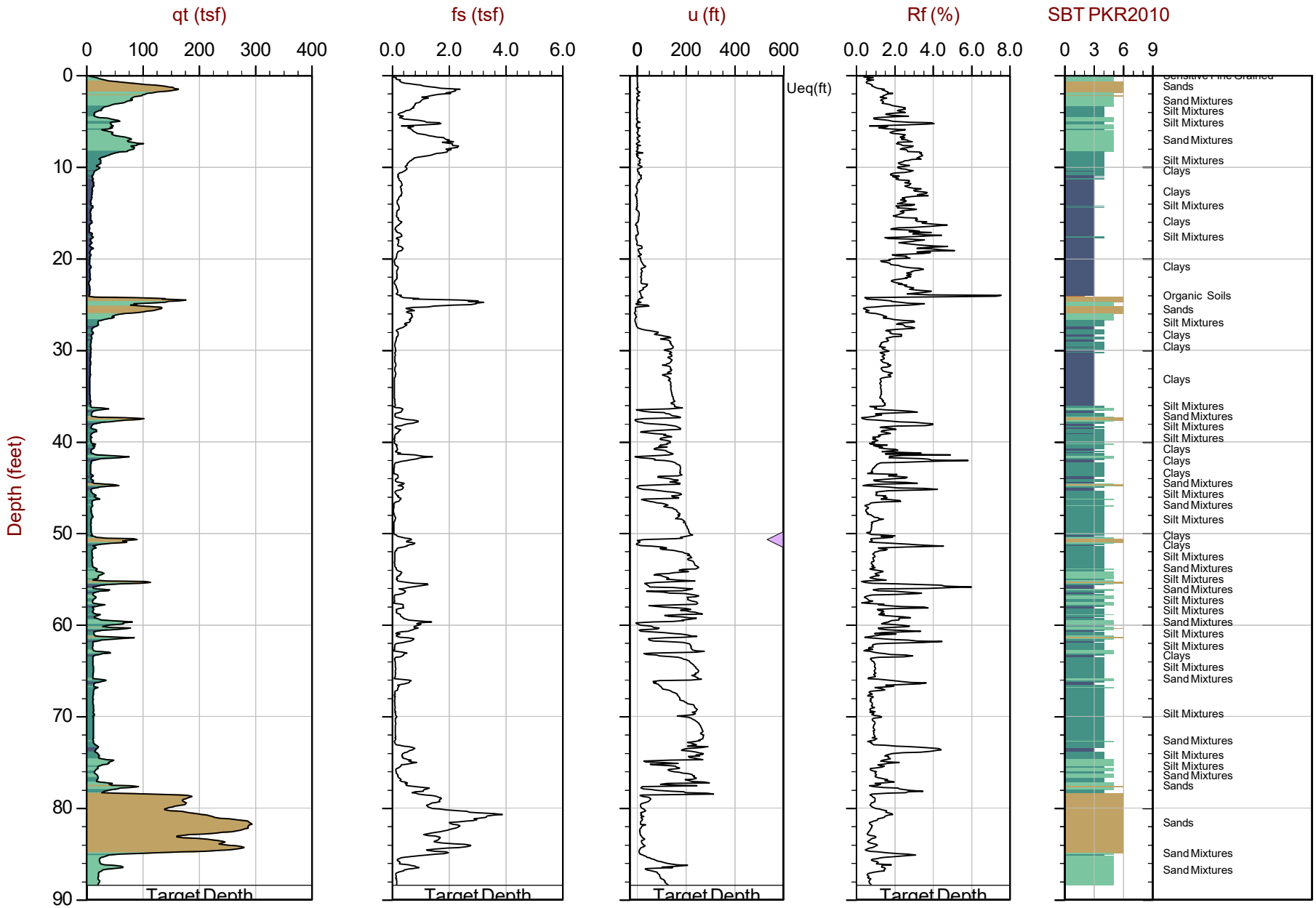
WT: 0.275 m / 0.902 ft
Ueq: 76.1 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-05 10:42
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-04
Cone: 794:T1500F15U35



Max Depth: 26.950 m / 88.42 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP04.COR

00 31 32-183

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.801276 Long: -111.926833
Sheet No: 1 of 1

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

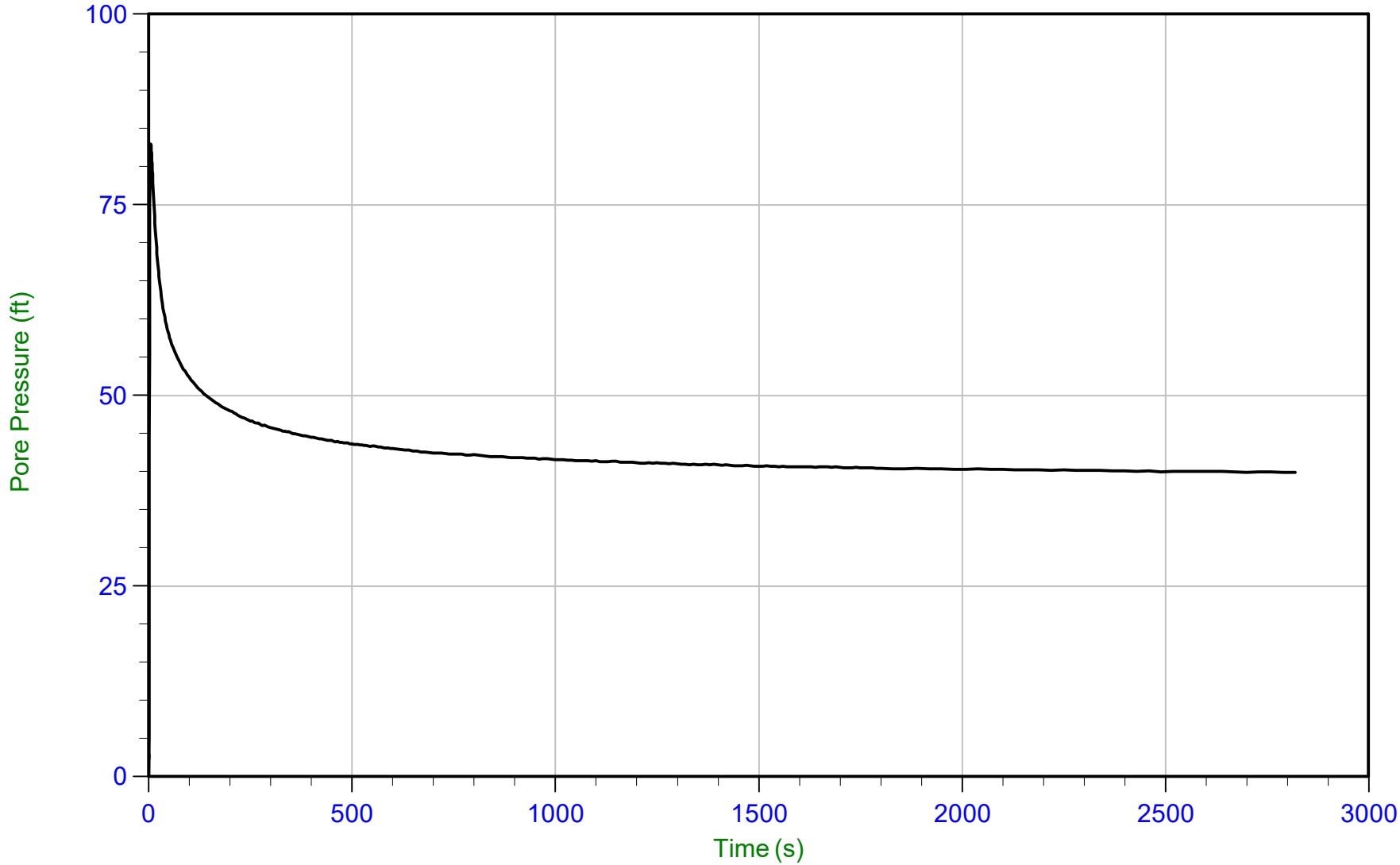
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/05/2021 09:48
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-04
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP04.ppd2
Depth: 15.450 m / 50.688 ft
Duration: 2820.0 s

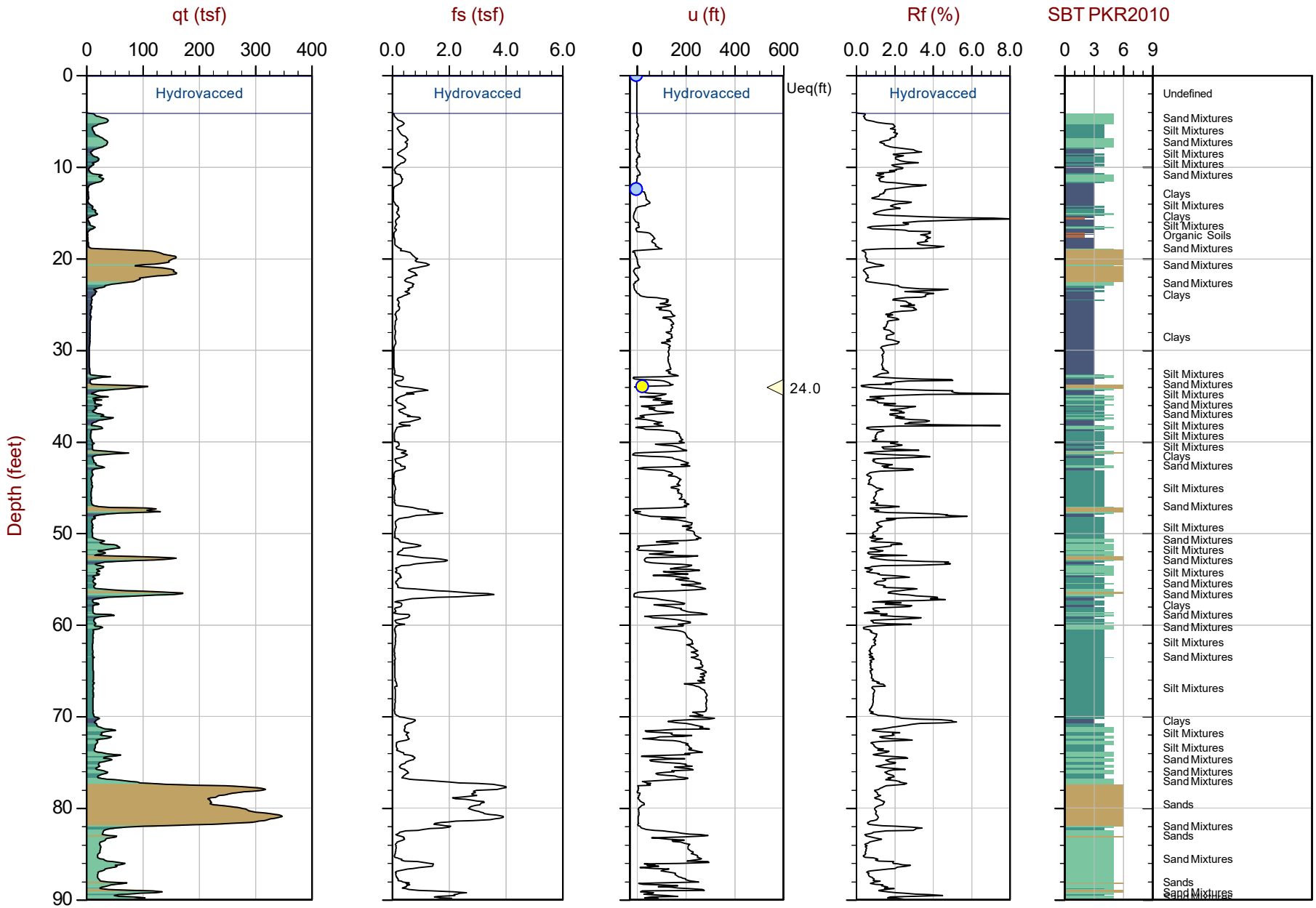
u Min: -0.2 ft
u Max: 82.9 ft
u Final: 39.9 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-04 10:02
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-05
Cone: 794:T1500F15U35



Max Depth: 41.925 m / 137.55 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP05.COR

00 31 32-185

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.801075 Long: -111.926915
Sheet No: 1 of 2

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

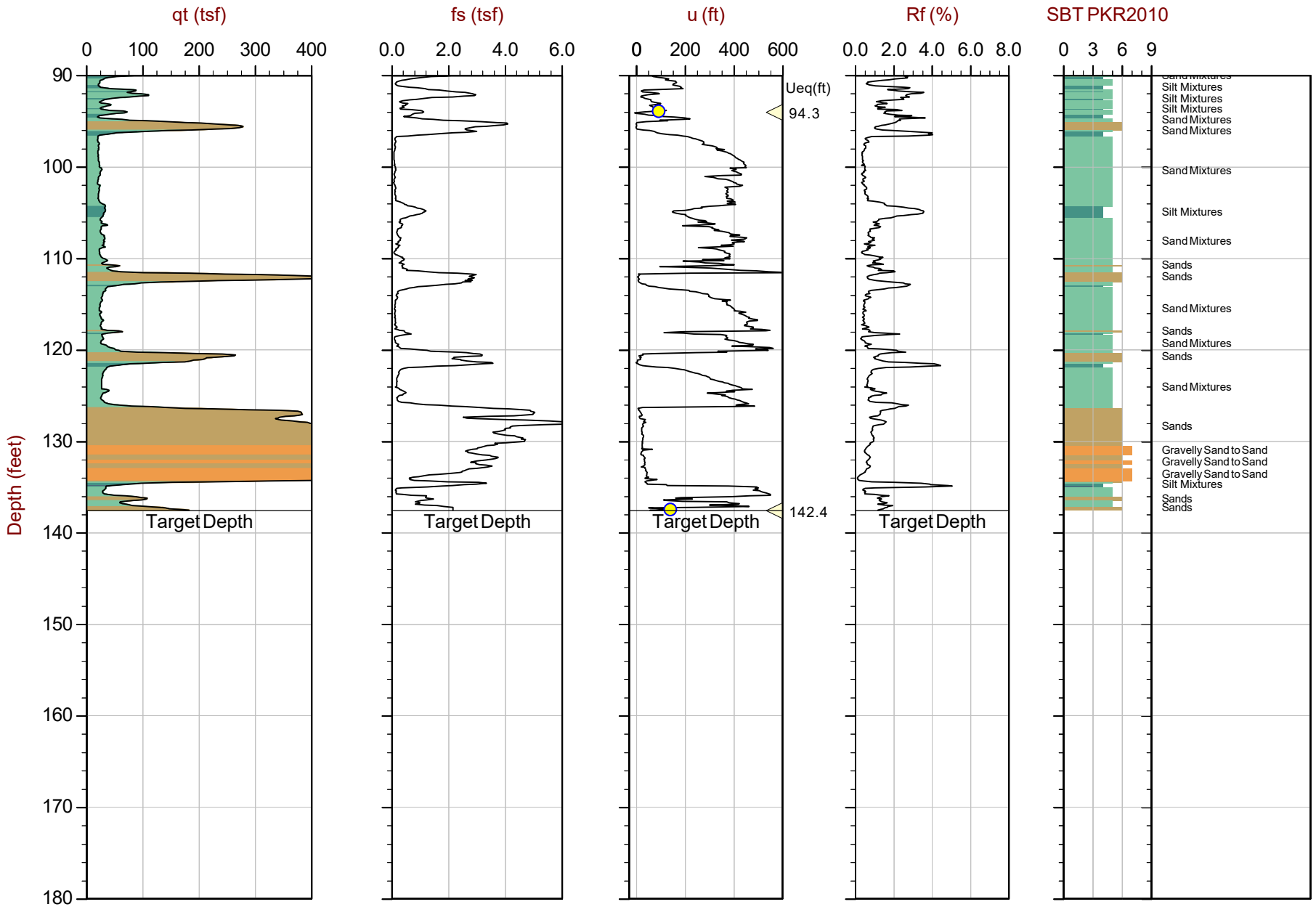
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-04 10:02
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-05
Cone: 794:T1500F15U35



Max Depth: 41.925 m / 137.55 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP05.COR

00 31 32-186

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.801075 Long: -111.926915
Sheet No: 2 of 2

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

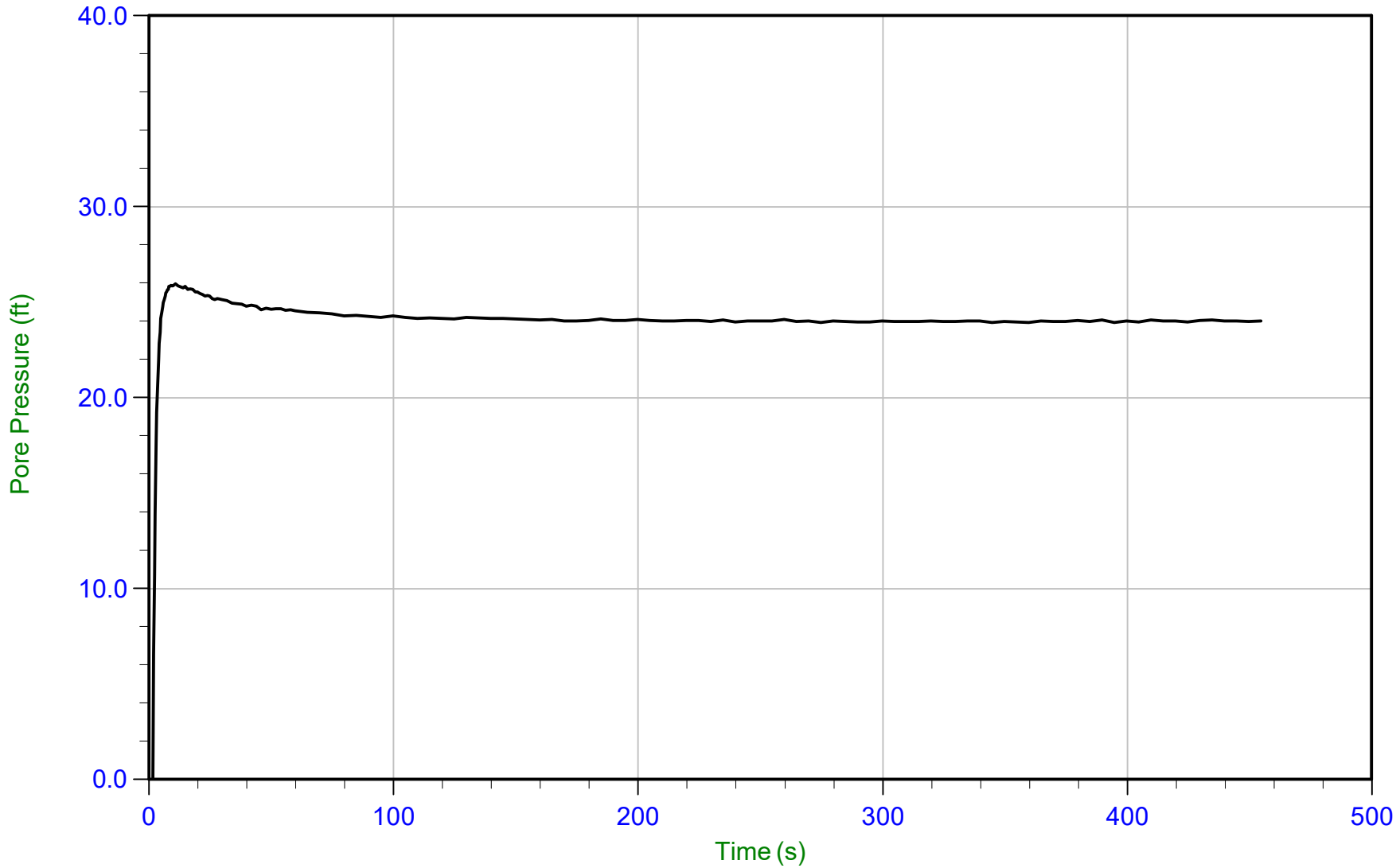
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/04/2021 10:02
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-05
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP05.ppd2
Depth: 10.375 m / 34.038 ft
Duration: 455.0 s

u Min: -10.5 ft
u Max: 26.0 ft
u Final: 24.0 ft

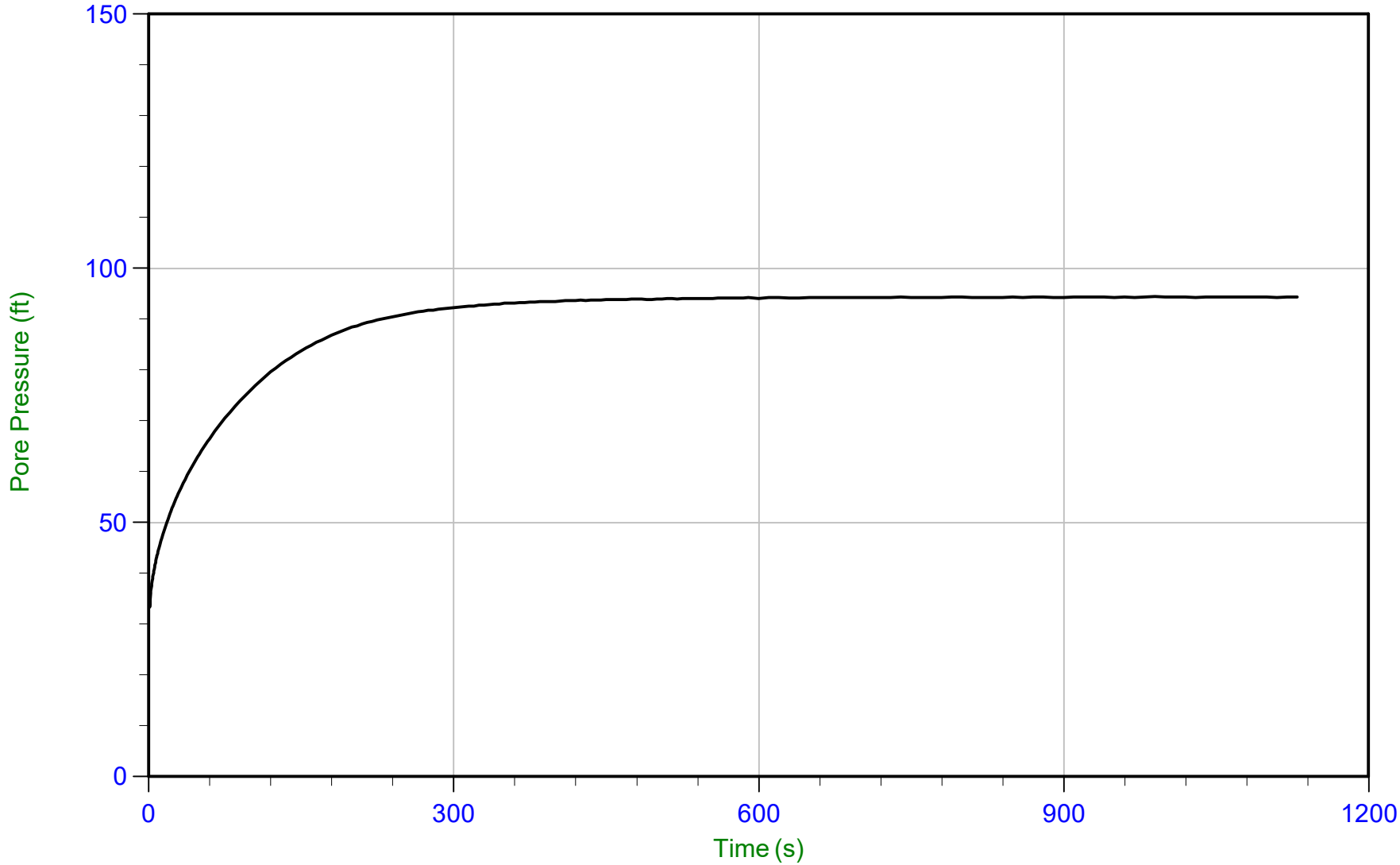
WT: 3.060 m / 10.039 ft
Ueq: 24.0 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/04/2021 10:02
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-05
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP05.ppd2
Depth: 28.650 m / 93.995 ft
Duration: 1130.0 s

u Min: 33.3 ft
u Max: 94.4 ft
u Final: 94.4 ft

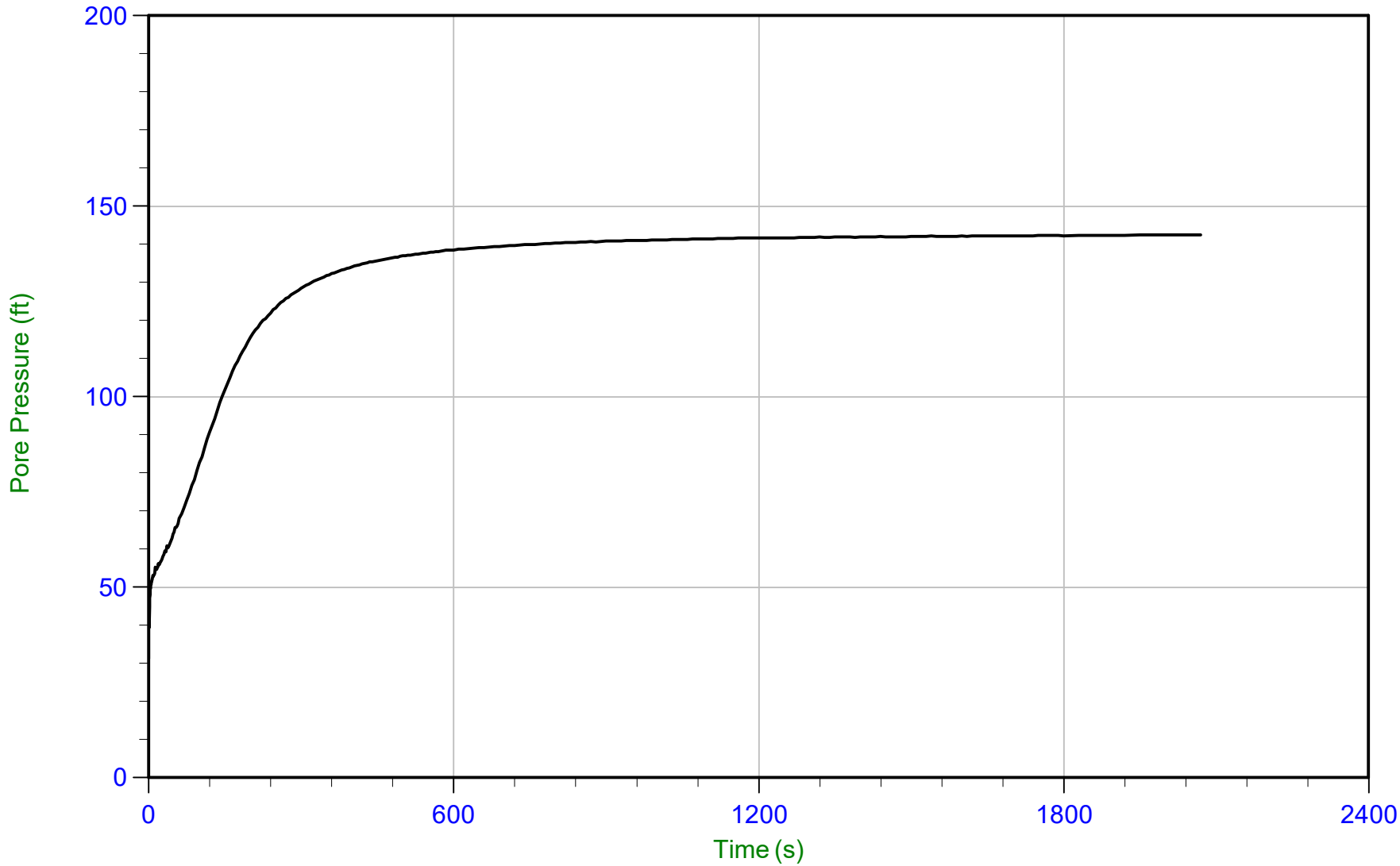
WT: -0.106 m / -0.348 ft
Ueq: 94.3 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/04/2021 10:02
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-05
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP05.ppd2
Depth: 41.925 m / 137.548 ft
Duration: 2070.0 s

u Min: 31.2 ft
u Max: 142.5 ft
u Final: 142.5 ft

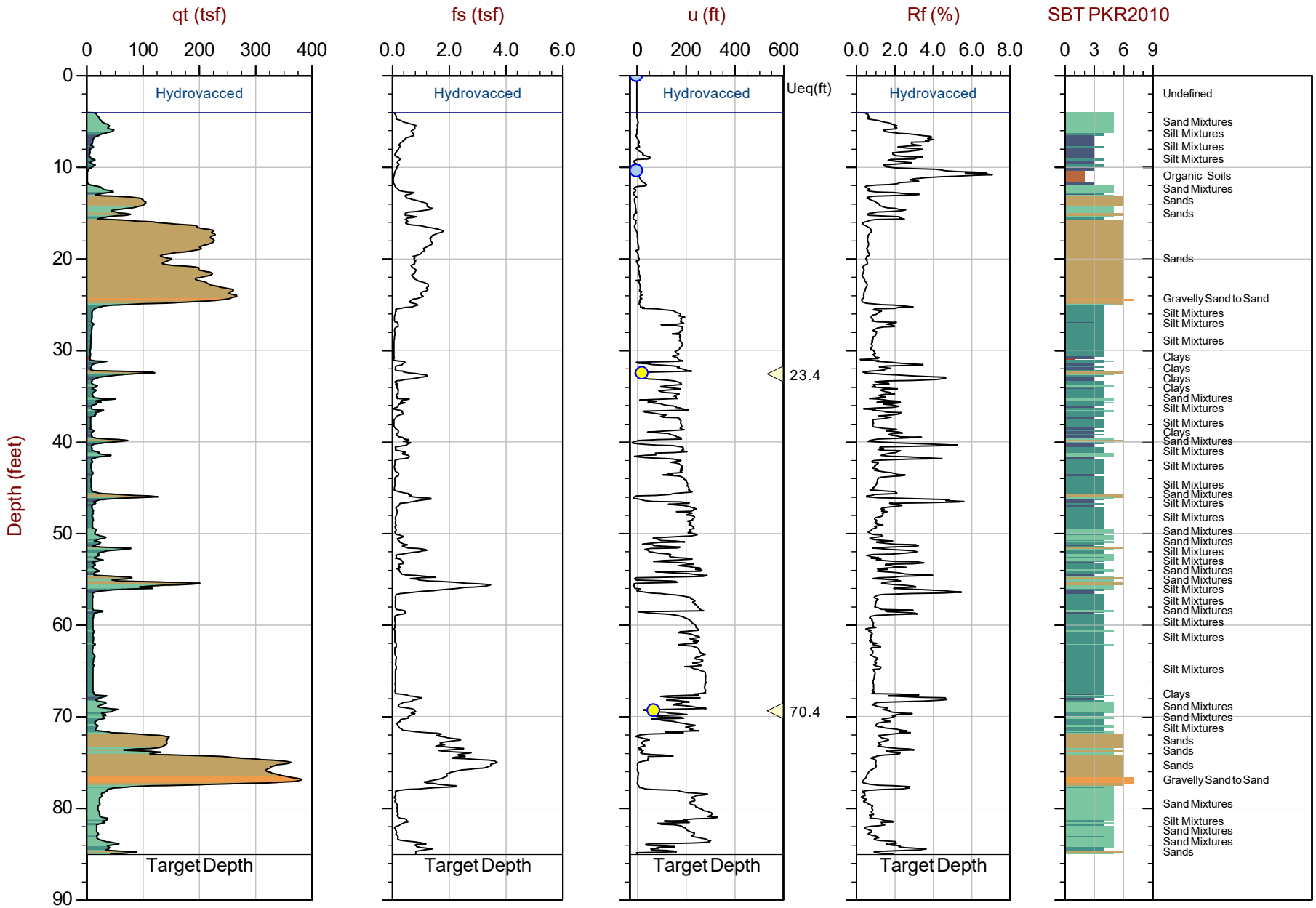
WT: -1.507 m / -4.945 ft
Ueq: 142.5 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-03 13:46
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-06
Cone: 794:T1500F15U35



Max Depth: 25.925 m / 85.05 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP06.COR

00 31 32-190

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.801101 Long: -111.927499
Sheet No: 1 of 1

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

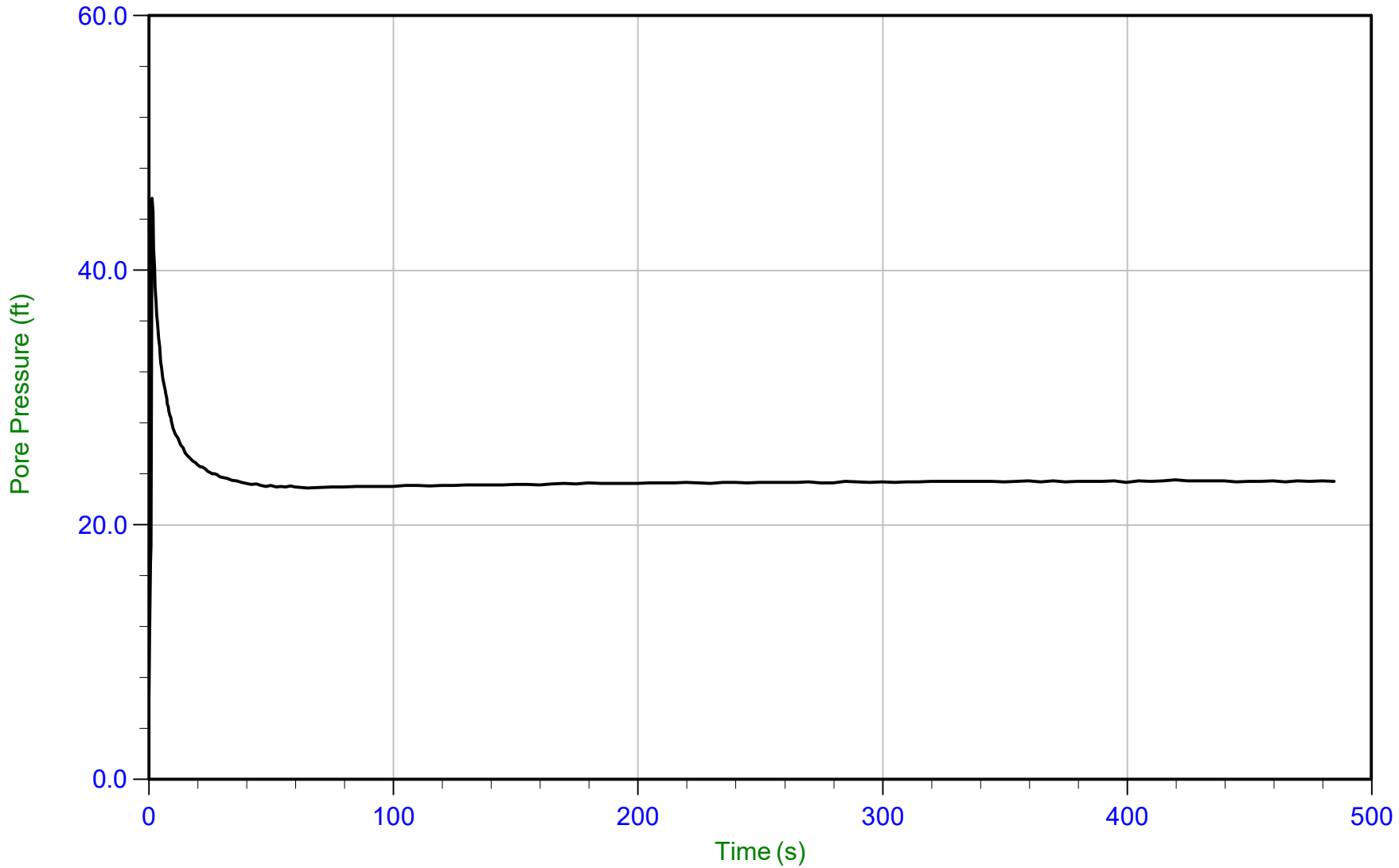
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/03/2021 13:46
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-06
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP06.ppd2
Depth: 9.925 m / 32.562 ft
Duration: 485.0 s

u Min: 6.8 ft
u Max: 45.6 ft
u Final: 23.4 ft

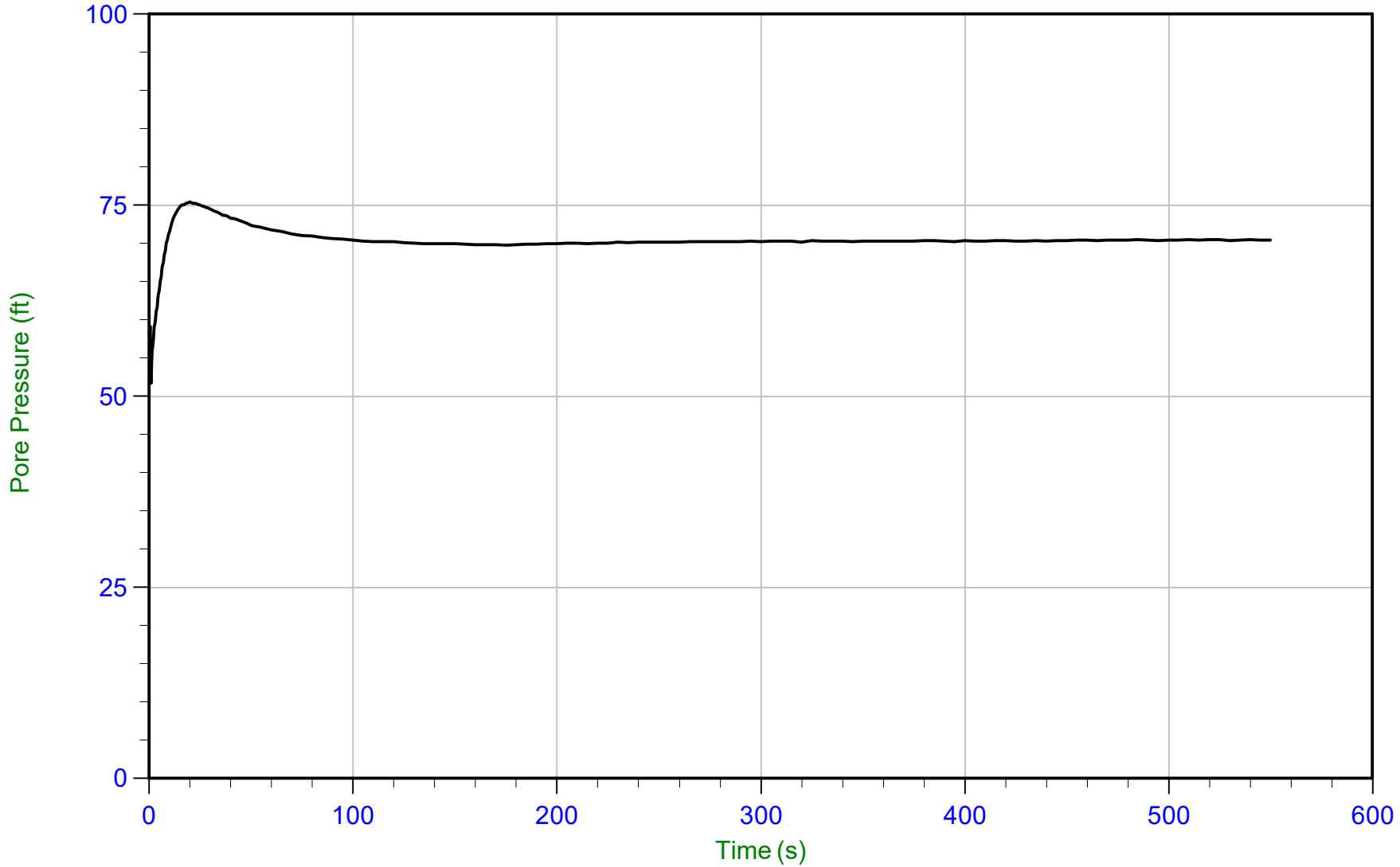
WT: 2.784 m / 9.133 ft
Ueq: 23.4 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/03/2021 13:46
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-06
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP06.ppd2
Depth: 21.150 m / 69.389 ft
Duration: 550.0 s

u Min: 51.7 ft
u Max: 75.4 ft
u Final: 70.4 ft

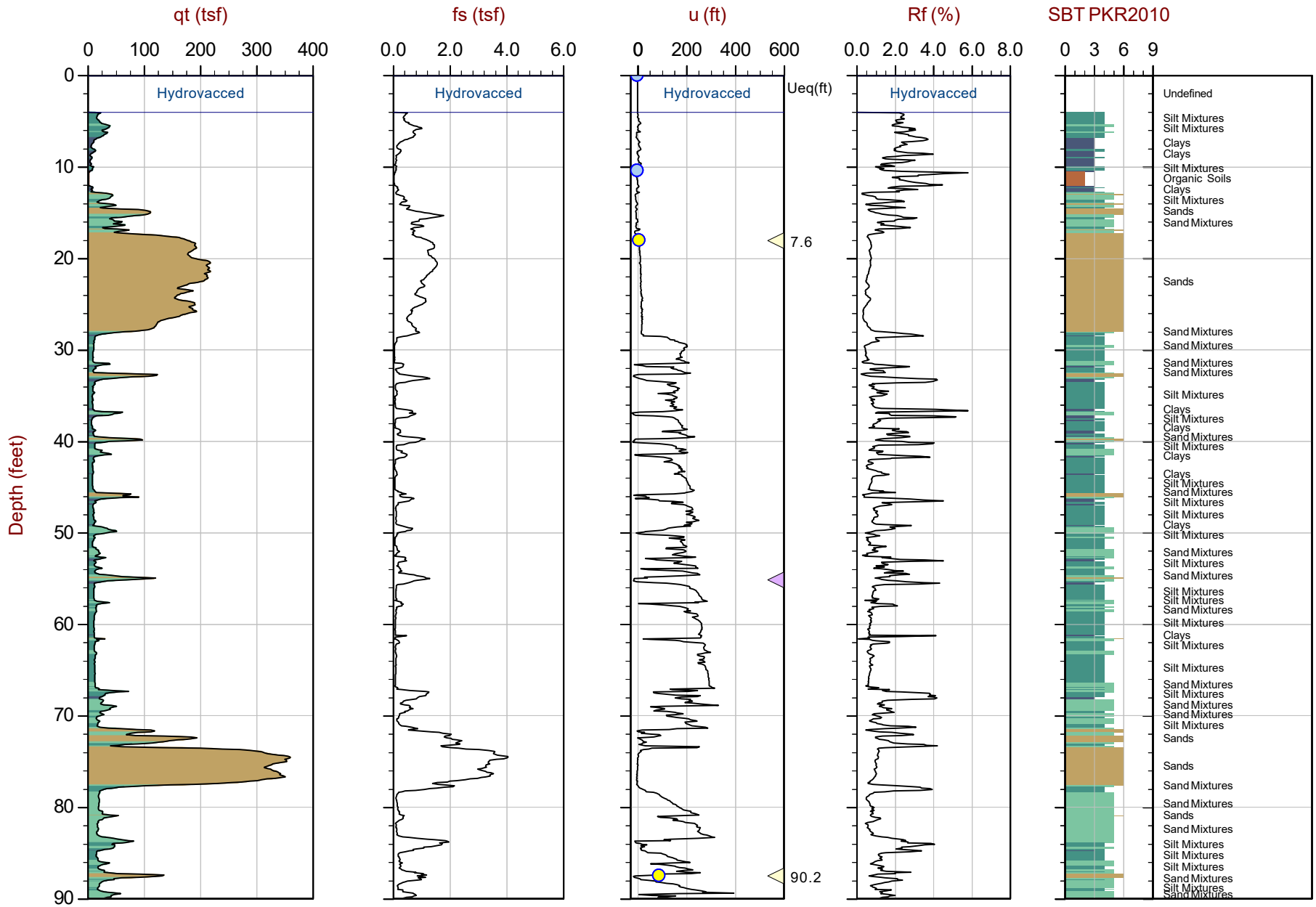
WT: -0.328 m / -1.077 ft
Ueq: 70.5 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-03 09:53
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-07
Cone: 794:T1500F15U35



Max Depth: 49.000 m / 160.76 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP07.COR

00 31 32-193

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.801015 Long: -111.927373
Sheet No: 1 of 2

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

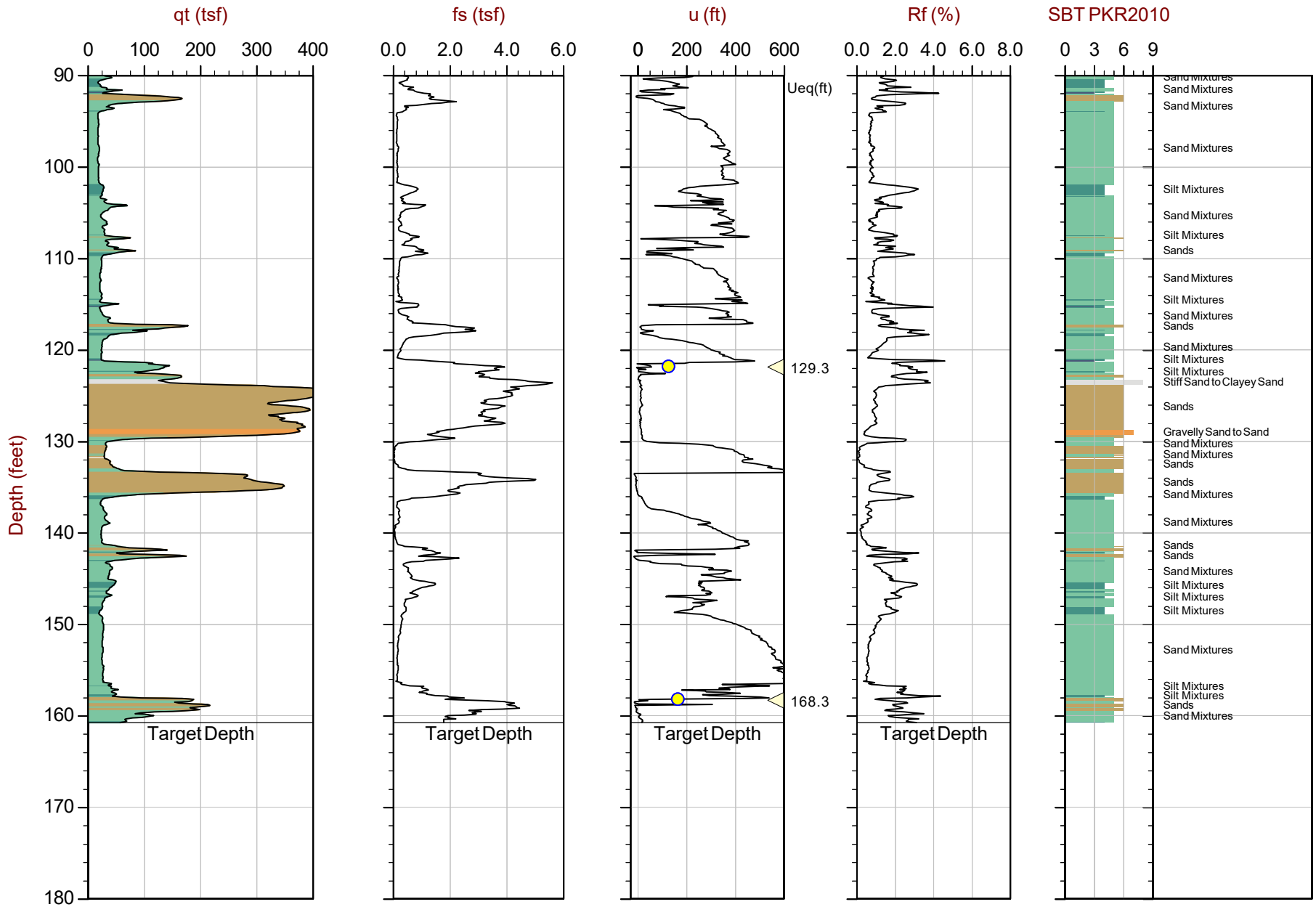
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-03 09:53
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-07
Cone: 794:T1500F15U35



Max Depth: 49.000 m / 160.76 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP07.COR

00 31 32-194

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.801015 Long: -111.927373
Sheet No: 2 of 2

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

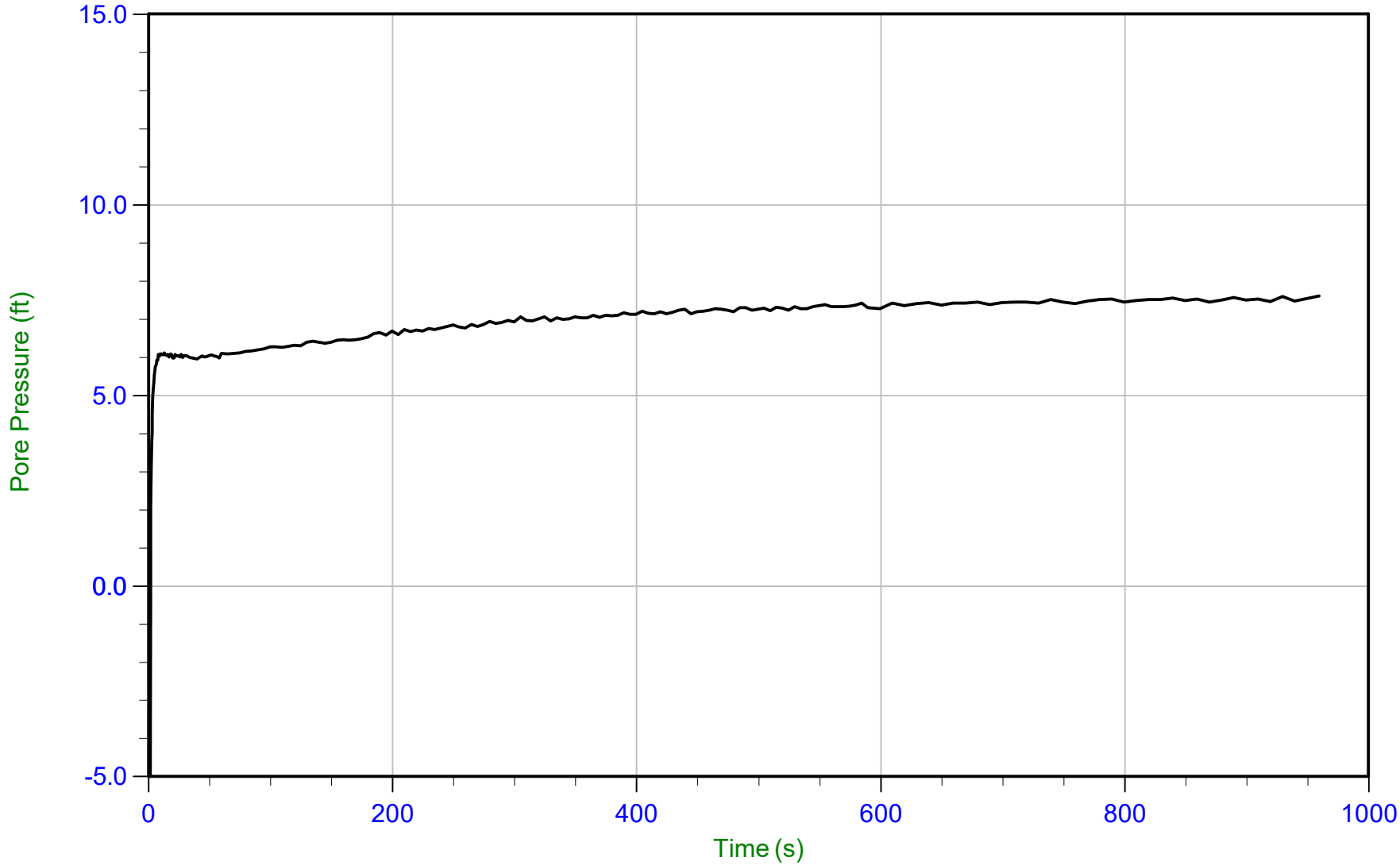
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/03/2021 09:53
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-07
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP07.ppd2
Depth: 5.500 m / 18.044 ft
Duration: 960.0 s

u Min: -7.0 ft
u Max: 7.6 ft
u Final: 7.6 ft

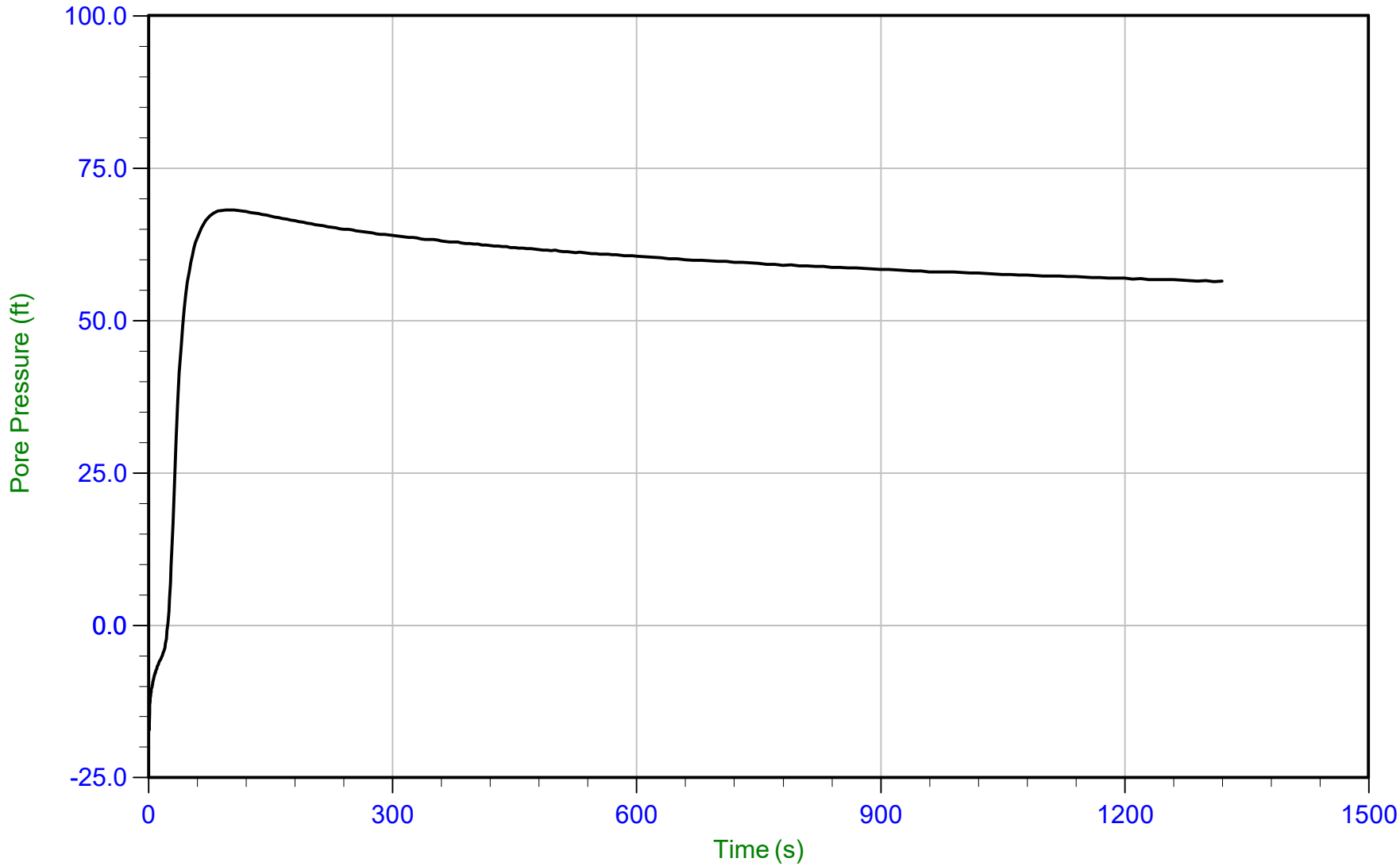
WT: 3.190 m / 10.465 ft
Ueq: 7.6 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/03/2021 09:53
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-07
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP07.ppd2
Depth: 16.800 m / 55.117 ft
Duration: 1320.0 s

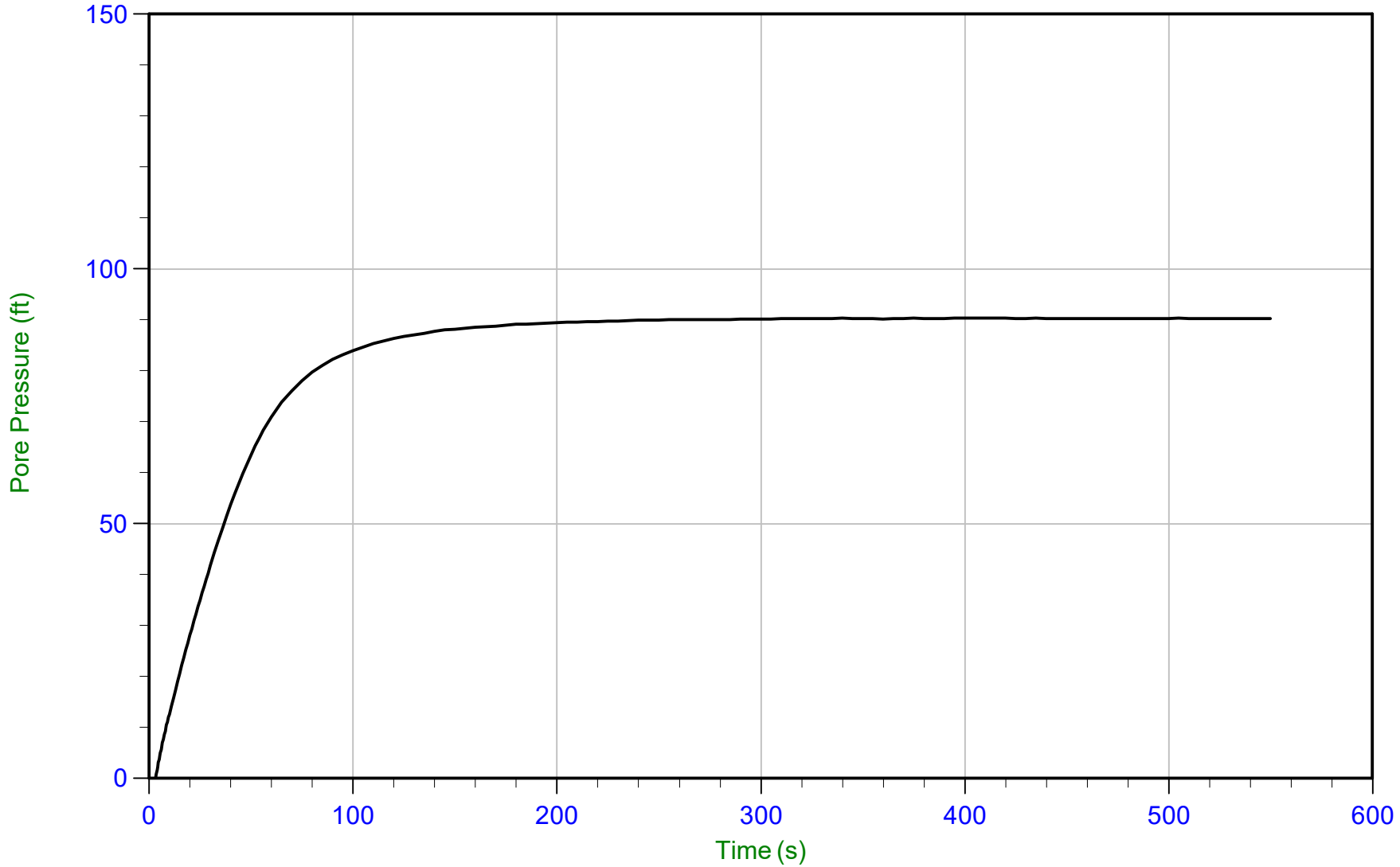
u Min: -17.2 ft
u Max: 68.1 ft
u Final: 56.4 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/03/2021 09:53
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-07
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP07.ppd2
Depth: 26.675 m / 87.515 ft
Duration: 550.0 s

u Min: -9.1 ft
u Max: 90.4 ft
u Final: 90.2 ft

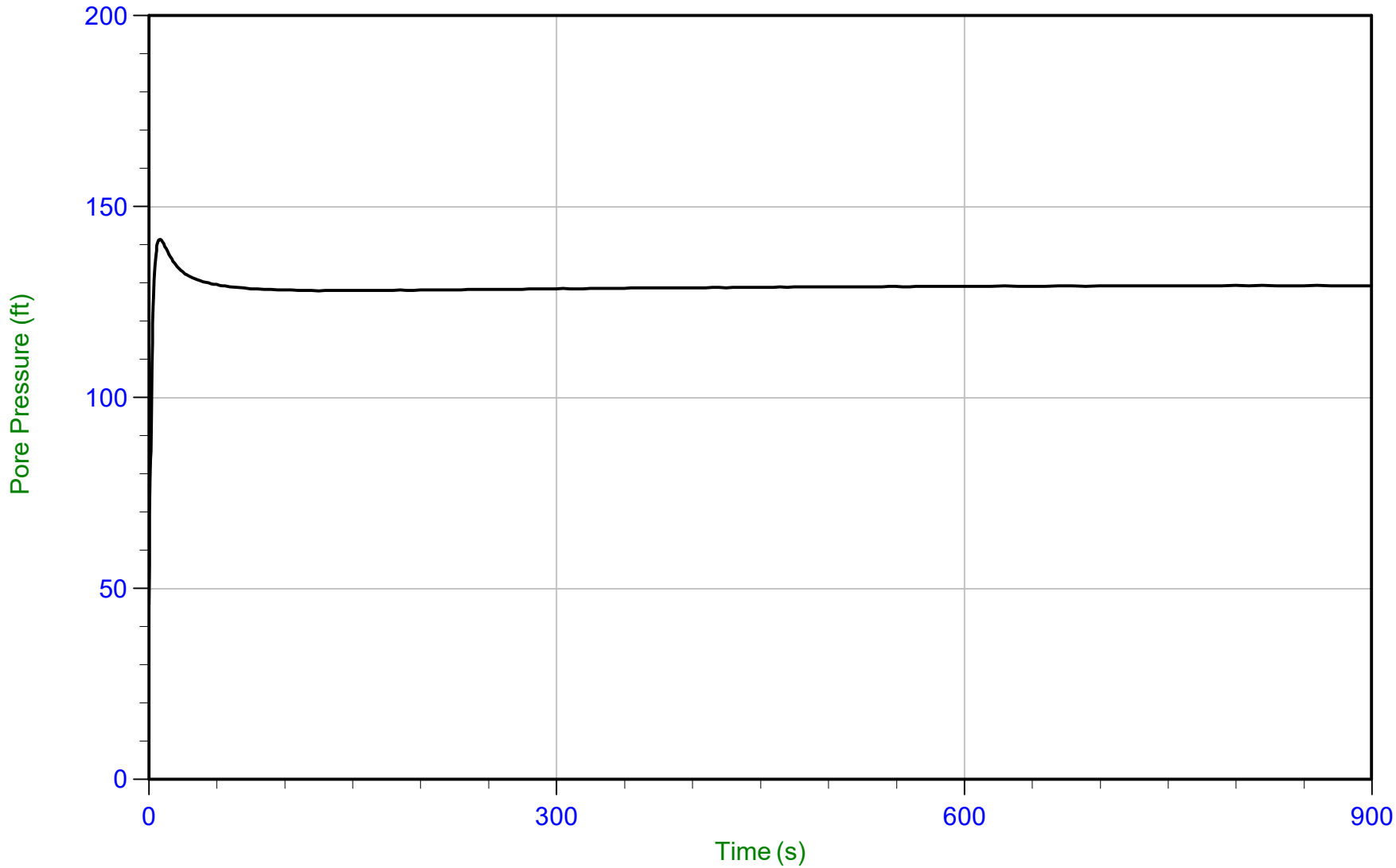
WT: -0.823 m / -2.700 ft
Ueq: 90.2 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/03/2021 09:53
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-07
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP07.ppd2
Depth: 37.150 m / 121.882 ft
Duration: 900.0 s

u Min: 45.8 ft
u Max: 141.4 ft
u Final: 129.3 ft

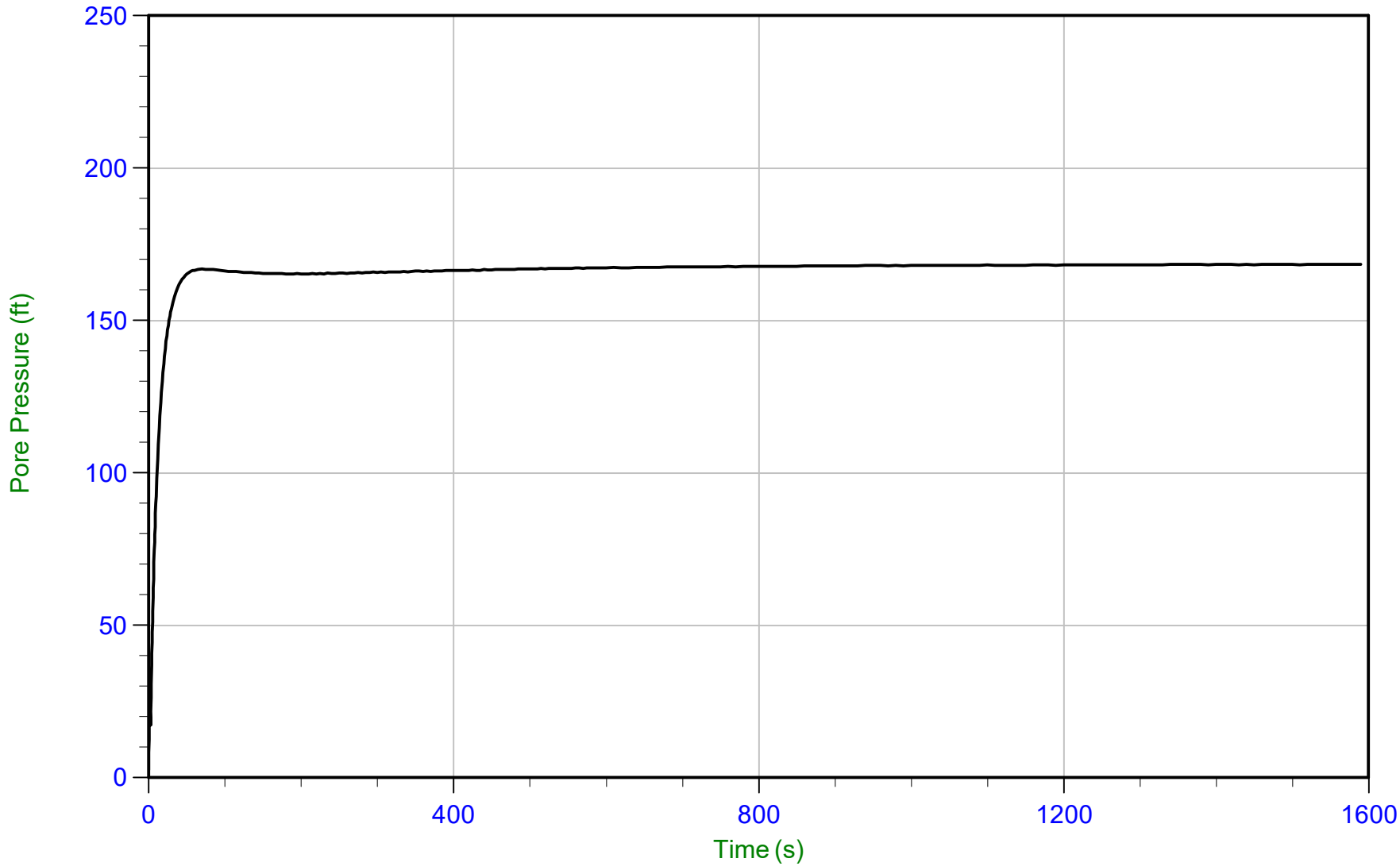
WT: -2.277 m / -7.469 ft
Ueq: 129.4 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/03/2021 09:53
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-07
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP07.ppd2
Depth: 48.250 m / 158.299 ft
Duration: 1590.0 s

u Min: 2.6 ft
u Max: 168.5 ft
u Final: 168.4 ft

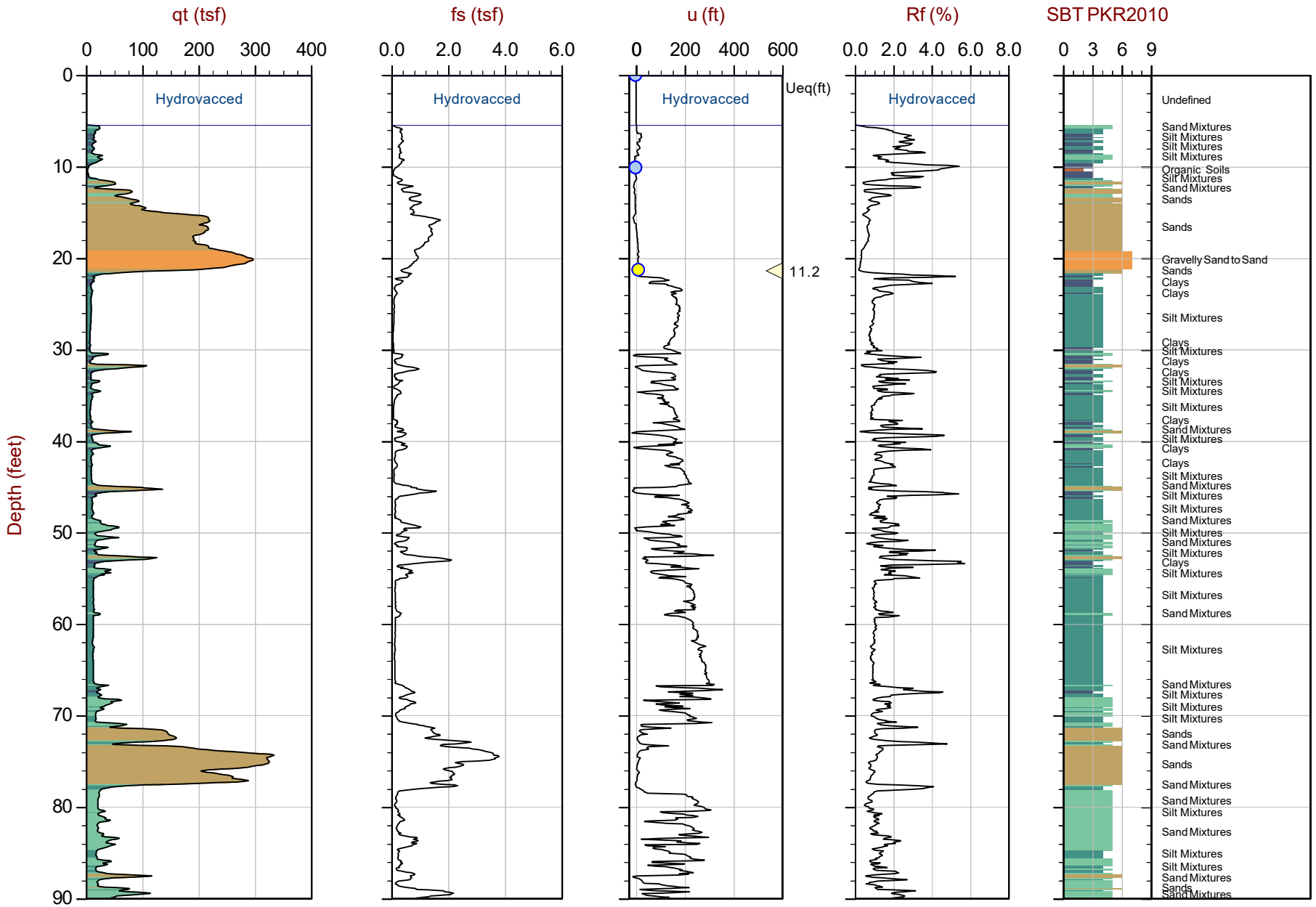
WT: -3.090 m / -10.139 ft
Ueq: 168.4 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-04 08:17
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-08
Cone: 794:T1500F15U35



Max Depth: 40.050 m / 131.40 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP08.COR

00 31 32-200

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.800829 Long: -111.927399
Sheet No: 1 of 2

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

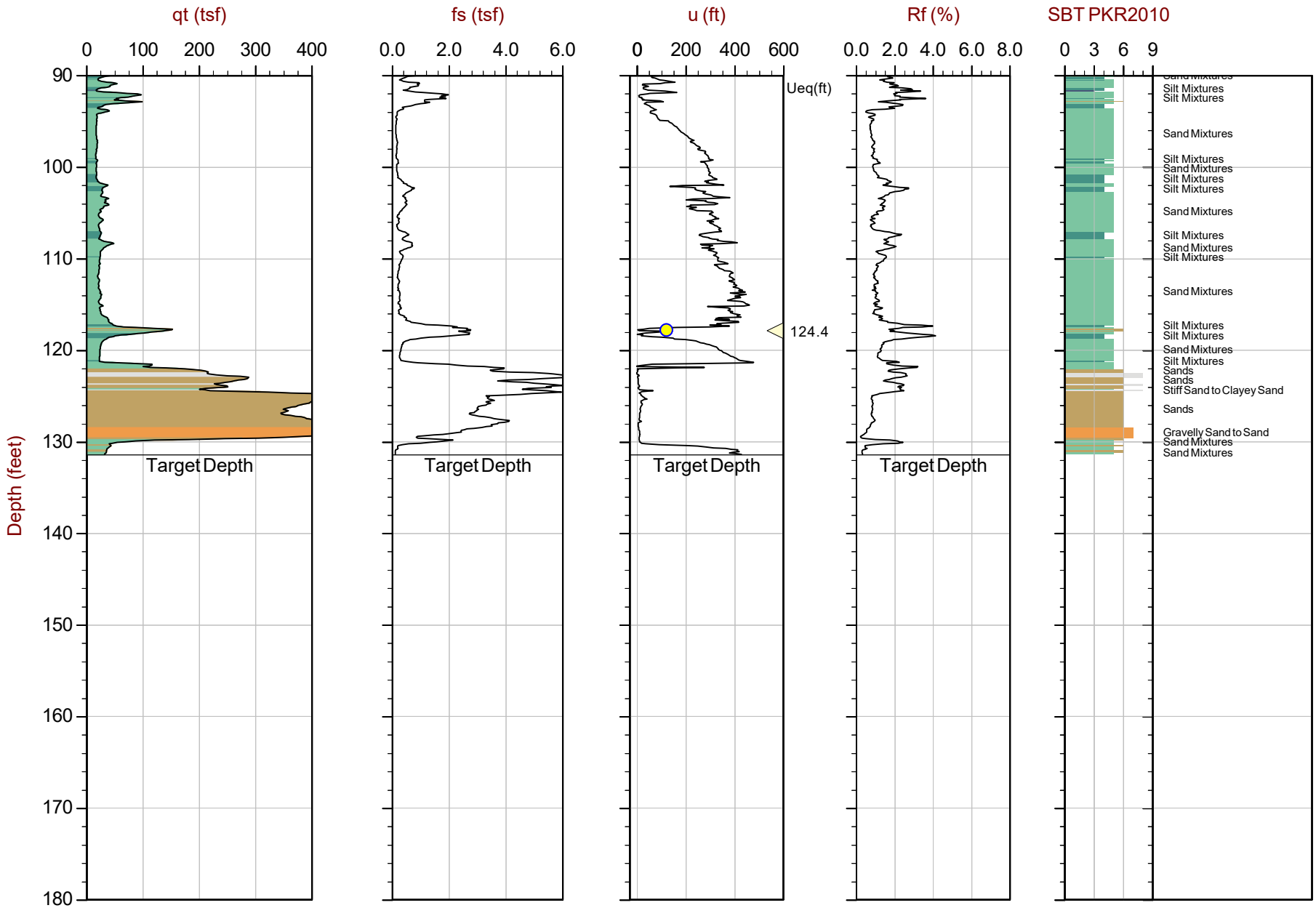
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 2021-08-04 08:17
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-08
Cone: 794:T1500F15U35



Max Depth: 40.050 m / 131.40 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-52-22799_CP08.COR

00 31 32-201

SBT: Robertson, 2010 (CPT '10)
Coords: Lat: 40.800829 Long: -111.927399
Sheet No: 2 of 2

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

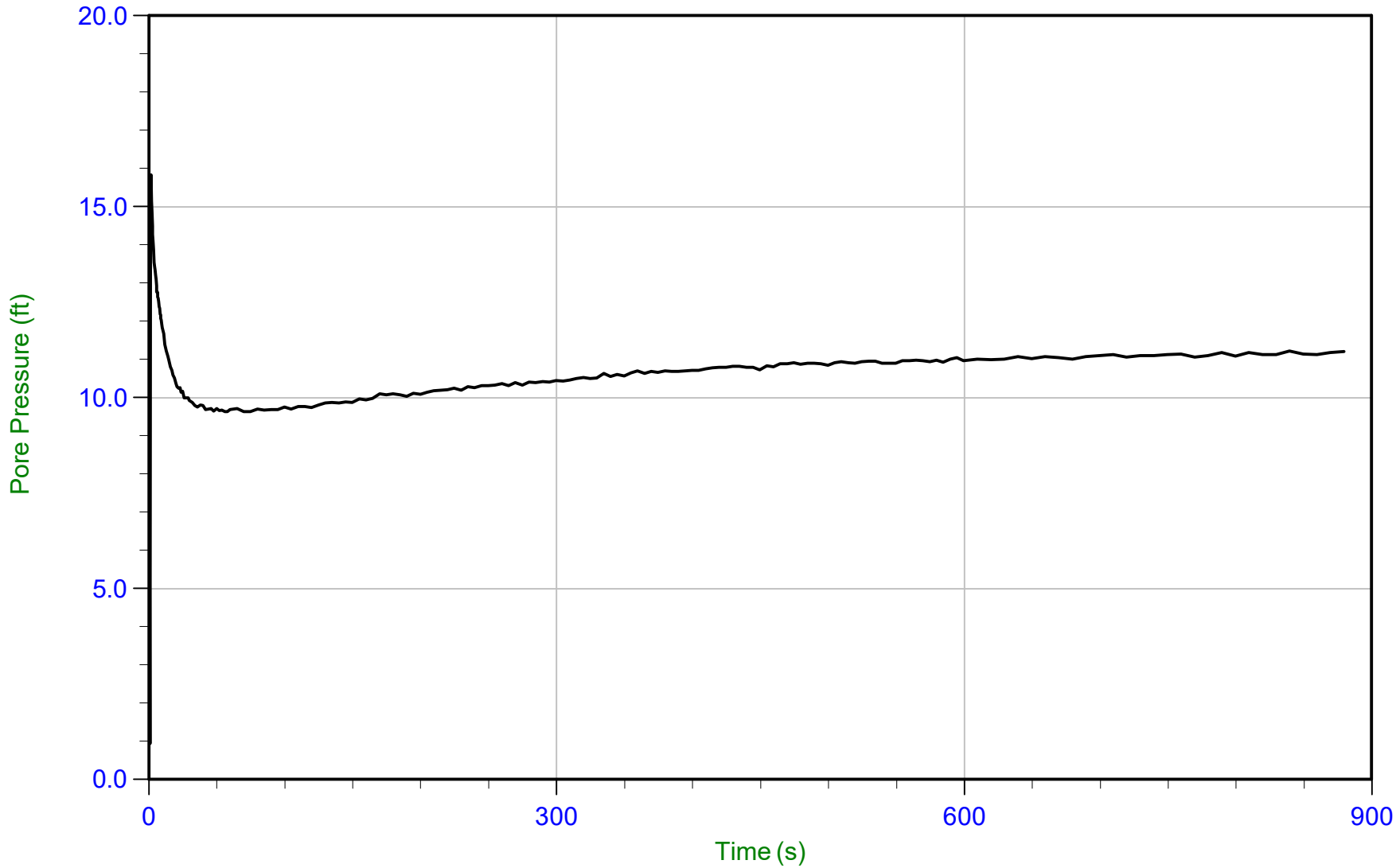
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/04/2021 08:17
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-08
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP08.ppd2
Depth: 6.500 m / 21.325 ft
Duration: 880.0 s

u Min: 0.9 ft
u Max: 15.8 ft
u Final: 11.2 ft

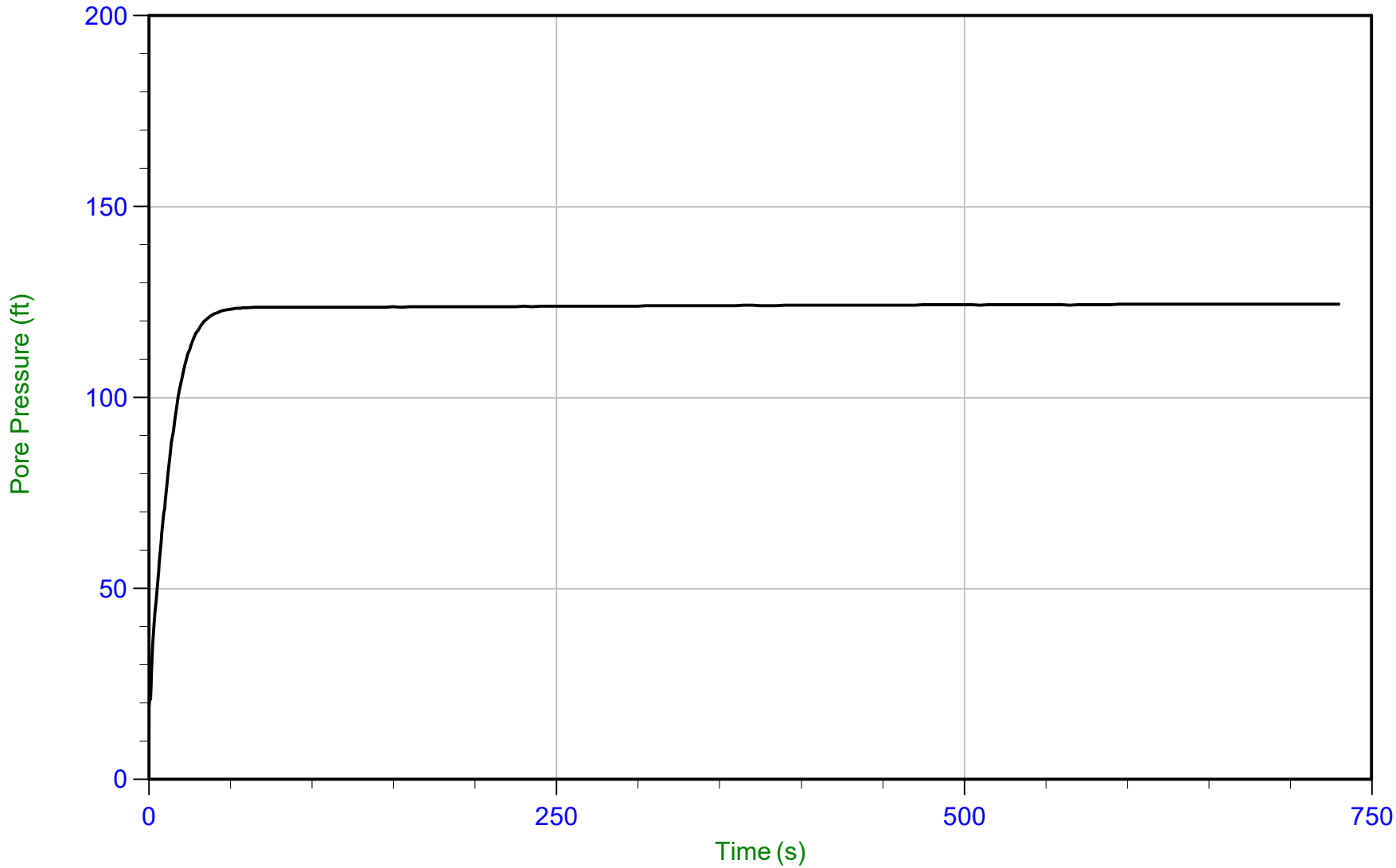
WT: 3.088 m / 10.130 ft
Ueq: 11.2 ft

CONETEC

AECOM

Job No: 21-52-22799
Date: 08/04/2021 08:17
Site: SLC WRF Influent Pump Station

Sounding: CPT21-OIPS-08
Cone: 794:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-52-22799_CP08.ppd2
Depth: 35.925 m / 117.863 ft
Duration: 730.0 s

u Min: 13.2 ft
u Max: 124.5 ft
u Final: 124.5 ft

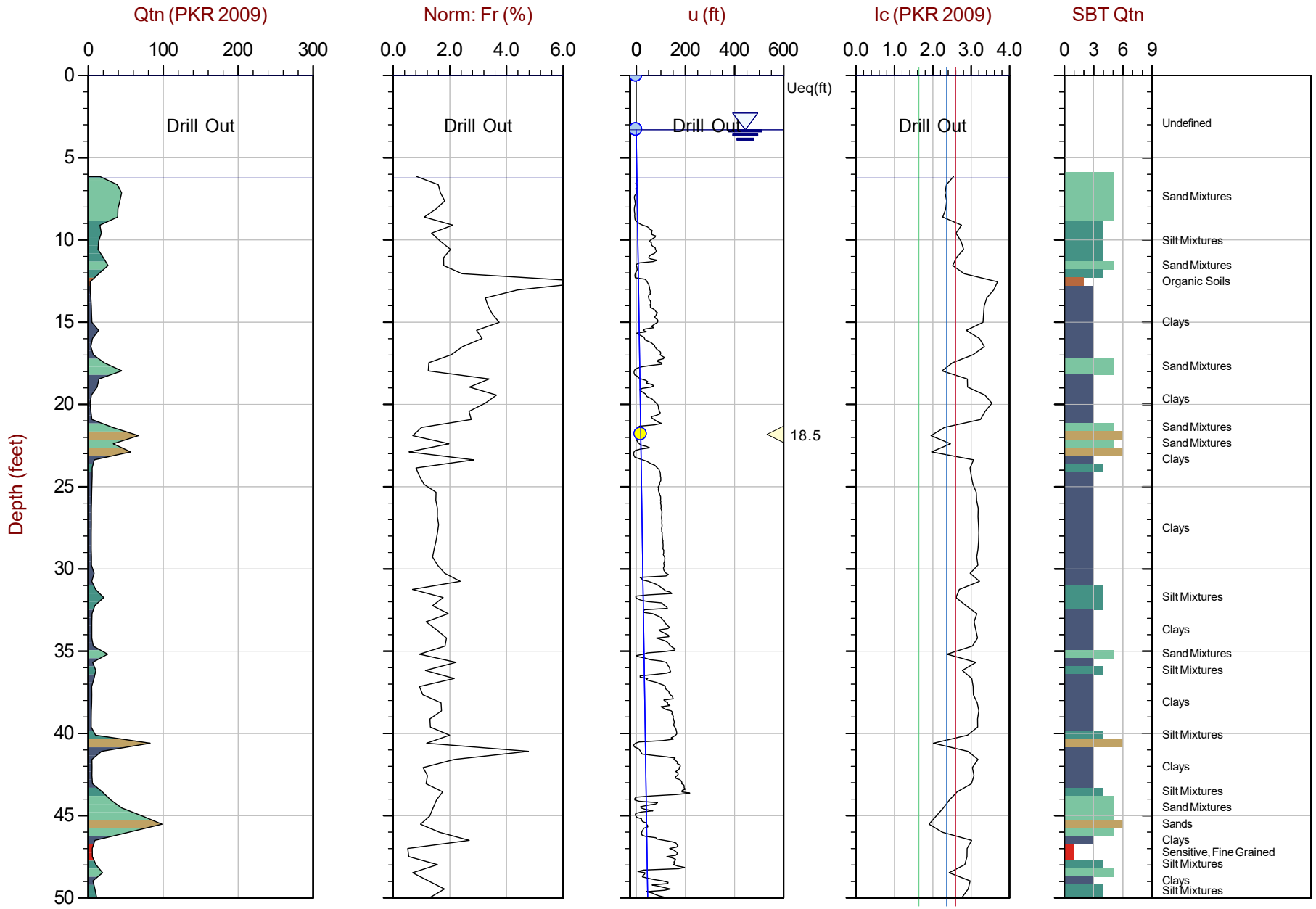
WT: -2.005 m / -6.579 ft
Ueq: 124.4 ft

CONETEC

AECOM

Job No: 19-52037
Date: 2019-07-25 08:22
Site: SLC WRF

Sounding: CP19-ITW-3
Cone: 242:T1500F15U500



Max Depth: 15.350 m / 50.36 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 19-52037_CP-ITW-3.COR
Unit Wt: SBTQtn (PKR2009)

00 31 32-204

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.805534 Long: -111.933421

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

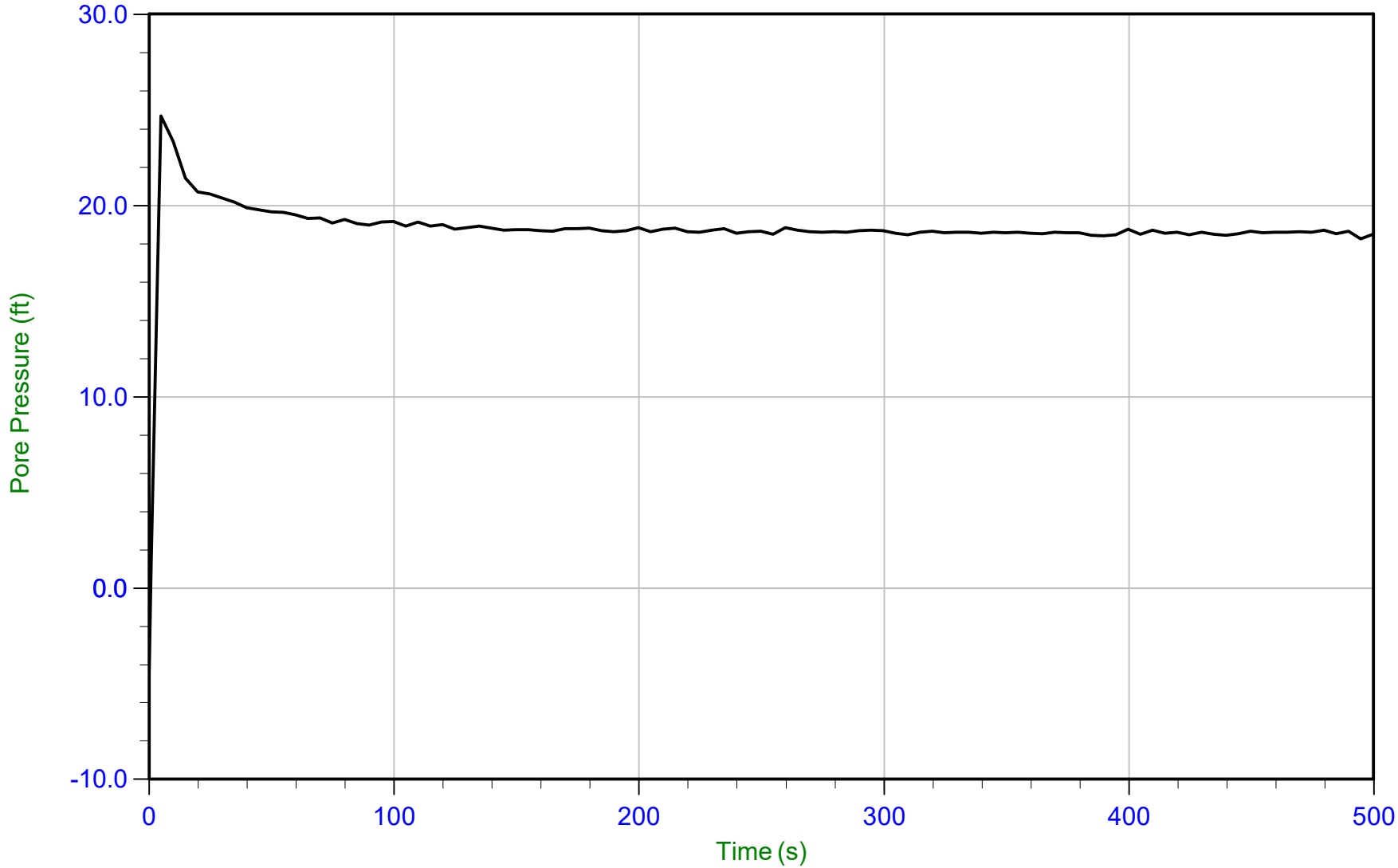
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 19-52037
Date: 25-Jul-2019 08:22:22
Site: SLC WRF

Sounding: CP19-ITW-3
Cone: 242 Area=15 cm²



Trace Summary:

Filename: 19-52037_CP-ITW-3.PPD
Depth: 6.650 m / 21.817 ft
Duration: 500.0 s

u Min: -4.3 ft
u Max: 24.7 ft
u Final: 18.5 ft

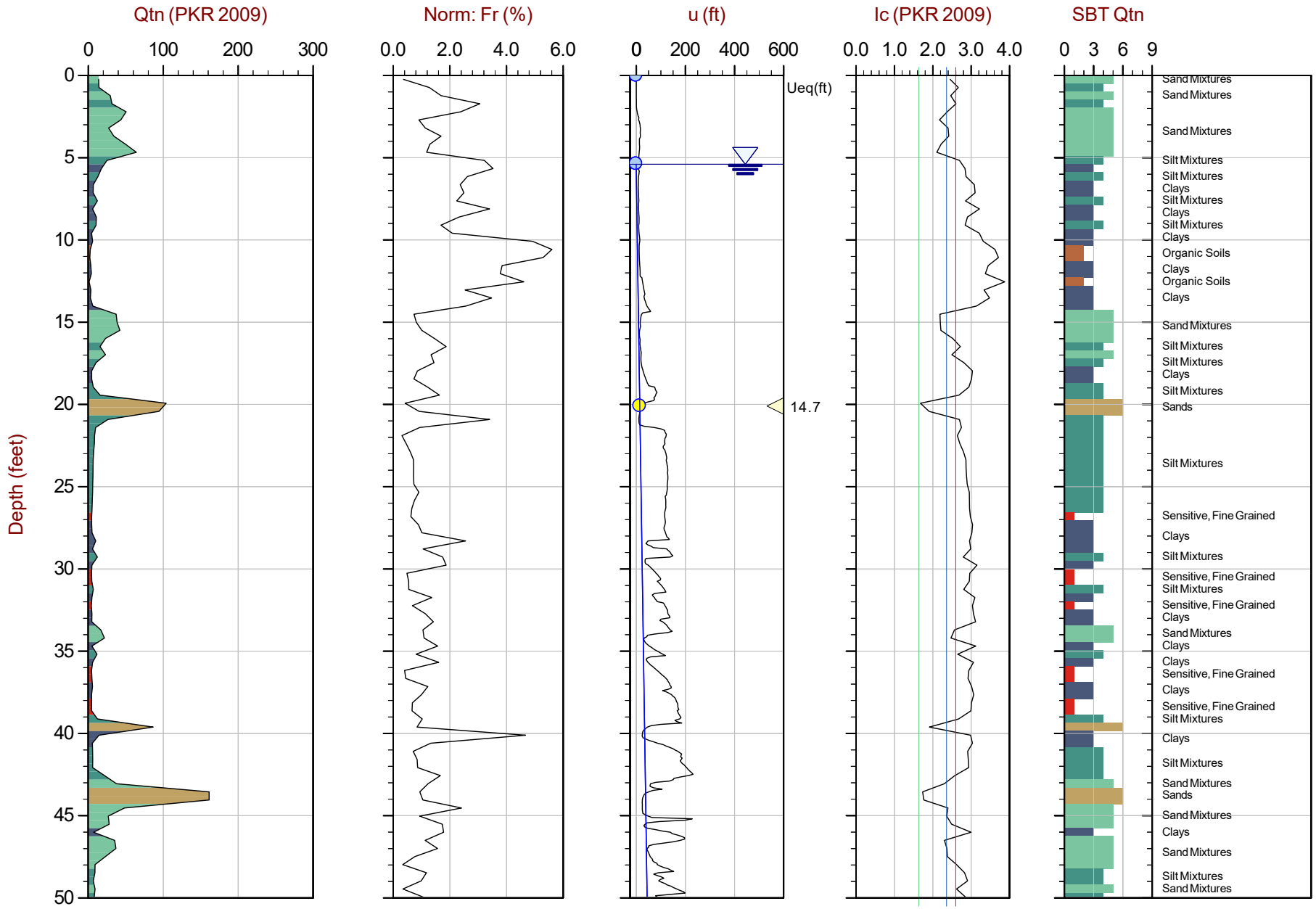
WT: 1.005 m / 3.296 ft
Ueq: 18.5 ft

CONETEC

AECOM

Job No: 19-52037
Date: 2019-08-16 08:58
Site: SLC WRF

Sounding: CP19-ITW-4
Cone: 418:T1500F15U500



Max Depth: 15.350 m / 50.36 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.150 m

File: 19-52037_CP-ITW-4.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.803161 Long: -111.932552

00 31 32-206

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

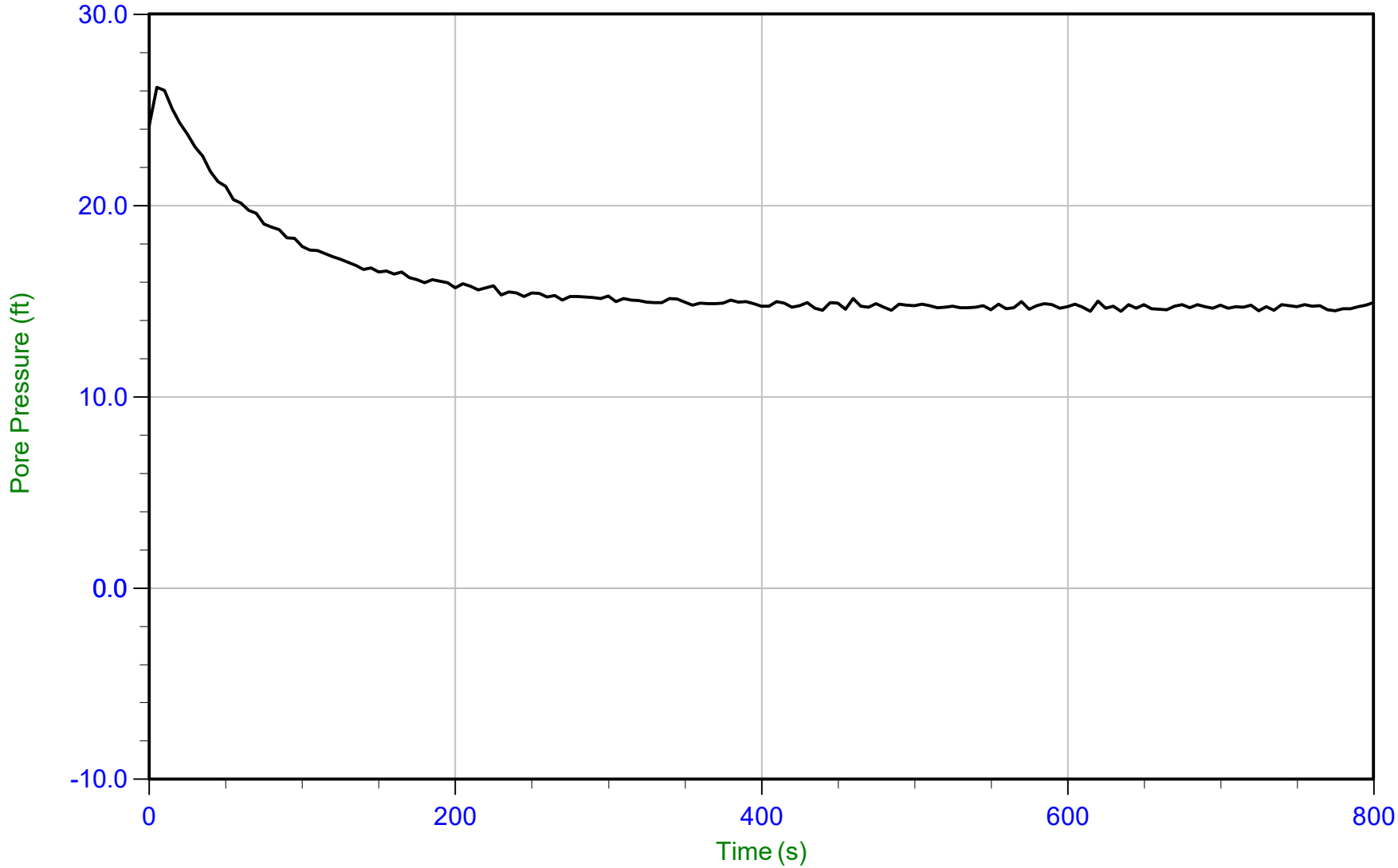
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 19-52037
Date: 16-Aug-2019 08:58:33
Site: SLC WRF

Sounding: CP19-ITW-4
Cone: 418 Area=15 cm²



Trace Summary:

Filename: 19-52037_CP-ITW-4.PPD
Depth: 6.125 m / 20.095 ft
Duration: 800.0 s

u Min: 14.5 ft
u Max: 26.2 ft
u Final: 14.9 ft

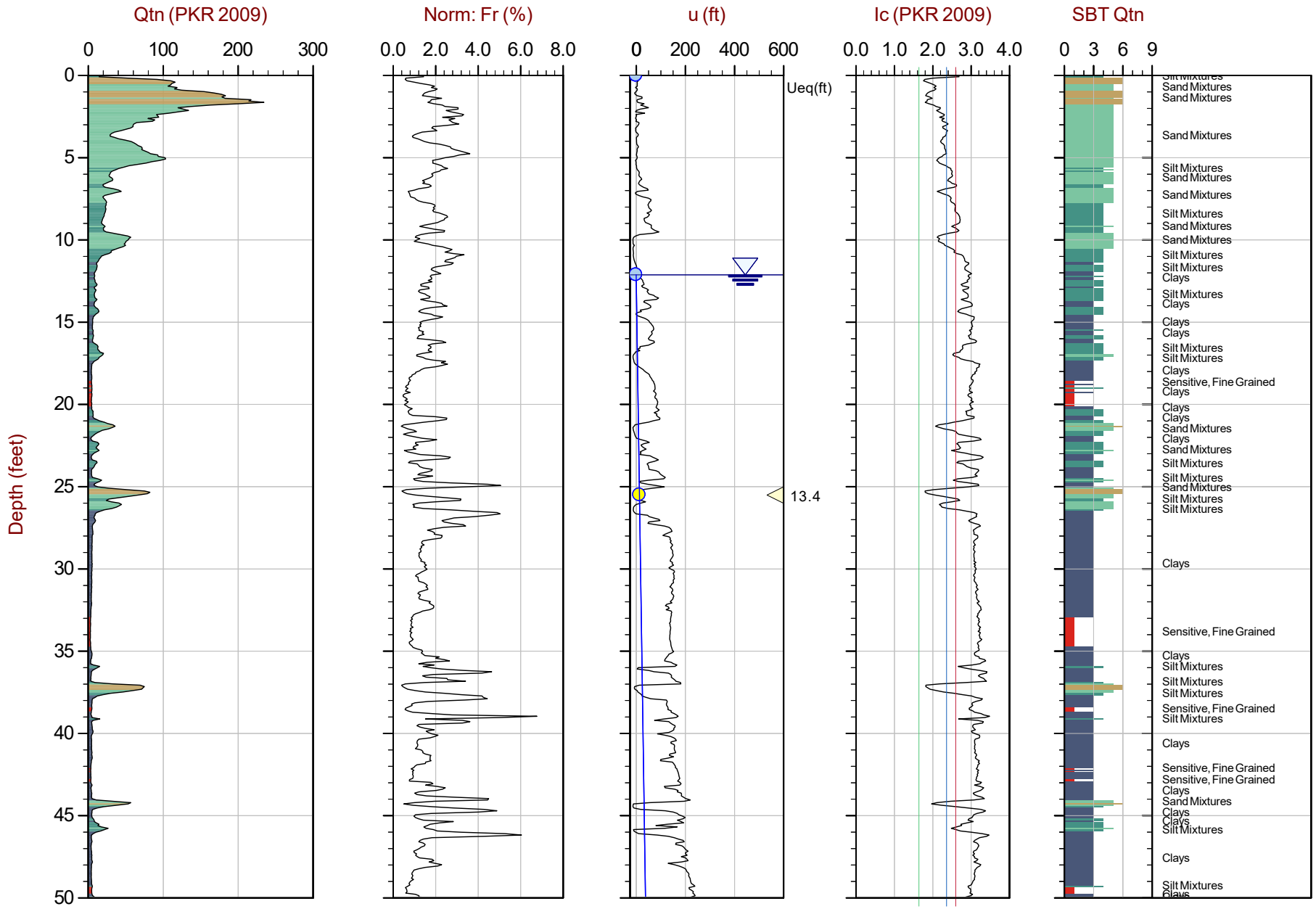
WT: 1.640 m / 5.381 ft
Ueq: 14.7 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-23 12:28
Site: Influent Tunnel

Sounding: CP20-IS-01
Cone: 657:T1500F15U500



Max Depth: 37.800 m / 124.01 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.802198 Long: -111.927141

00 31 32-208

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

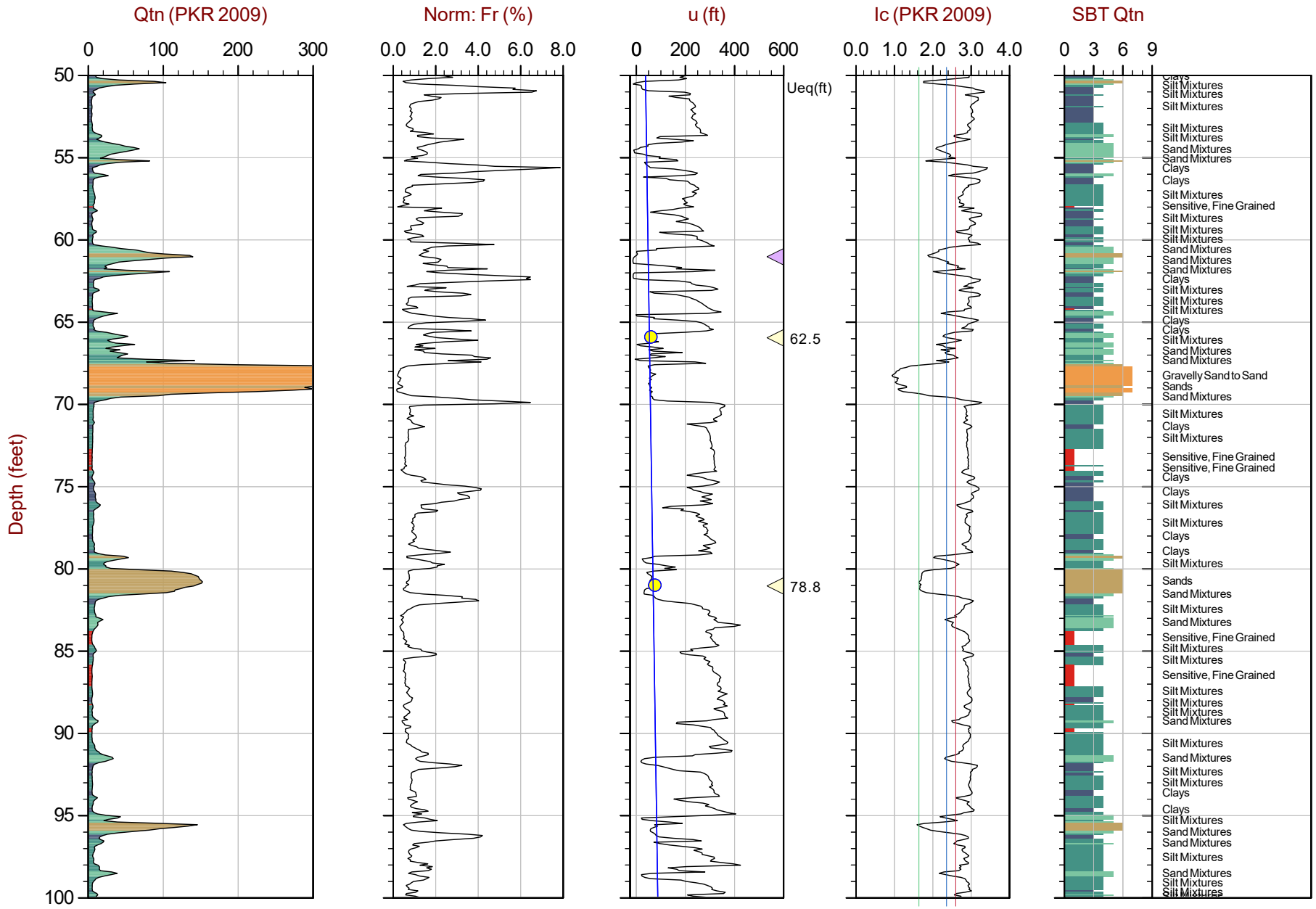
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-23 12:28
Site: Influent Tunnel

Sounding: CP20-IS-01
Cone: 657:T1500F15U500



Max Depth: 37.800 m / 124.01 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.802198 Long: -111.927141

00 31 32-209

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

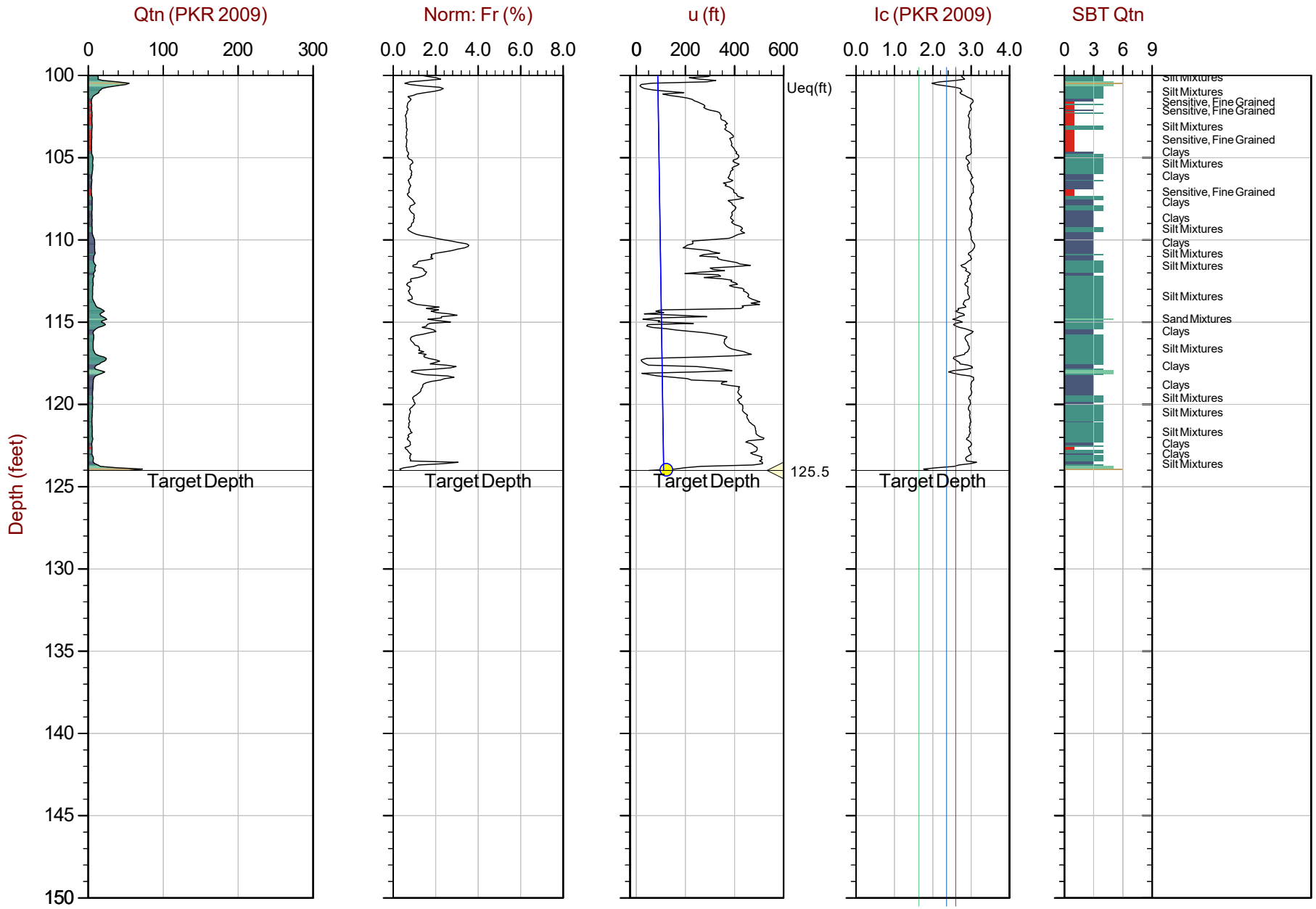
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-23 12:28
Site: Influent Tunnel

Sounding: CP20-IS-01
Cone: 657:T1500F15U500



Max Depth: 37.800 m / 124.01 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.802198 Long: -111.927141

00 31 32-210

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

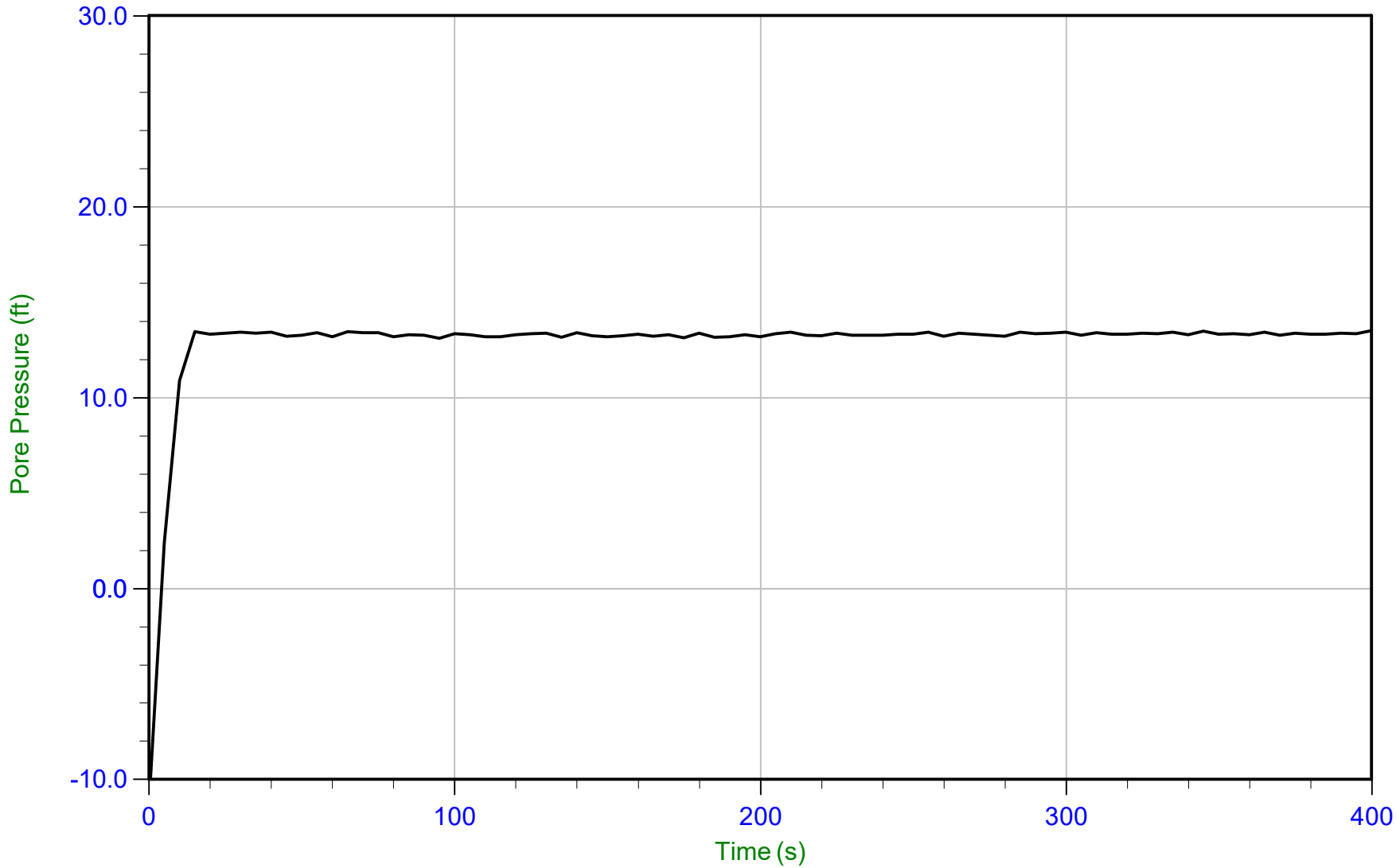
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 12:28
Site: Influent Tunnel

Sounding: CP20-IS-01
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-01.PPF
Depth: 7.775 m / 25.508 ft
Duration: 400.0 s

u Min: -11.3 ft
u Max: 13.5 ft
u Final: 13.5 ft

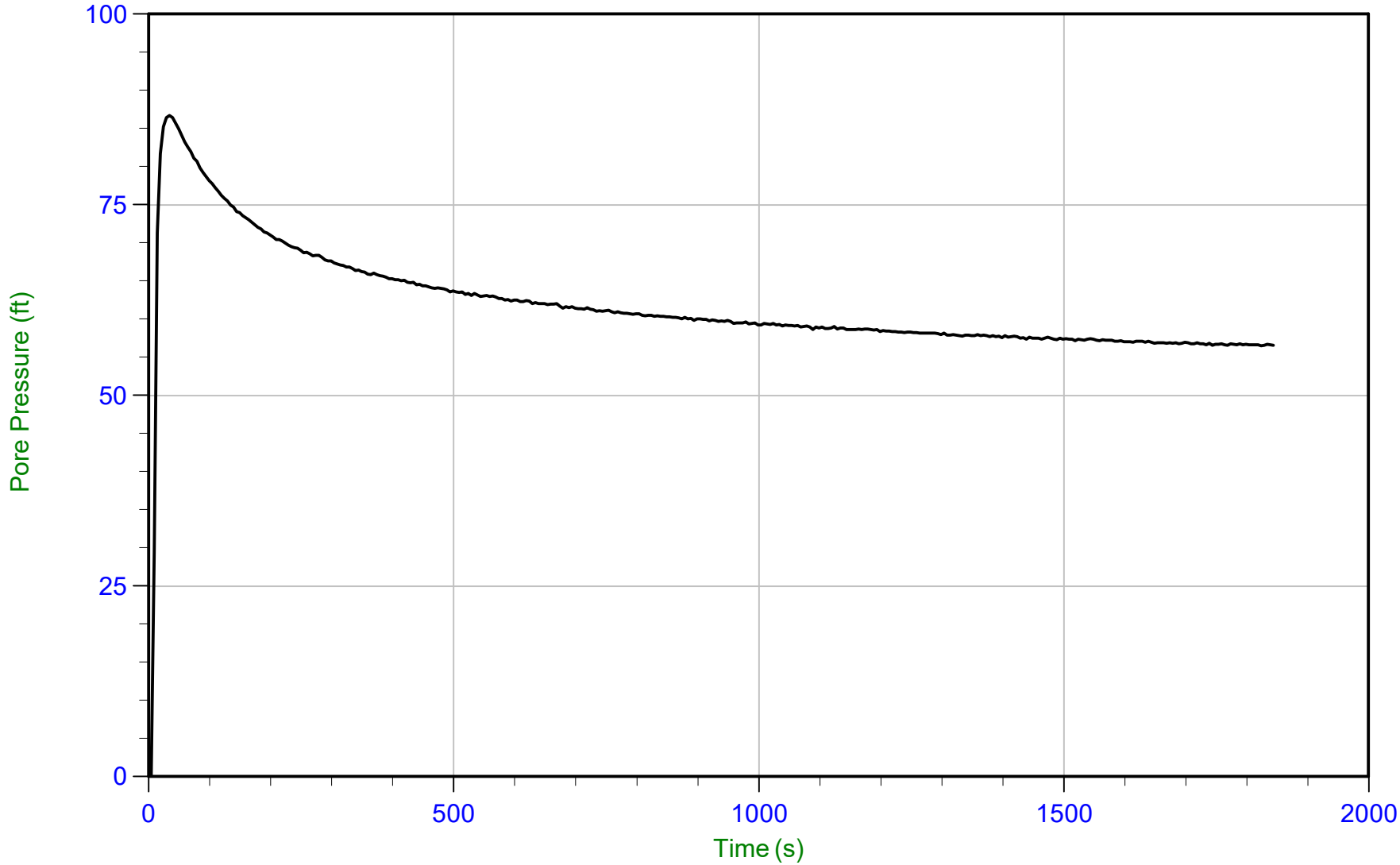
WT: 3.695 m / 12.123 ft
Ueq: 13.4 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 12:28
Site: Influent Tunnel

Sounding: CP20-IS-01
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-01.PPF
Depth: 18.600 m / 61.023 ft
Duration: 1845.0 s

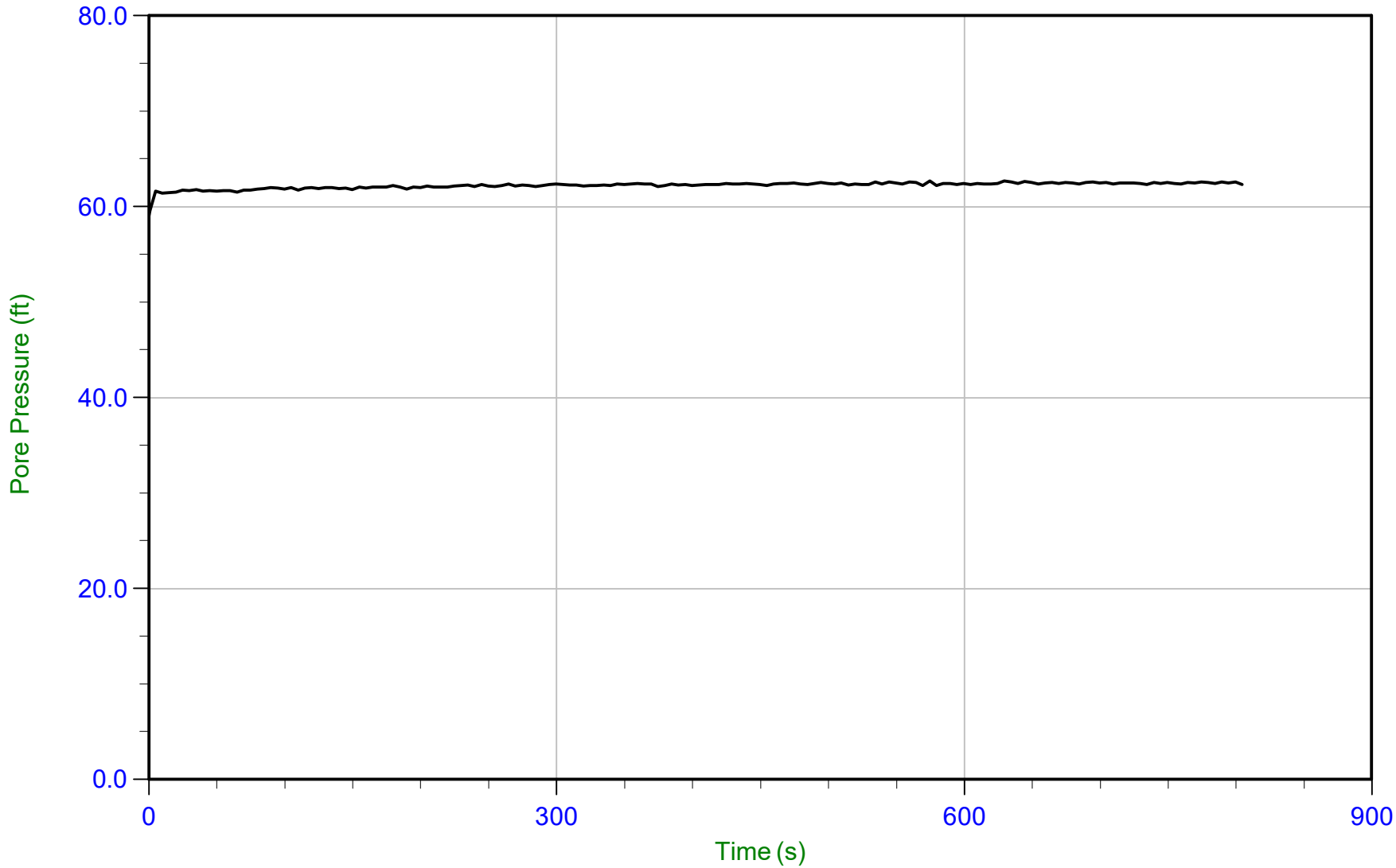
u Min: -9.1 ft
u Max: 86.7 ft
u Final: 56.6 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 12:28
Site: Influent Tunnel

Sounding: CP20-IS-01
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-01.PPF
Depth: 20.100 m / 65.944 ft
Duration: 805.0 s

u Min: 59.1 ft
u Max: 62.7 ft
u Final: 62.3 ft

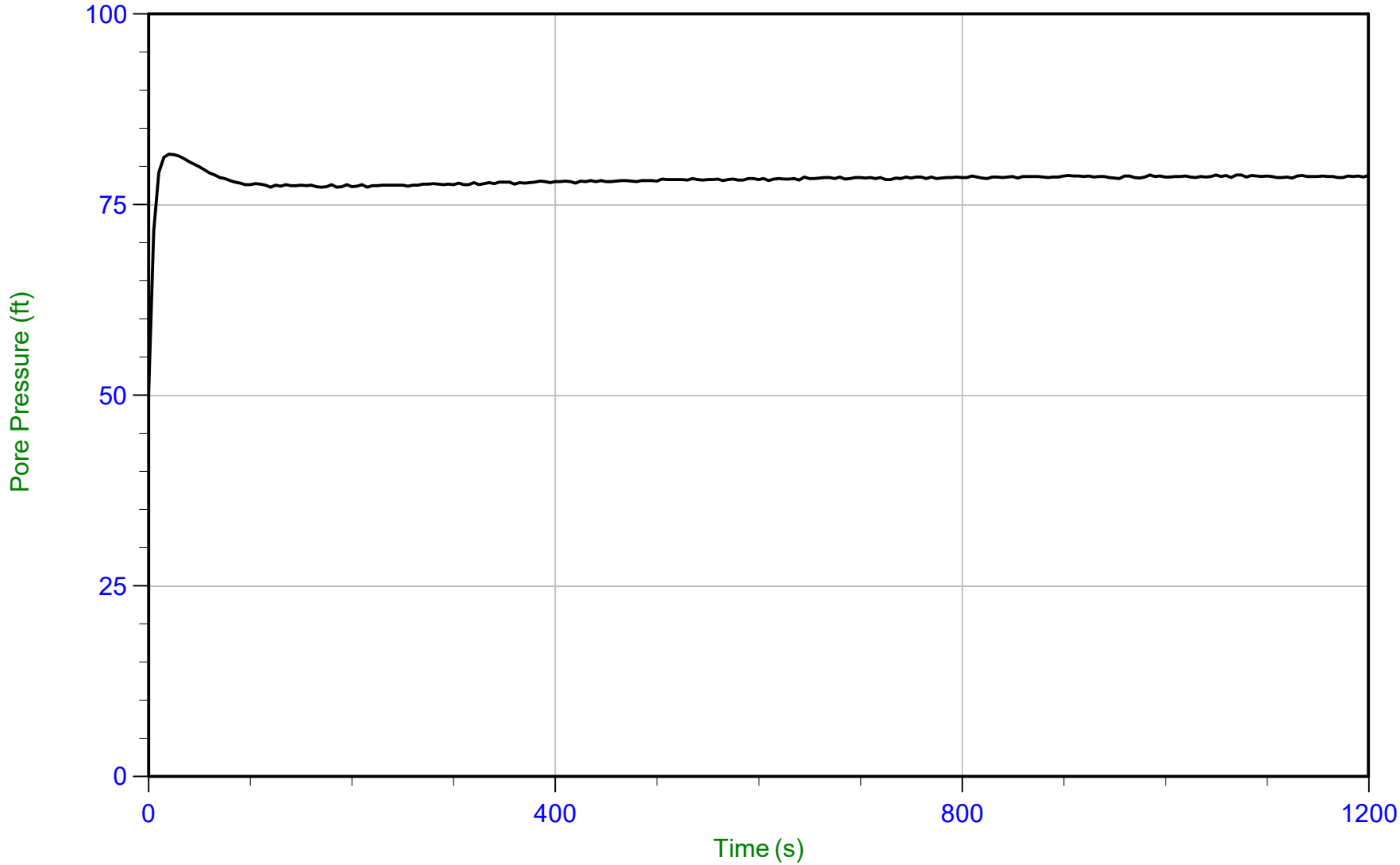
WT: 1.048 m / 3.438 ft
Ueq: 62.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 12:28
Site: Influent Tunnel

Sounding: CP20-IS-01
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-01.PPF
Depth: 24.700 m / 81.036 ft
Duration: 1200.0 s

u Min: 50.3 ft
u Max: 81.6 ft
u Final: 78.9 ft

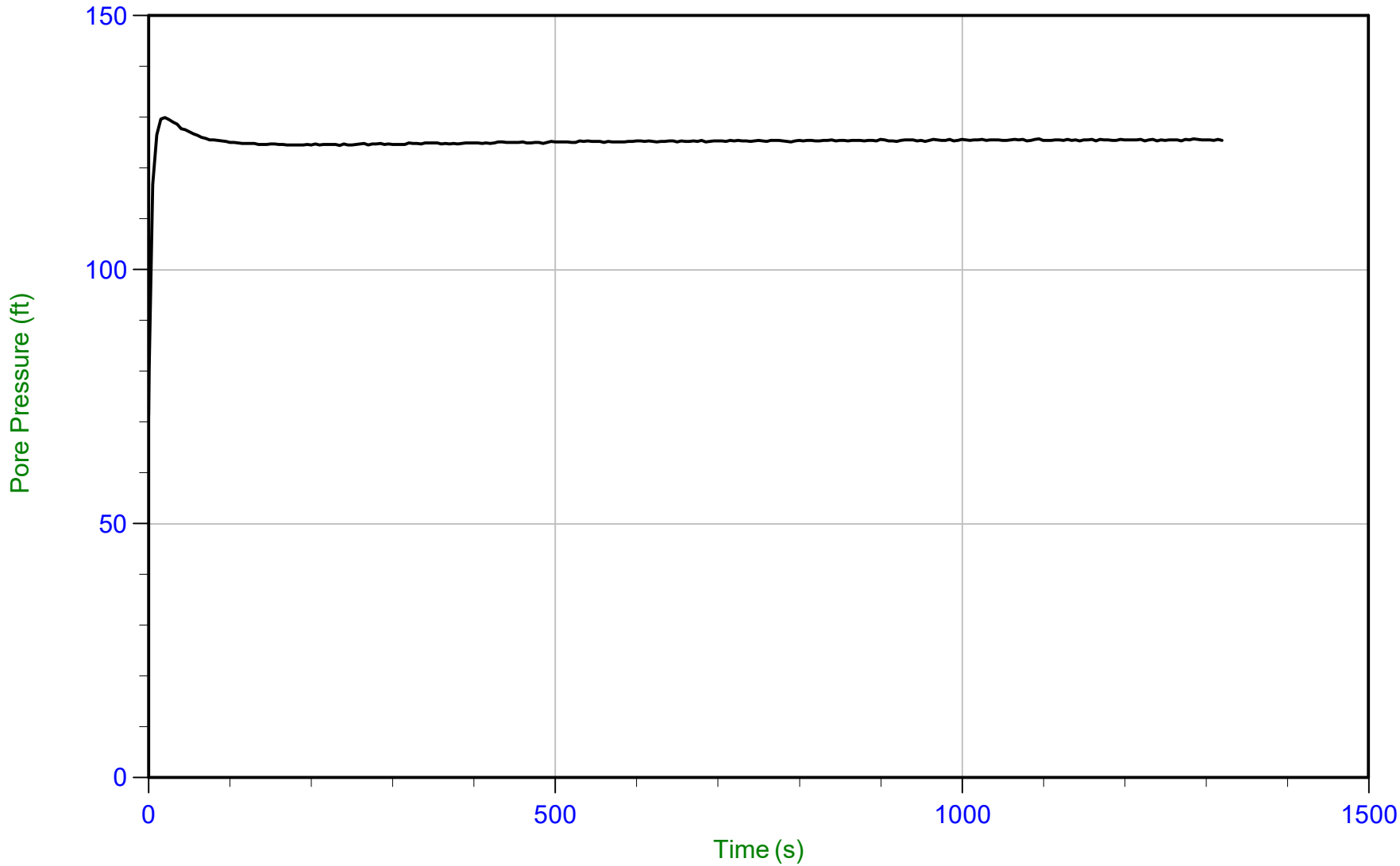
WT: 0.675 m / 2.215 ft
Ueq: 78.8 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 12:28
Site: Influent Tunnel

Sounding: CP20-IS-01
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-01.PPF
Depth: 37.800 m / 124.014 ft
Duration: 1320.0 s

u Min: 71.4 ft
u Max: 129.9 ft
u Final: 125.4 ft

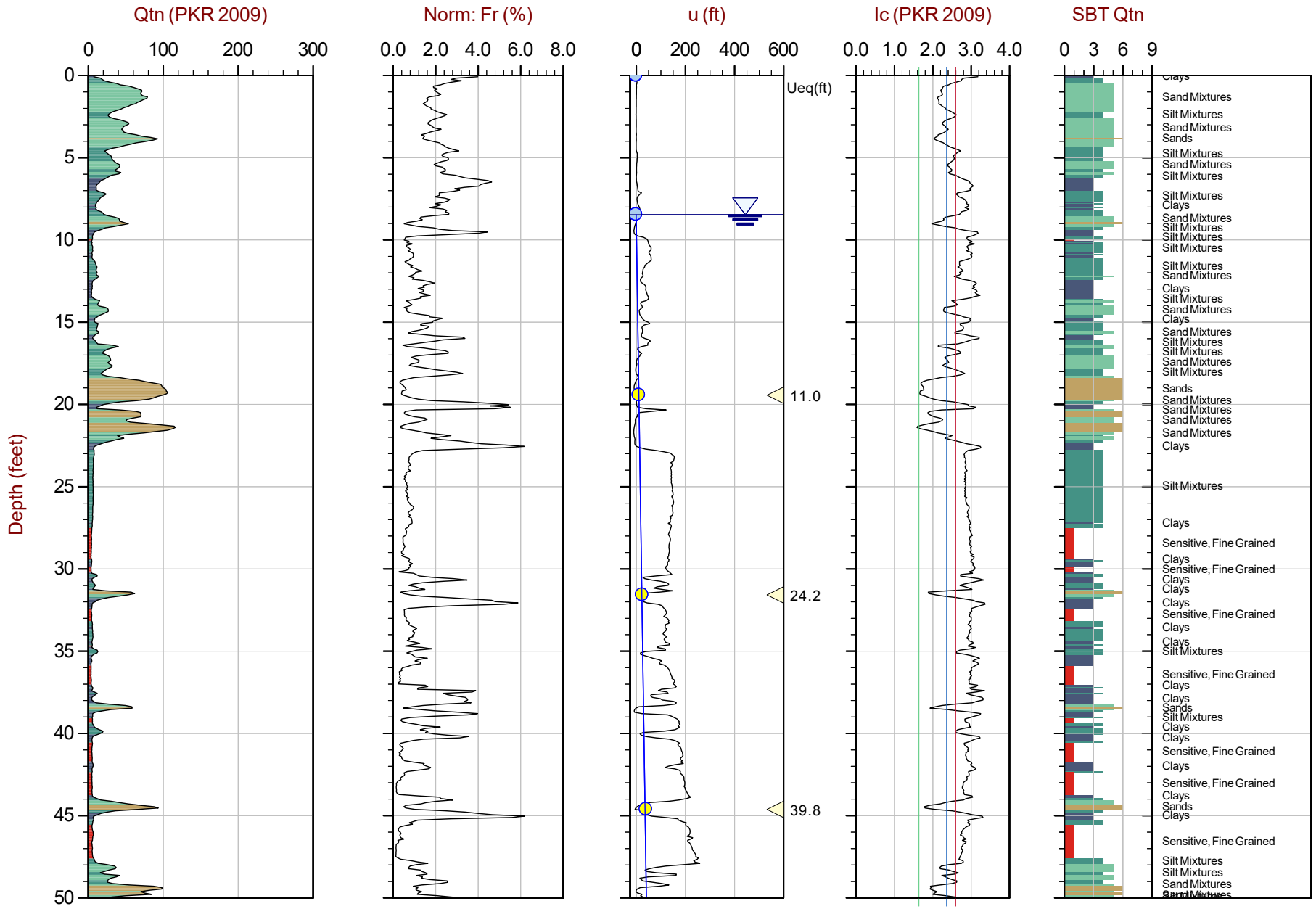
WT: -0.465 m / -1.526 ft
Ueq: 125.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-23 10:05
Site: Influent Tunnel

Sounding: CP20-IS-02
Cone: 657:T1500F15U500



Max Depth: 22.900 m / 75.13 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-02.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.802465 Long: -111.928534

00 31 32-216

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

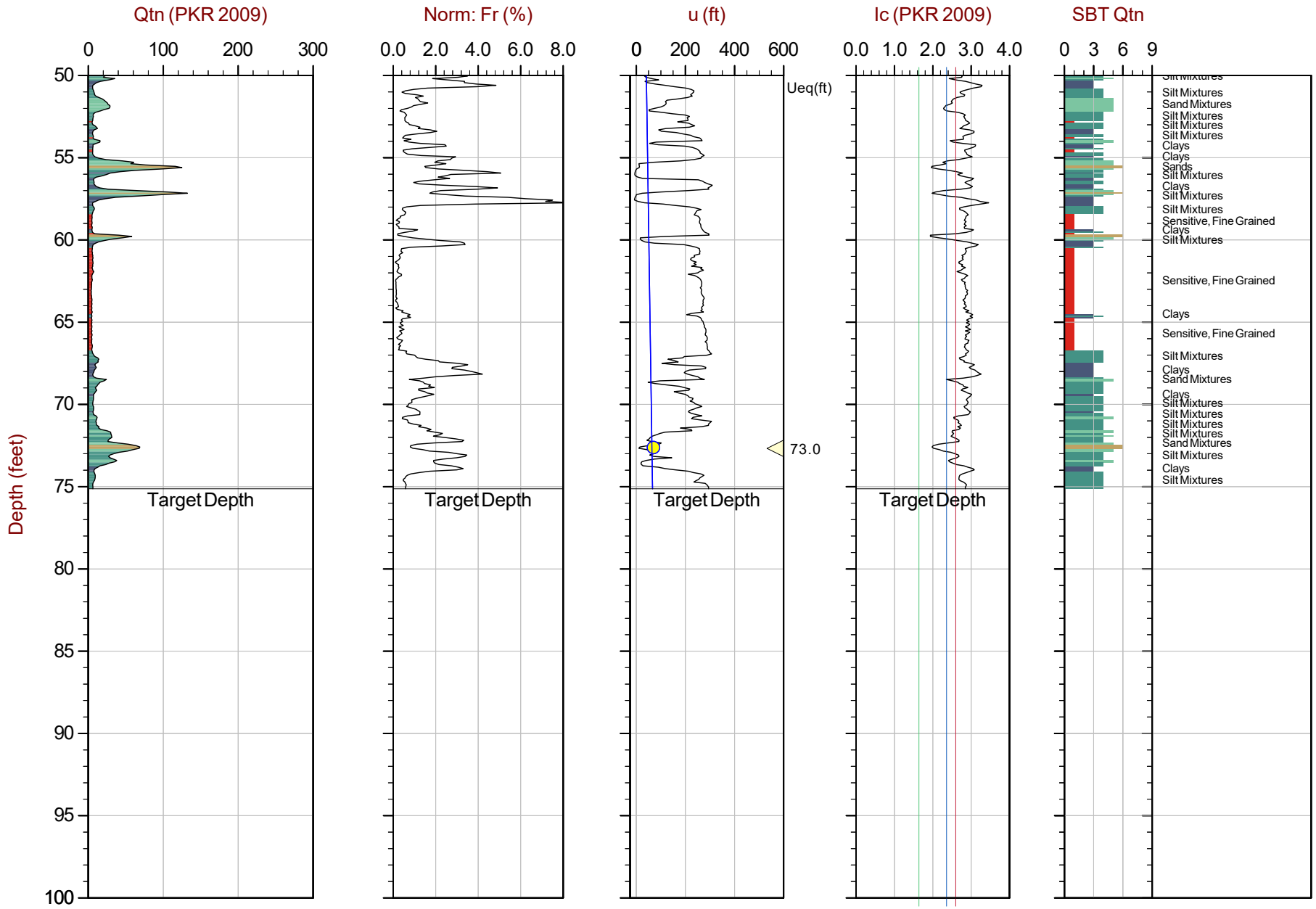
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-23 10:05
Site: Influent Tunnel

Sounding: CP20-IS-02
Cone: 657:T1500F15U500



Max Depth: 22.900 m / 75.13 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-02.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.802465 Long: -111.928534

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

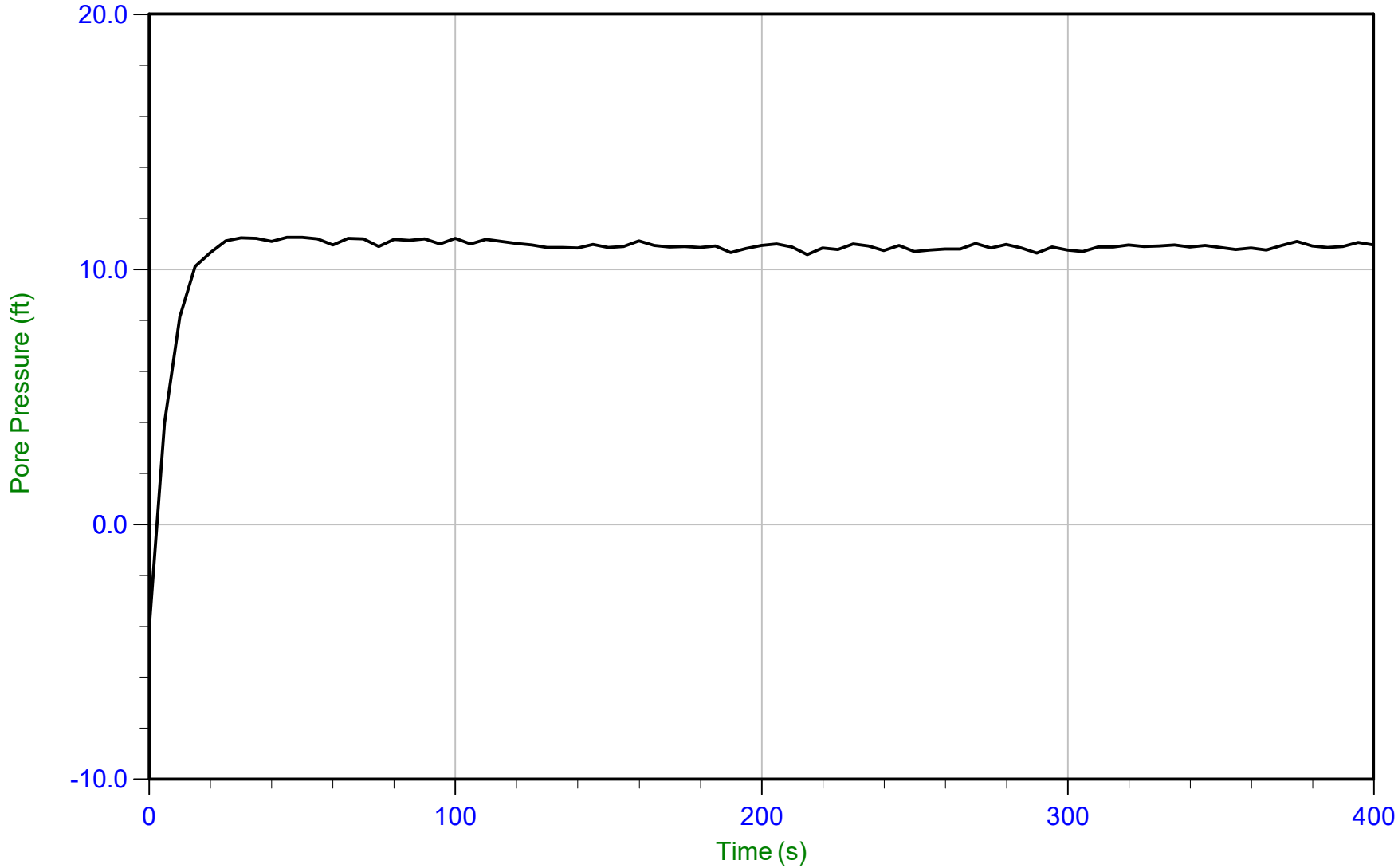
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 10:05
Site: Influent Tunnel

Sounding: CP20-IS-02
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-02.PPF
Depth: 5.925 m / 19.439 ft
Duration: 400.0 s

u Min: -4.1 ft
u Max: 11.3 ft
u Final: 10.9 ft

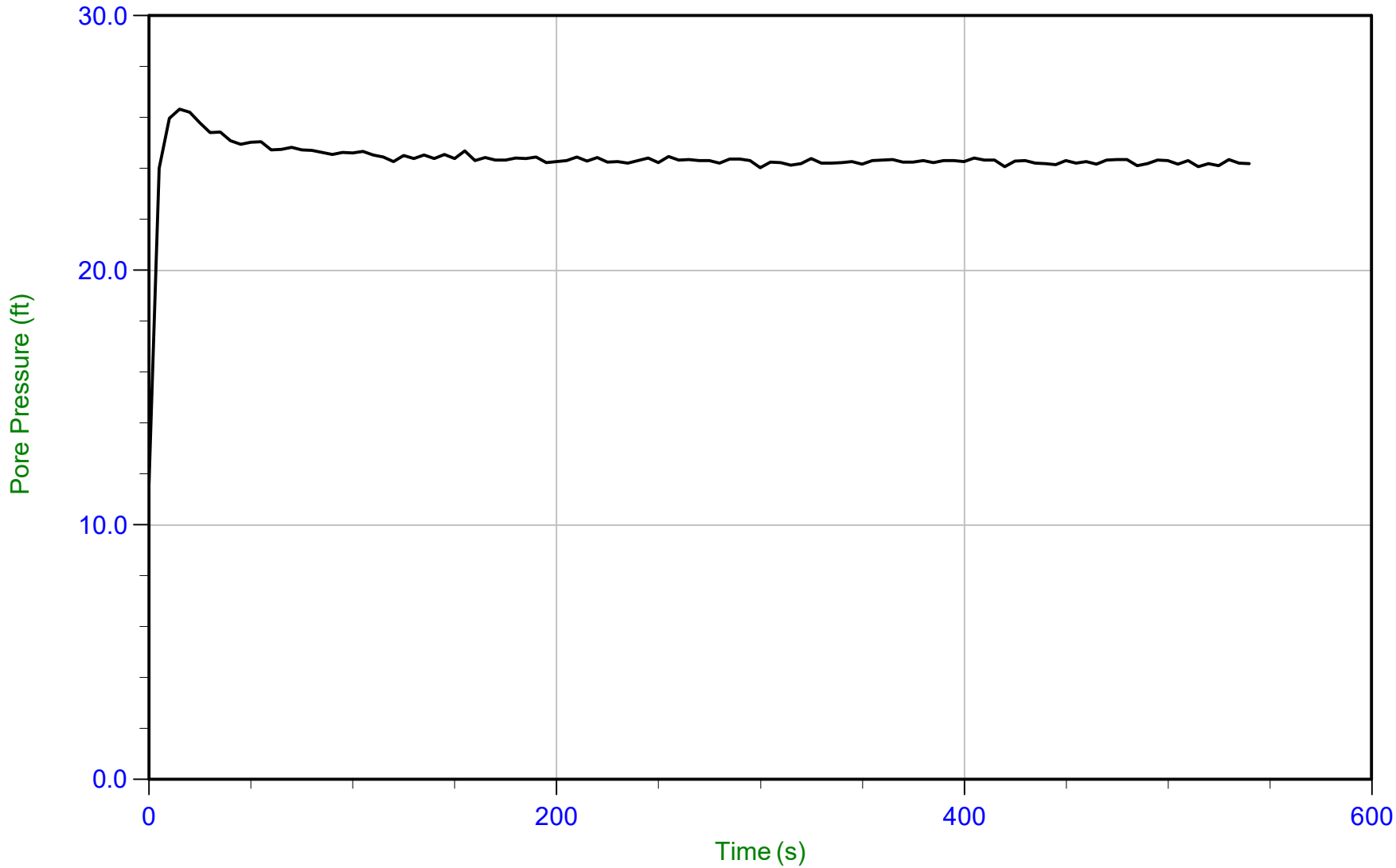
WT: 2.579 m / 8.461 ft
Ueq: 11.0 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 10:05
Site: Influent Tunnel

Sounding: CP20-IS-02
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-02.PPF
Depth: 9.625 m / 31.578 ft
Duration: 540.0 s

u Min: 11.6 ft
u Max: 26.3 ft
u Final: 24.2 ft

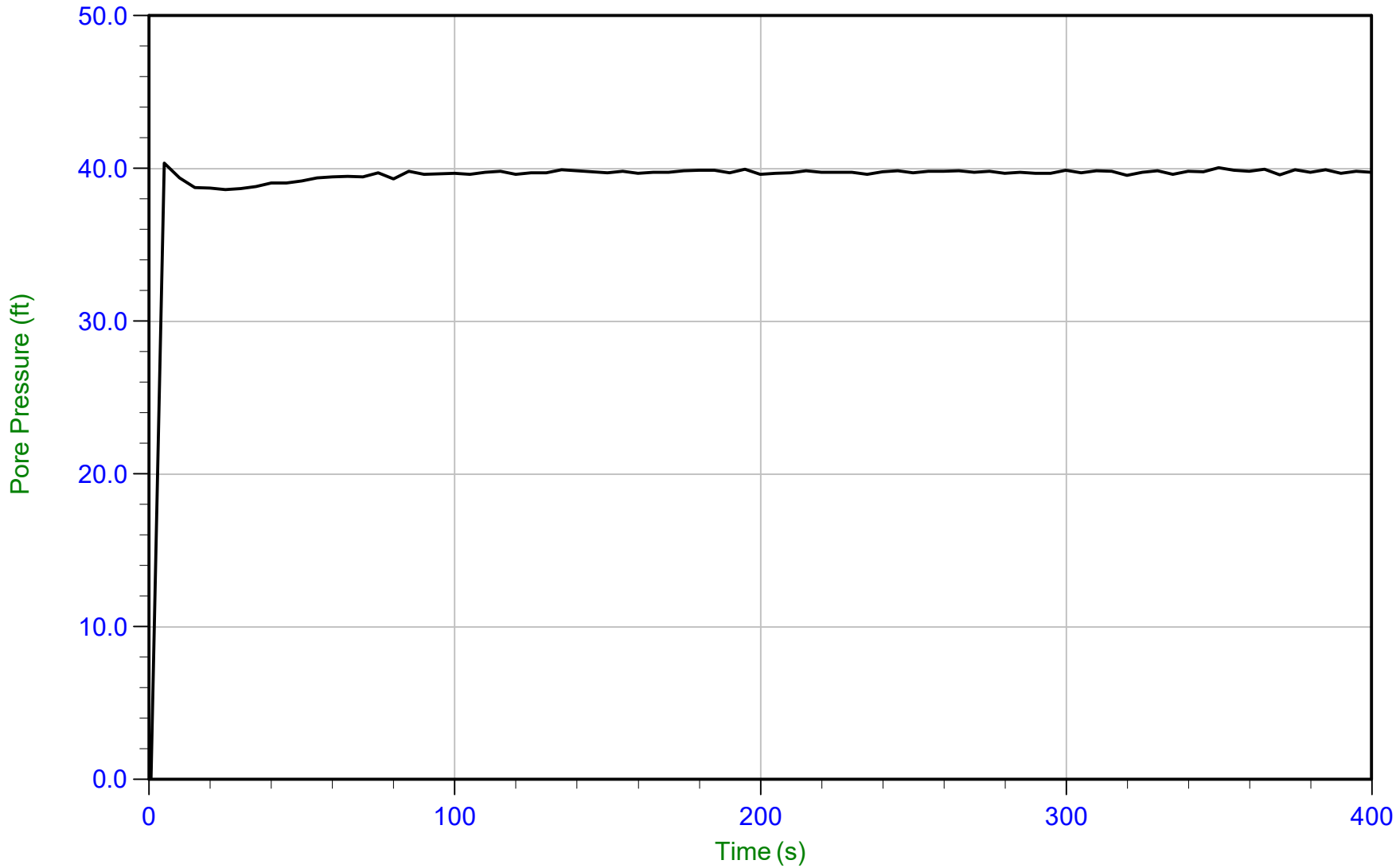
WT: 2.248 m / 7.375 ft
Ueq: 24.2 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 10:05
Site: Influent Tunnel

Sounding: CP20-IS-02
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-02.PPF
Depth: 13.600 m / 44.619 ft
Duration: 400.0 s

u Min: -6.2 ft
u Max: 40.3 ft
u Final: 39.8 ft

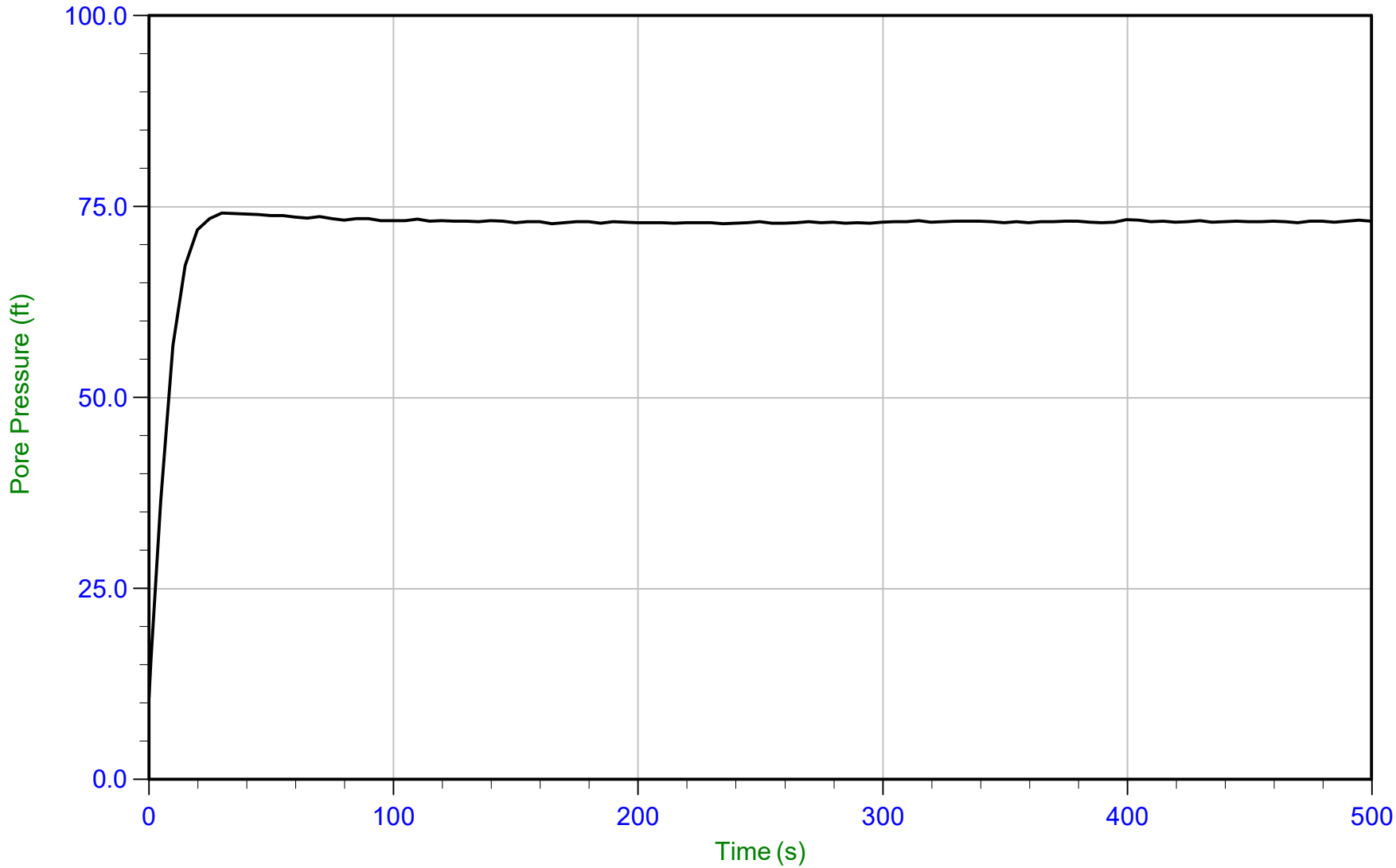
WT: 1.466 m / 4.810 ft
Ueq: 39.8 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 10:05
Site: Influent Tunnel

Sounding: CP20-IS-02
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-02.PPF
Depth: 22.150 m / 72.670 ft
Duration: 500.0 s

u Min: 10.6 ft
u Max: 74.1 ft
u Final: 73.1 ft

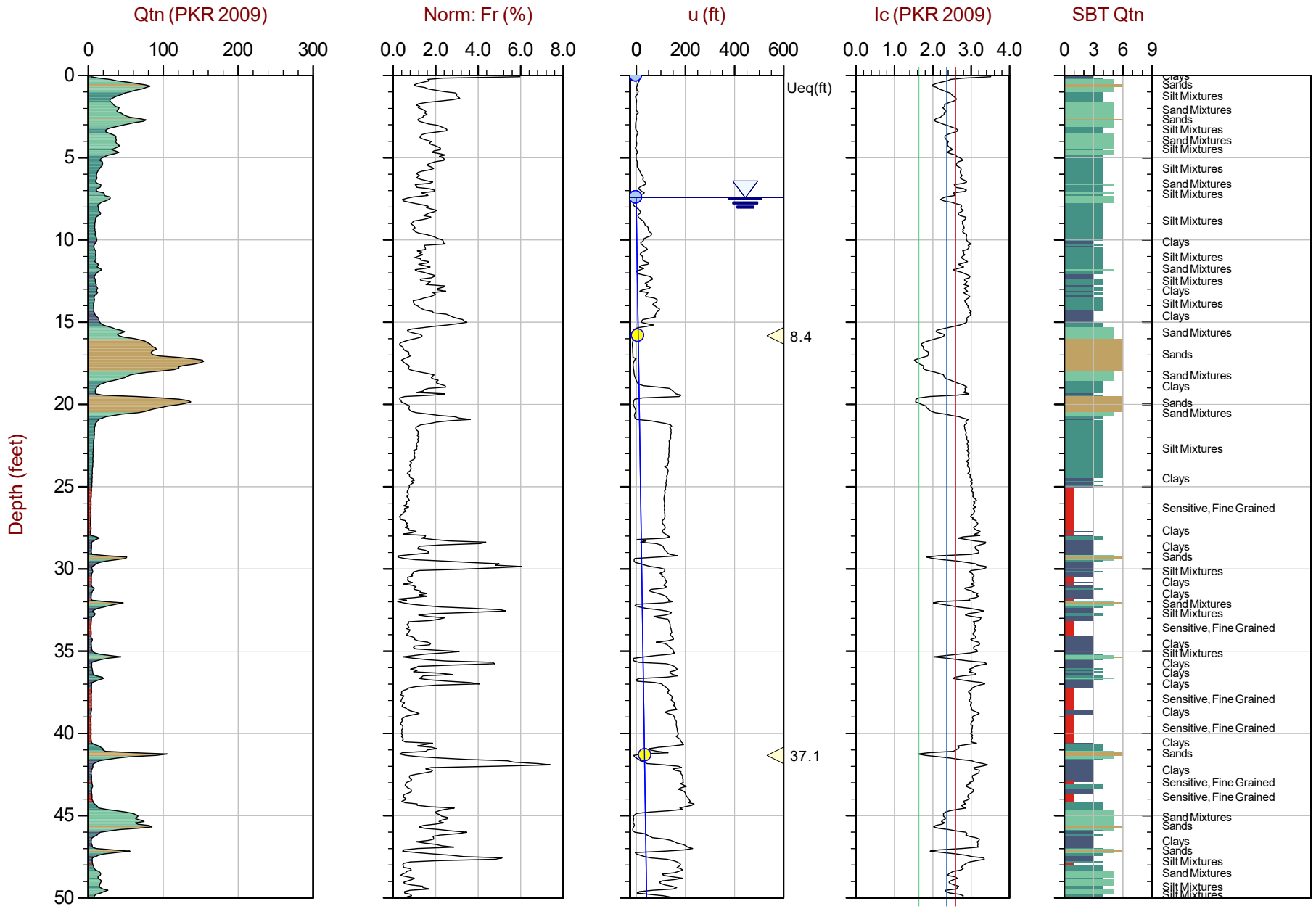
WT: -0.124 m / -0.407 ft
Ueq: 73.1 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-23 07:23
Site: Influent Tunnel

Sounding: CP20-IS-03
Cone: 657:T1500F15U500



Max Depth: 36.850 m / 120.90 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-03.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.802721 Long: -111.929822

00 31 32-222

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

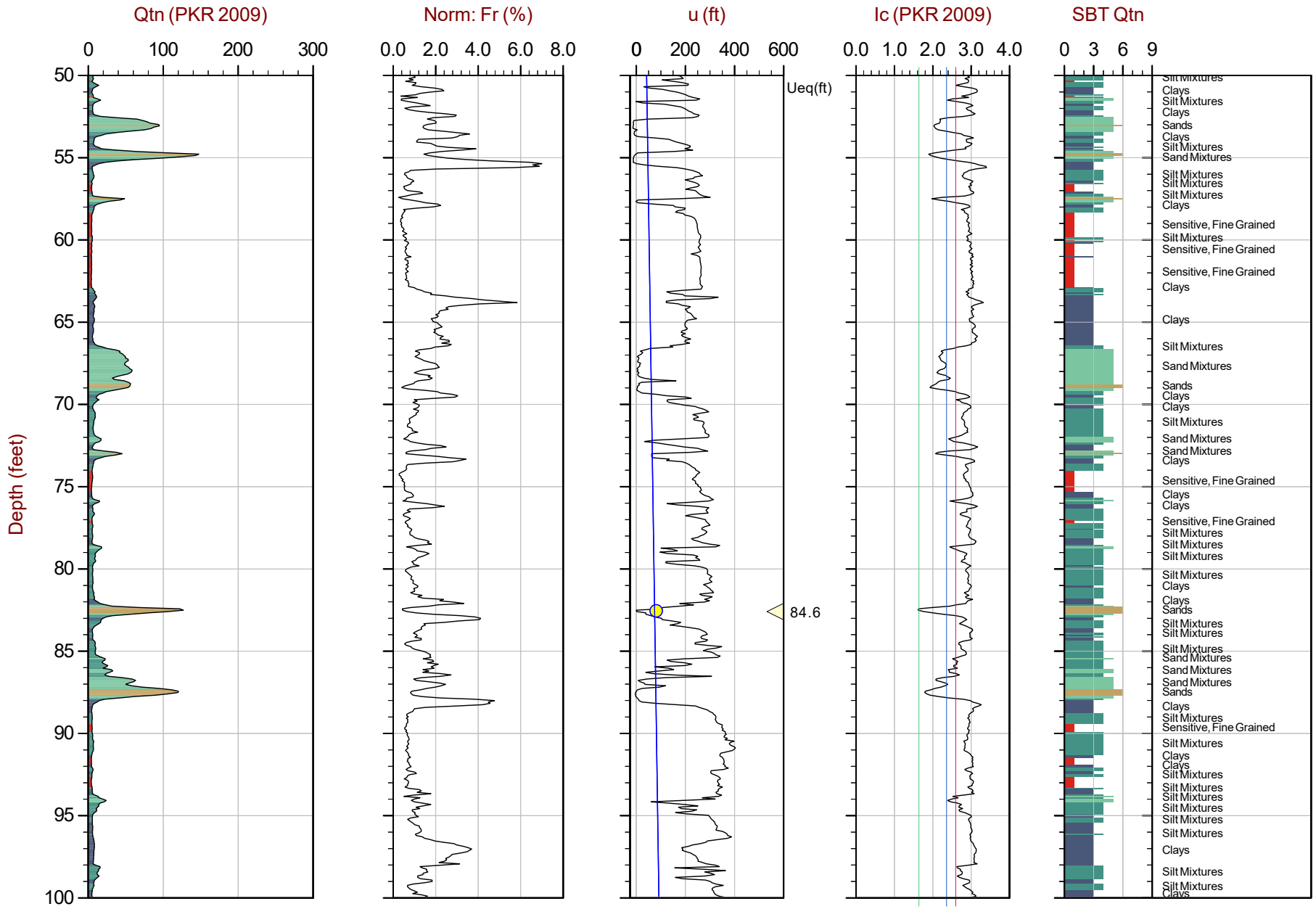
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-23 07:23
Site: Influent Tunnel

Sounding: CP20-IS-03
Cone: 657:T1500F15U500



Max Depth: 36.850 m / 120.90 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-03.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.802721 Long: -111.929822

00 31 32-223

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

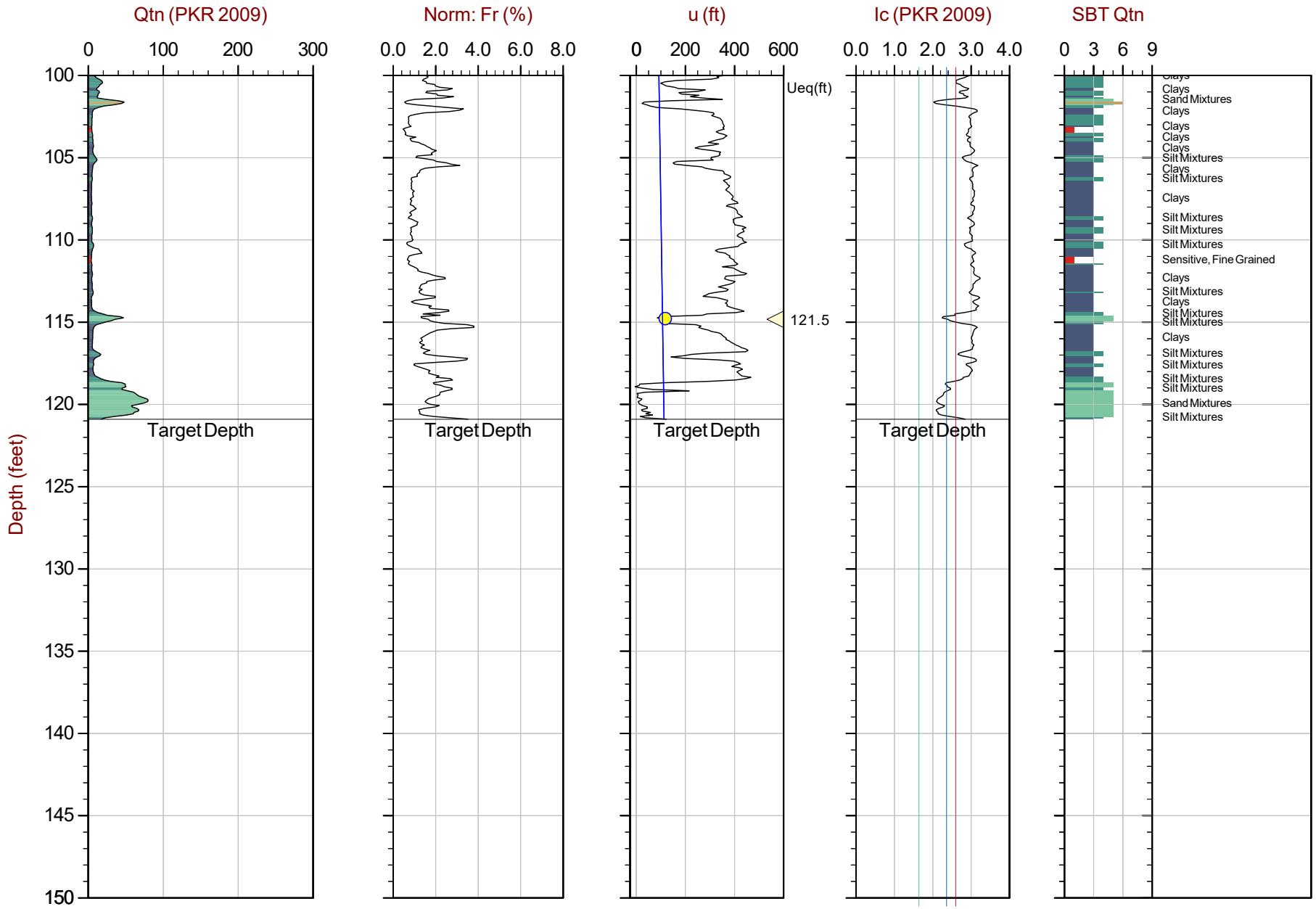
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-23 07:23
Site: Influent Tunnel

Sounding: CP20-IS-03
Cone: 657:T1500F15U500



Max Depth: 36.850 m / 120.90 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-03.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.802721 Long: -111.929822

00 31 32-224

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

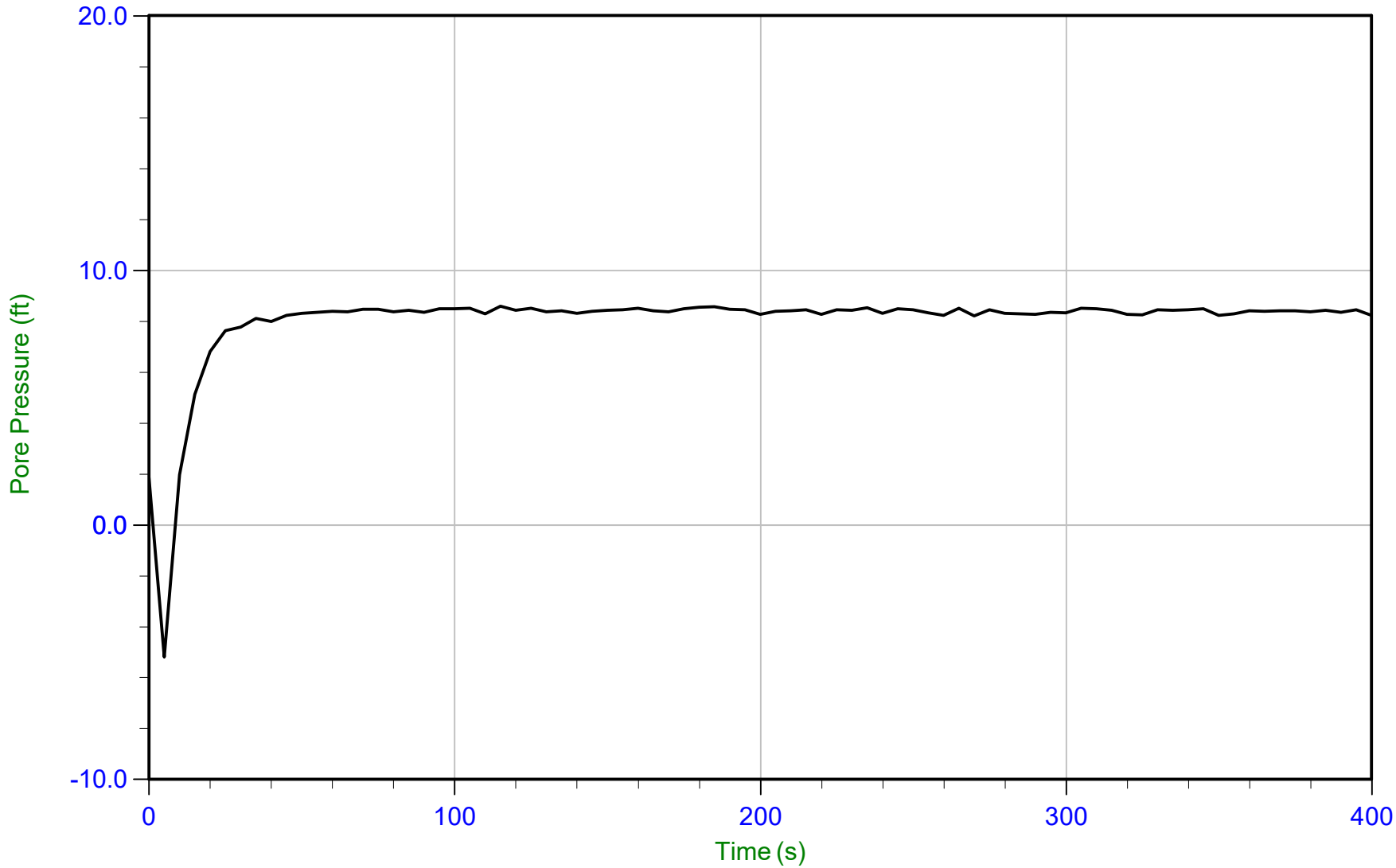
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 07:05
Site: Influent Tunnel

Sounding: CP20-IS-03
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-03.PPF
Depth: 4.825 m / 15.830 ft
Duration: 400.0 s

u Min: -5.2 ft
u Max: 8.6 ft
u Final: 8.2 ft

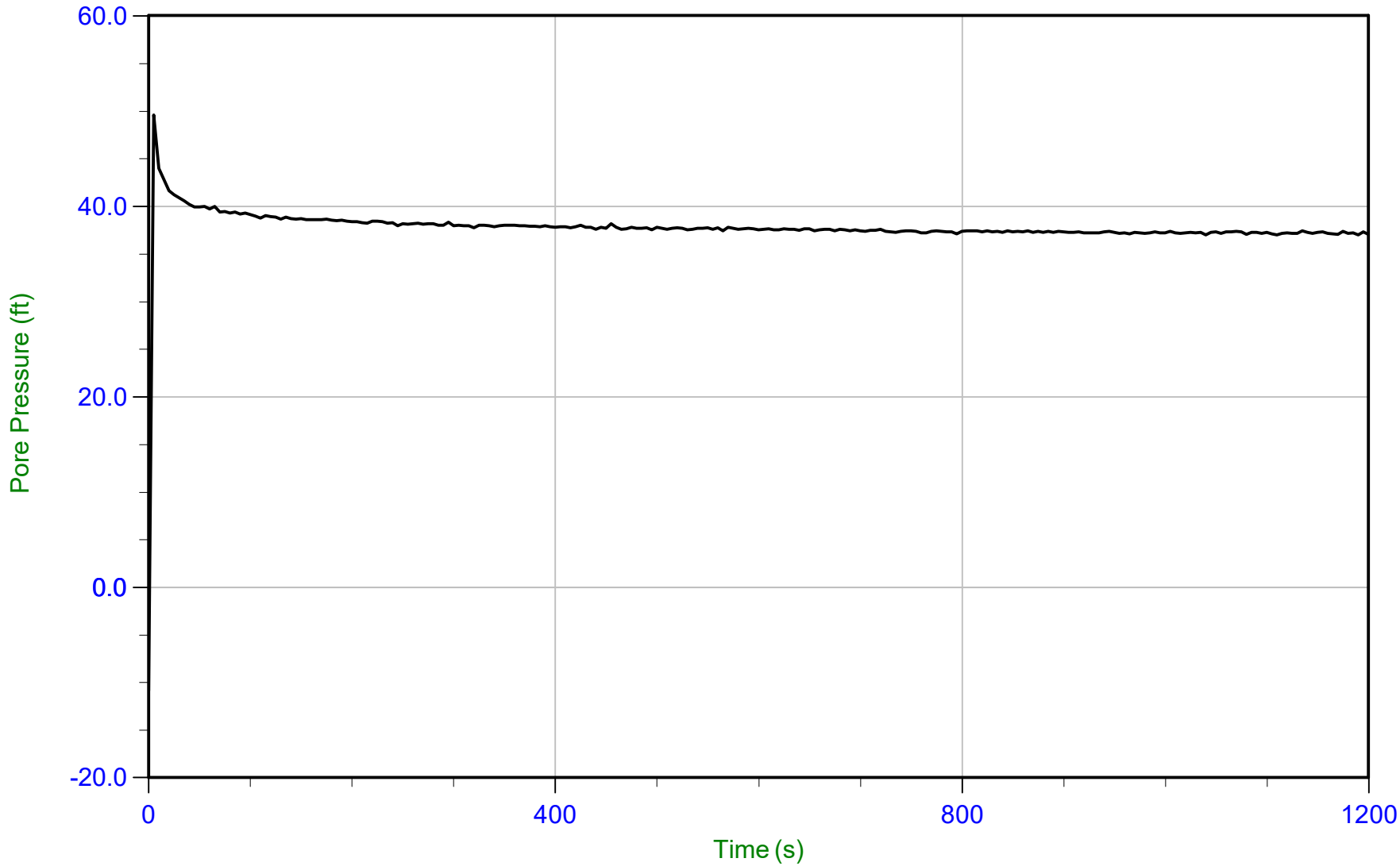
WT: 2.264 m / 7.428 ft
Ueq: 8.4 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 07:05
Site: Influent Tunnel

Sounding: CP20-IS-03
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-03.PPF
Depth: 12.600 m / 41.338 ft
Duration: 1200.0 s

u Min: -10.8 ft
u Max: 49.6 ft
u Final: 37.0 ft

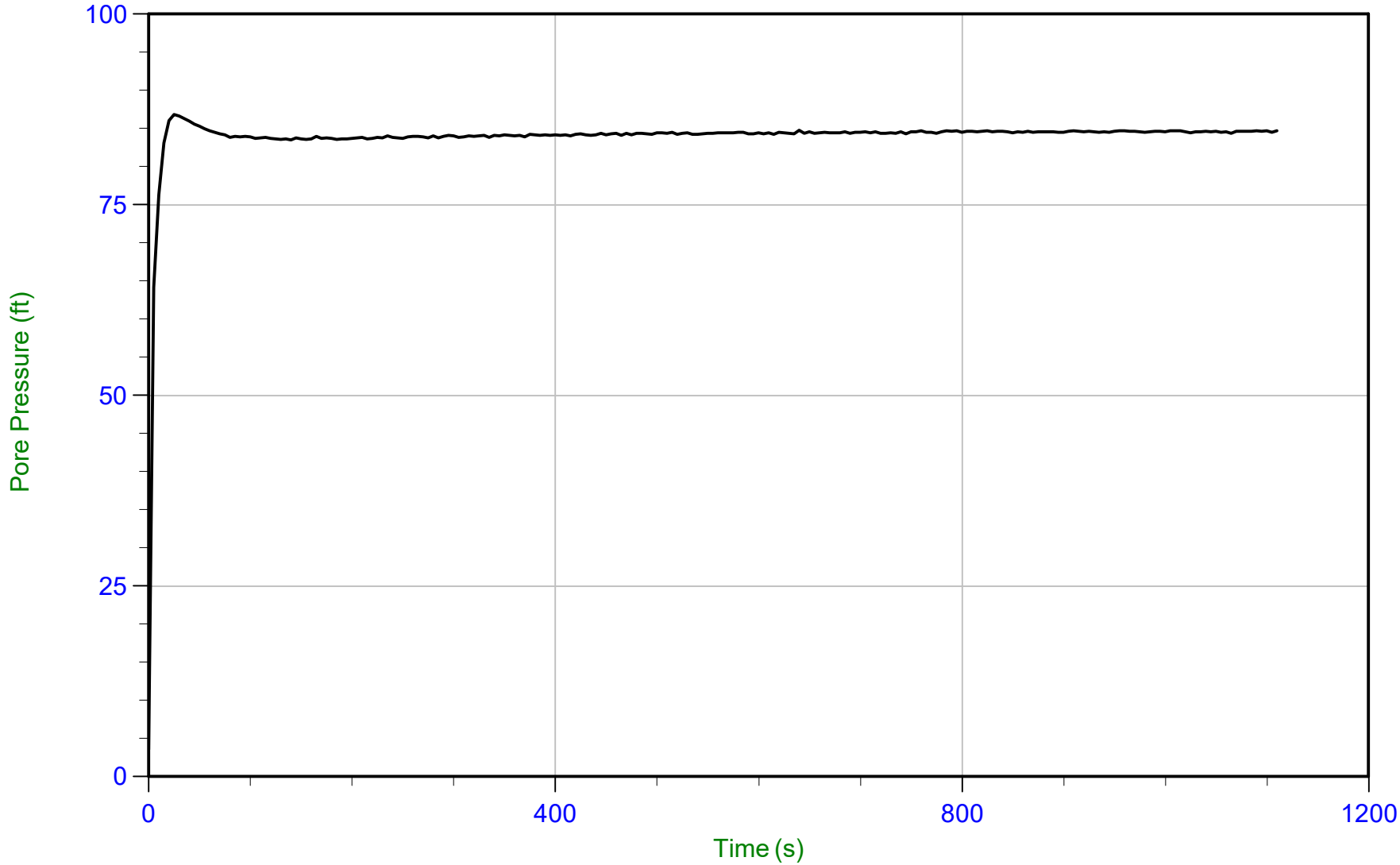
WT: 1.295 m / 4.249 ft
Ueq: 37.1 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 07:05
Site: Influent Tunnel

Sounding: CP20-IS-03
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-03.PPF
Depth: 25.175 m / 82.594 ft
Duration: 1110.0 s

u Min: 3.5 ft
u Max: 86.8 ft
u Final: 84.7 ft

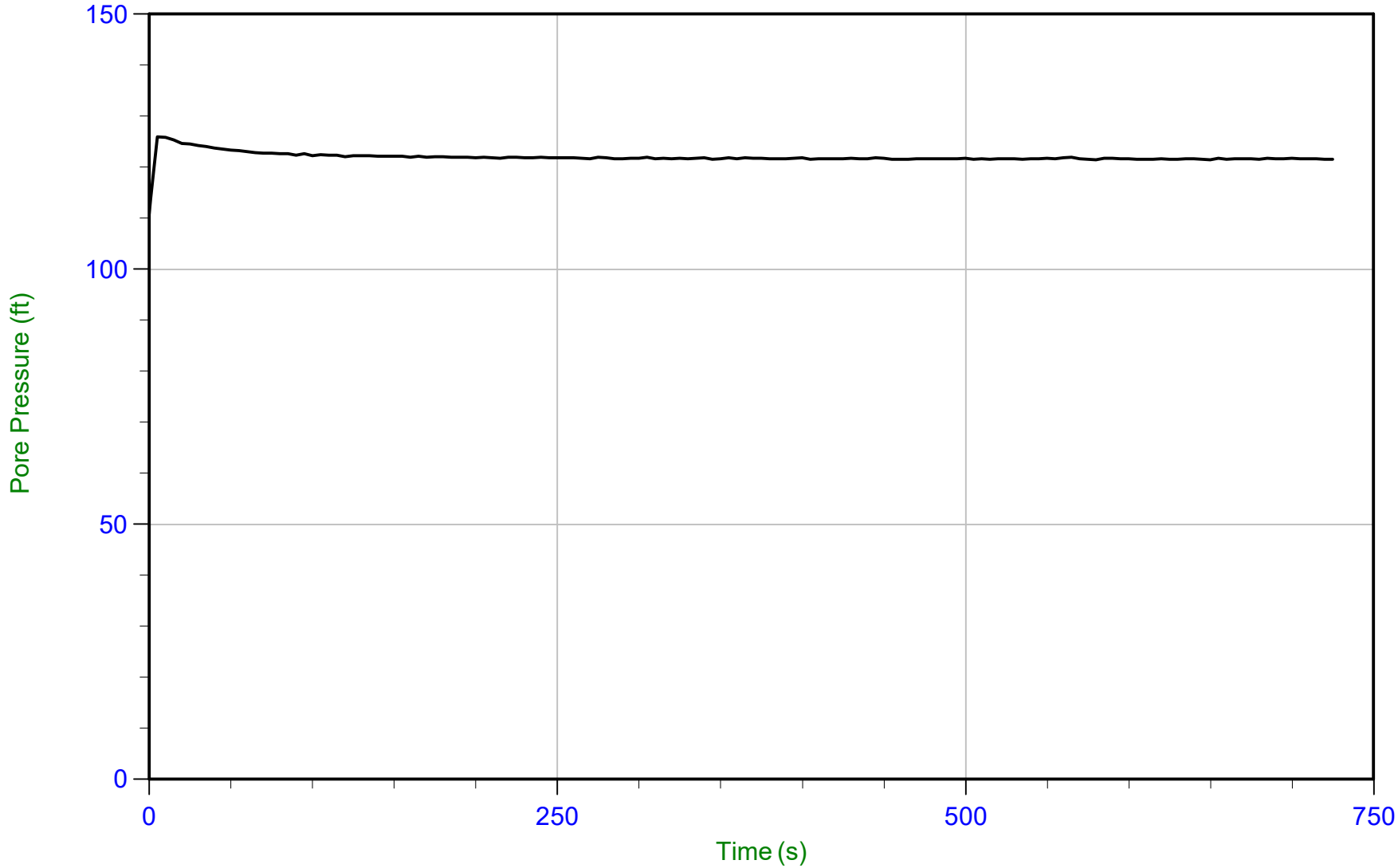
WT: -0.629 m / -2.064 ft
Ueq: 84.7 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/23/2020 07:05
Site: Influent Tunnel

Sounding: CP20-IS-03
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-03.PPF
Depth: 35.000 m / 114.828 ft
Duration: 725.0 s

u Min: 110.9 ft
u Max: 125.9 ft
u Final: 121.5 ft

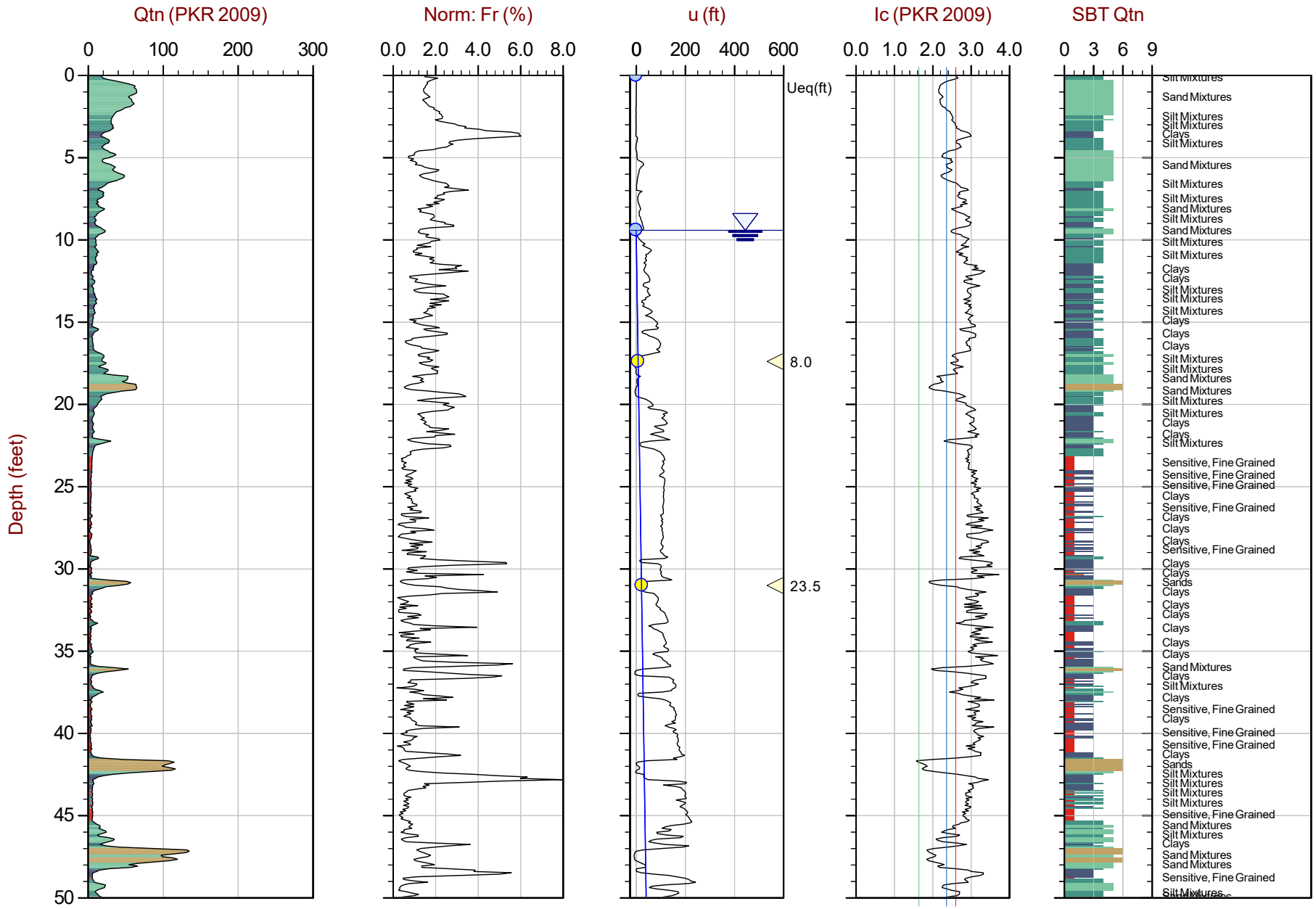
WT: -2.048 m / -6.719 ft
Ueq: 121.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-22 09:36
Site: Influent Tunnel

Sounding: CP20-IS-04
Cone: 657:T1500F15U500



Max Depth: 22.875 m / 75.05 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-04.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.802957 Long: -111.931183

00 31 32-229

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

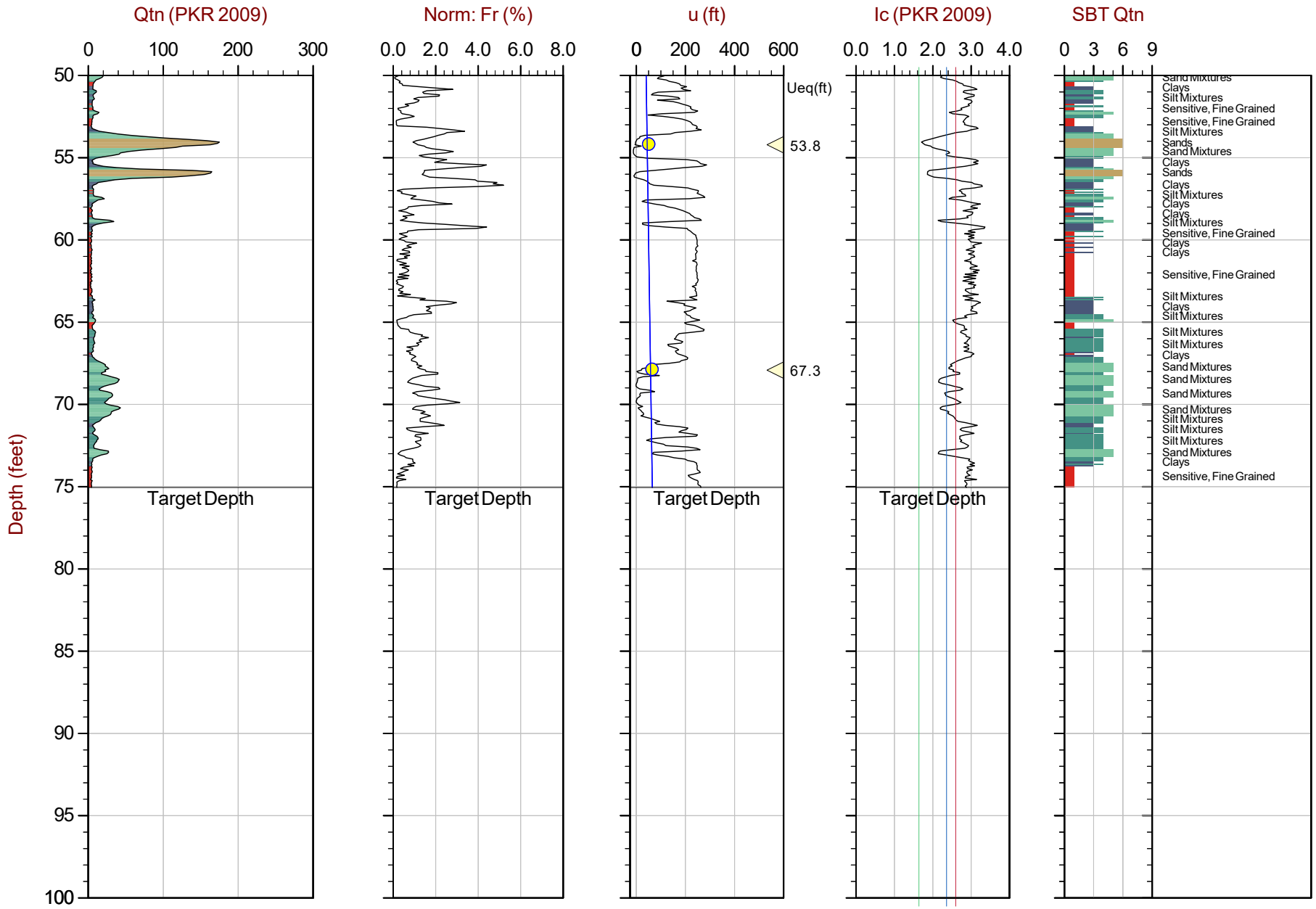
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-22 09:36
Site: Influent Tunnel

Sounding: CP20-IS-04
Cone: 657:T1500F15U500



Max Depth: 22.875 m / 75.05 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-04.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.802957 Long: -111.931183

00 31 32-230

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

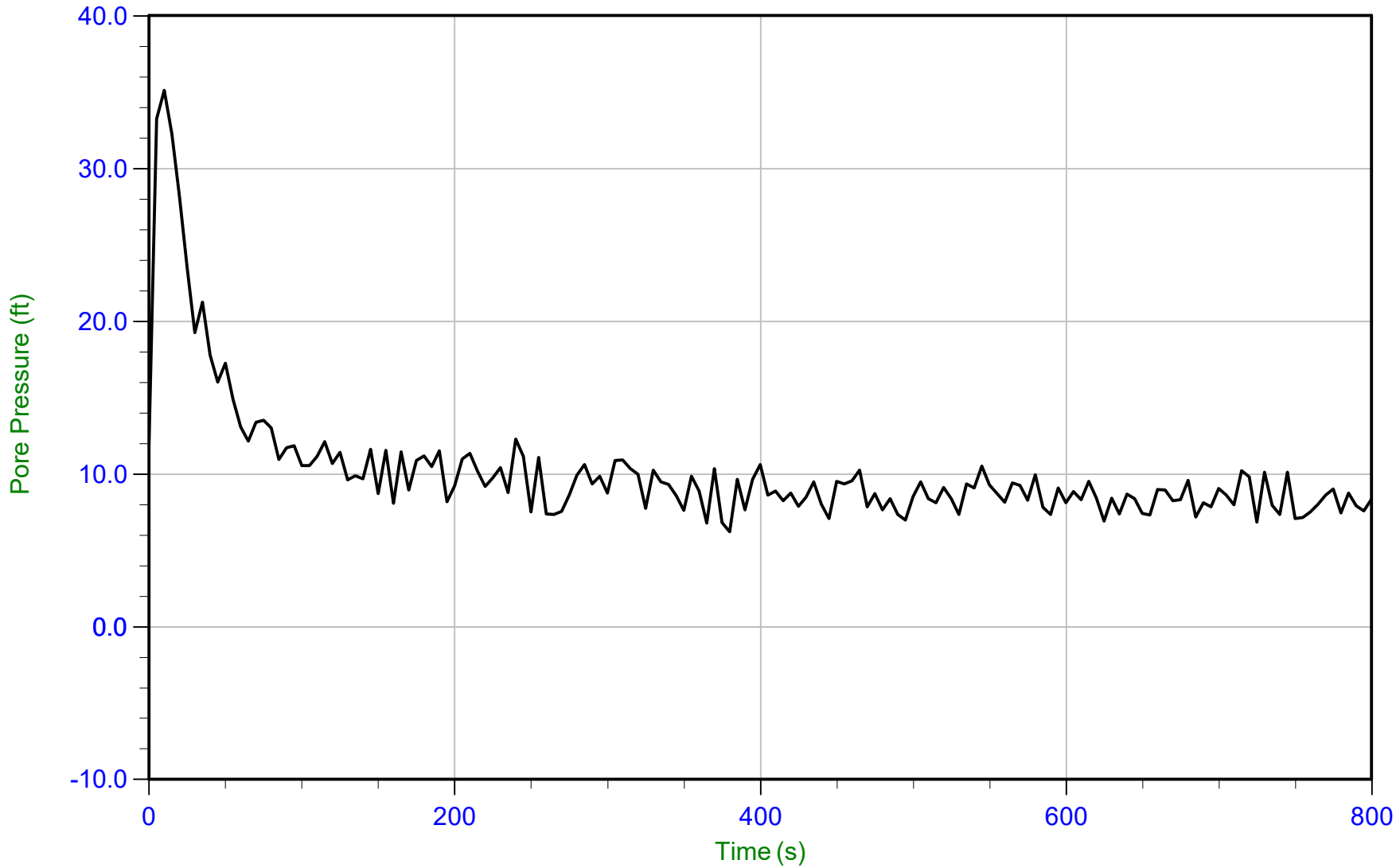
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/22/2020 09:36
Site: Influent Tunnel

Sounding: CP20-IS-04
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-04.PPF
Depth: 5.300 m / 17.388 ft
Duration: 800.0 s

u Min: 6.2 ft
u Max: 35.1 ft
u Final: 8.3 ft

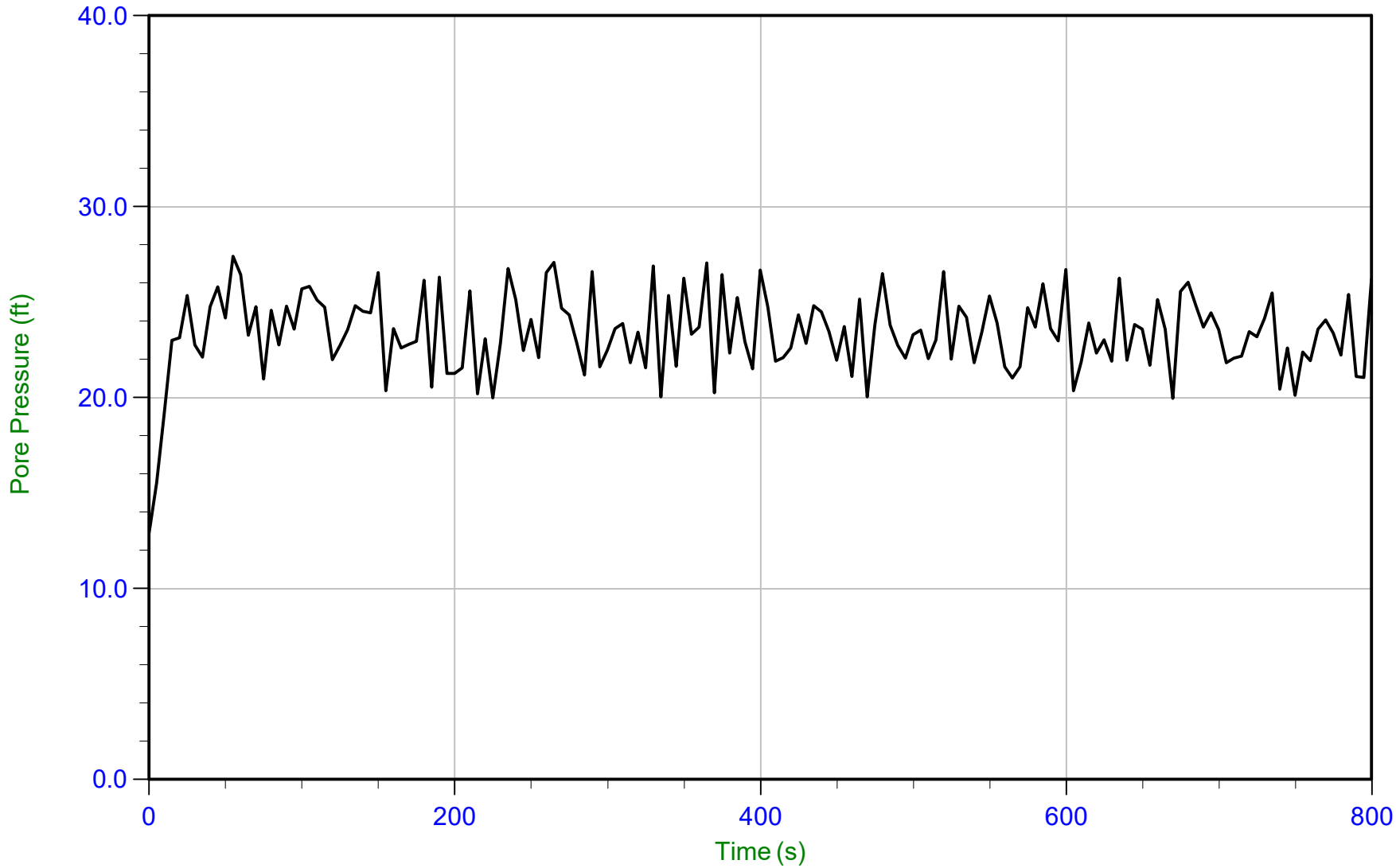
WT: 2.867 m / 9.406 ft
Ueq: 8.0 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/22/2020 09:36
Site: Influent Tunnel

Sounding: CP20-IS-04
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-04.PPF
Depth: 9.450 m / 31.004 ft
Duration: 800.0 s

u Min: 12.9 ft
u Max: 27.4 ft
u Final: 26.2 ft

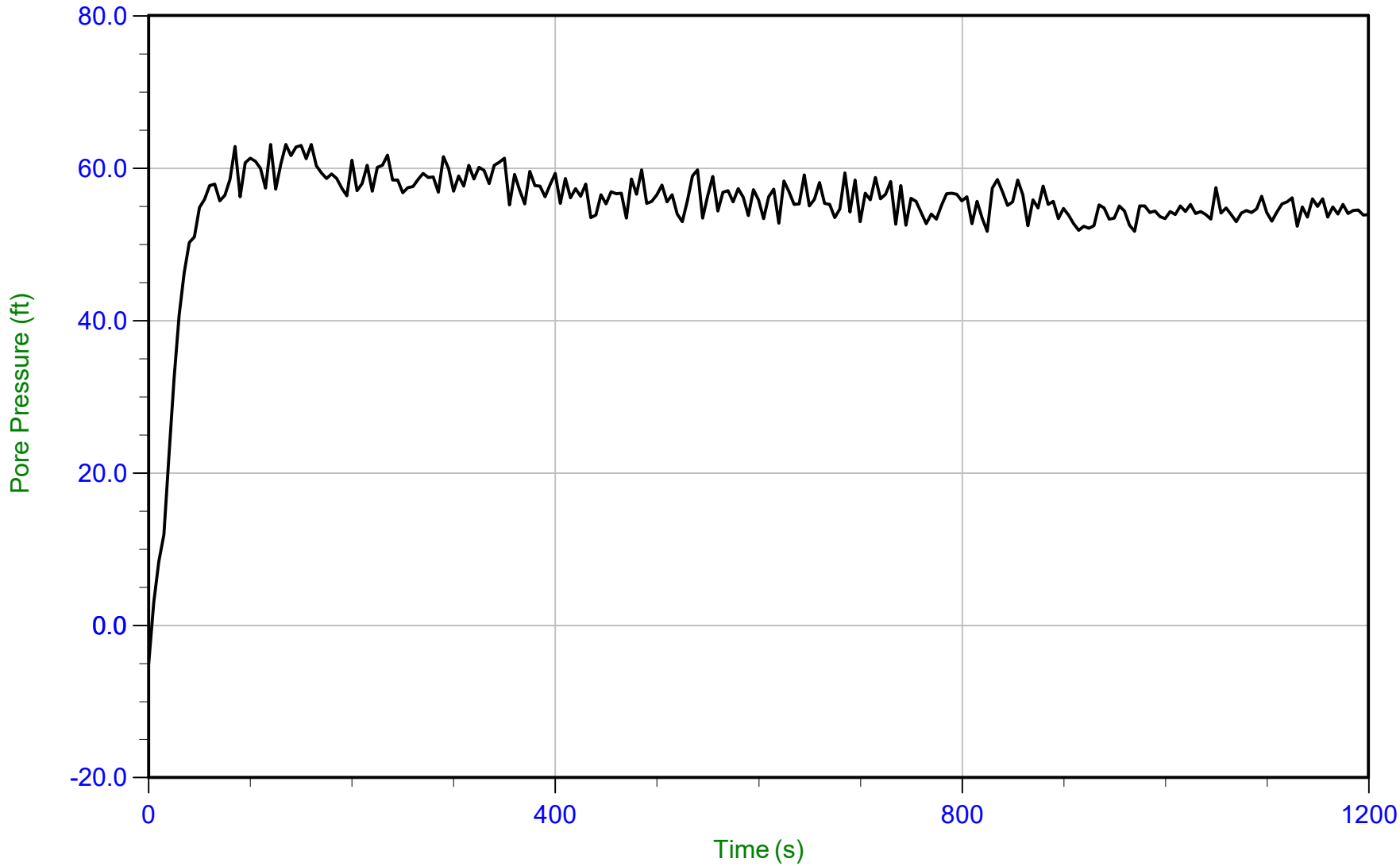
WT: 2.280 m / 7.480 ft
Ueq: 23.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/22/2020 09:36
Site: Influent Tunnel

Sounding: CP20-IS-04
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-04.PPF
Depth: 16.525 m / 54.215 ft
Duration: 1200.0 s

u Min: -5.1 ft
u Max: 63.1 ft
u Final: 53.9 ft

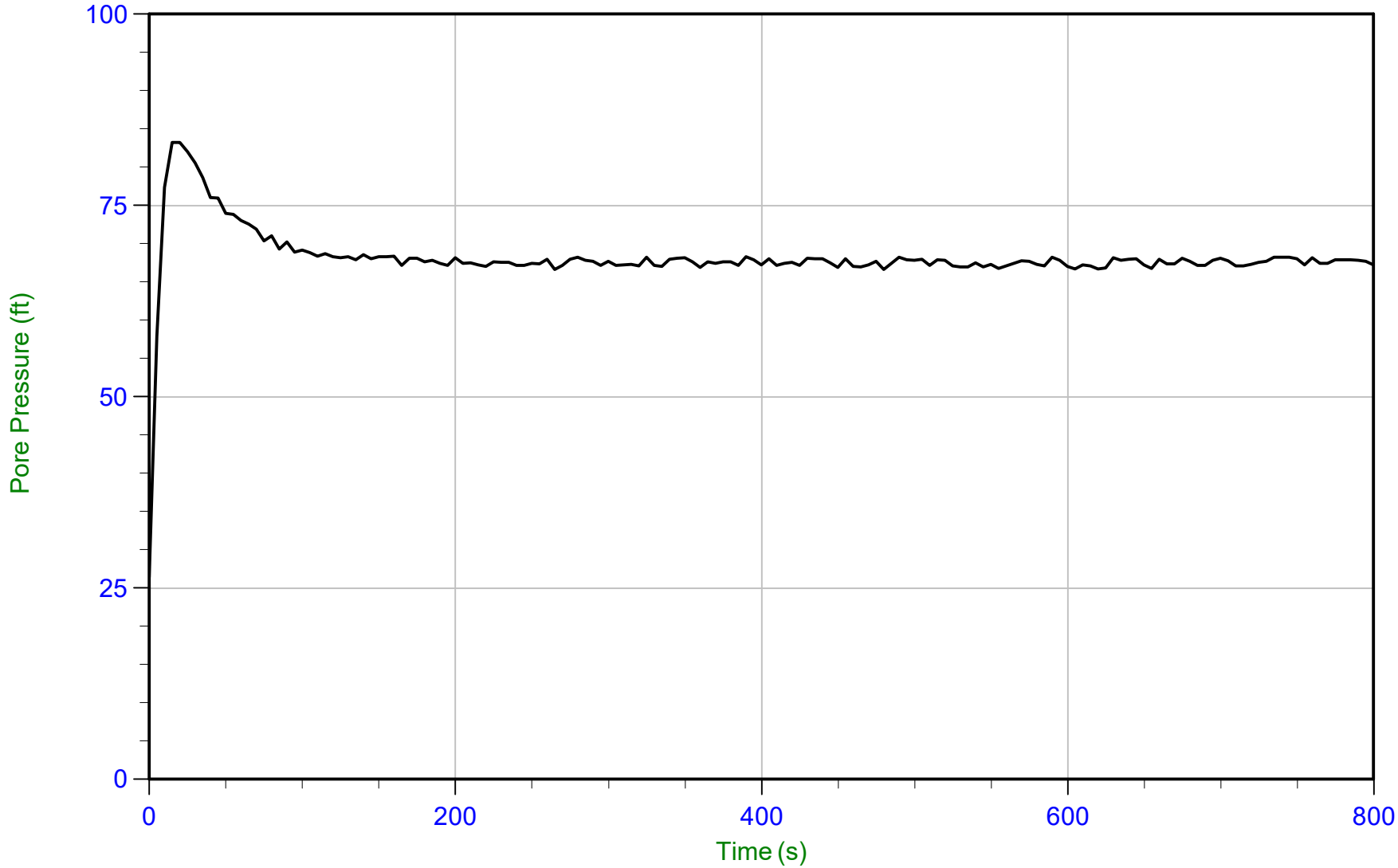
WT: 0.101 m / 0.331 ft
Ueq: 53.9 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/22/2020 09:36
Site: Influent Tunnel

Sounding: CP20-IS-04
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-04.PPF
Depth: 20.700 m / 67.913 ft
Duration: 800.0 s

u Min: 26.4 ft
u Max: 83.2 ft
u Final: 67.2 ft

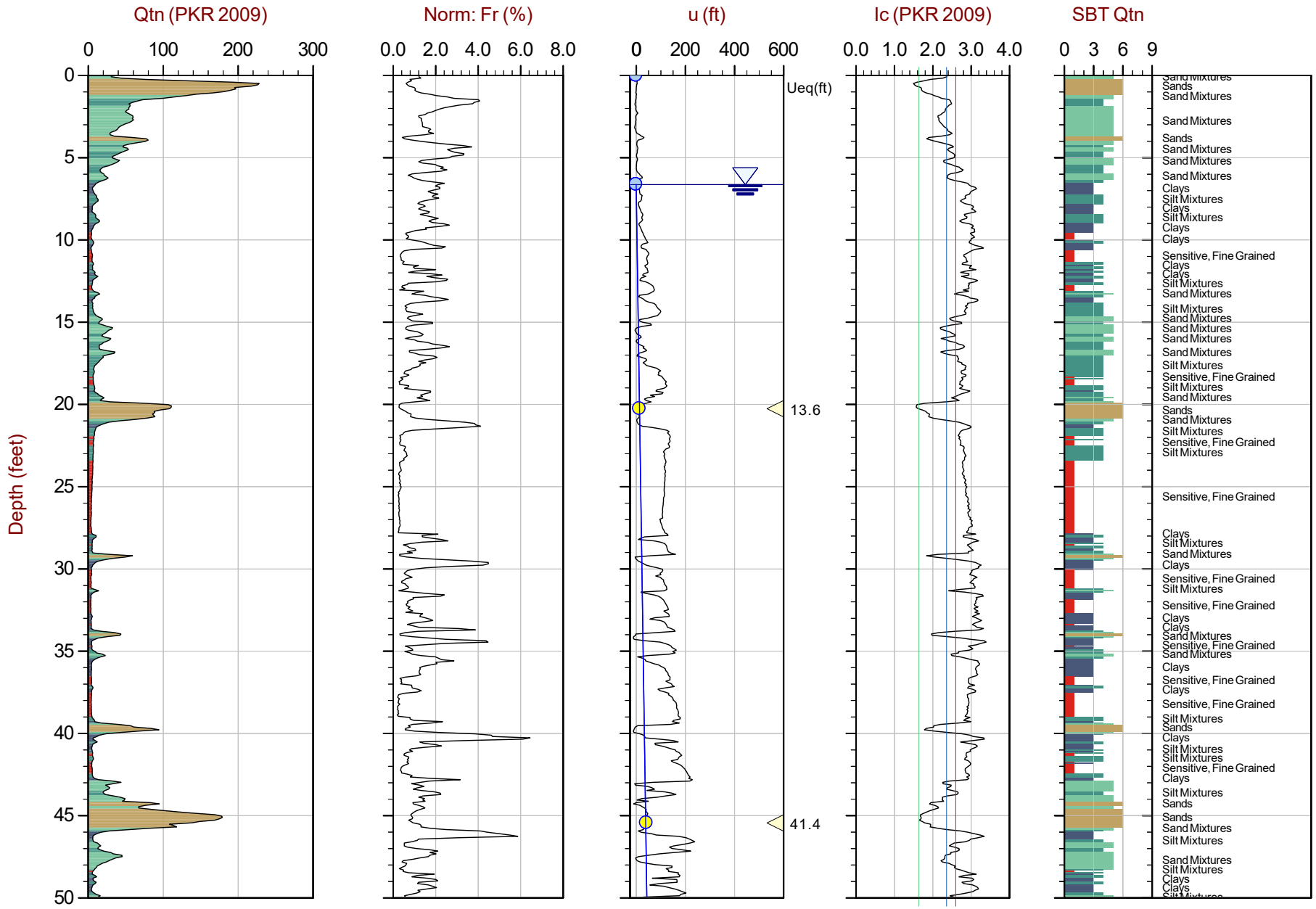
WT: 0.186 m / 0.610 ft
Ueq: 67.3 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-22 13:28
Site: Influent Tunnel

Sounding: CP20-IS-05
Cone: 657:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-05.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.803181 Long: -111.932459

00 31 32-235

Equilibrium Pore Pressure (Ueq) ○ Assumed Ueq ◁ Dissipation, Ueq achieved ◁ Dissipation, Ueq not achieved — Hydrostatic Line

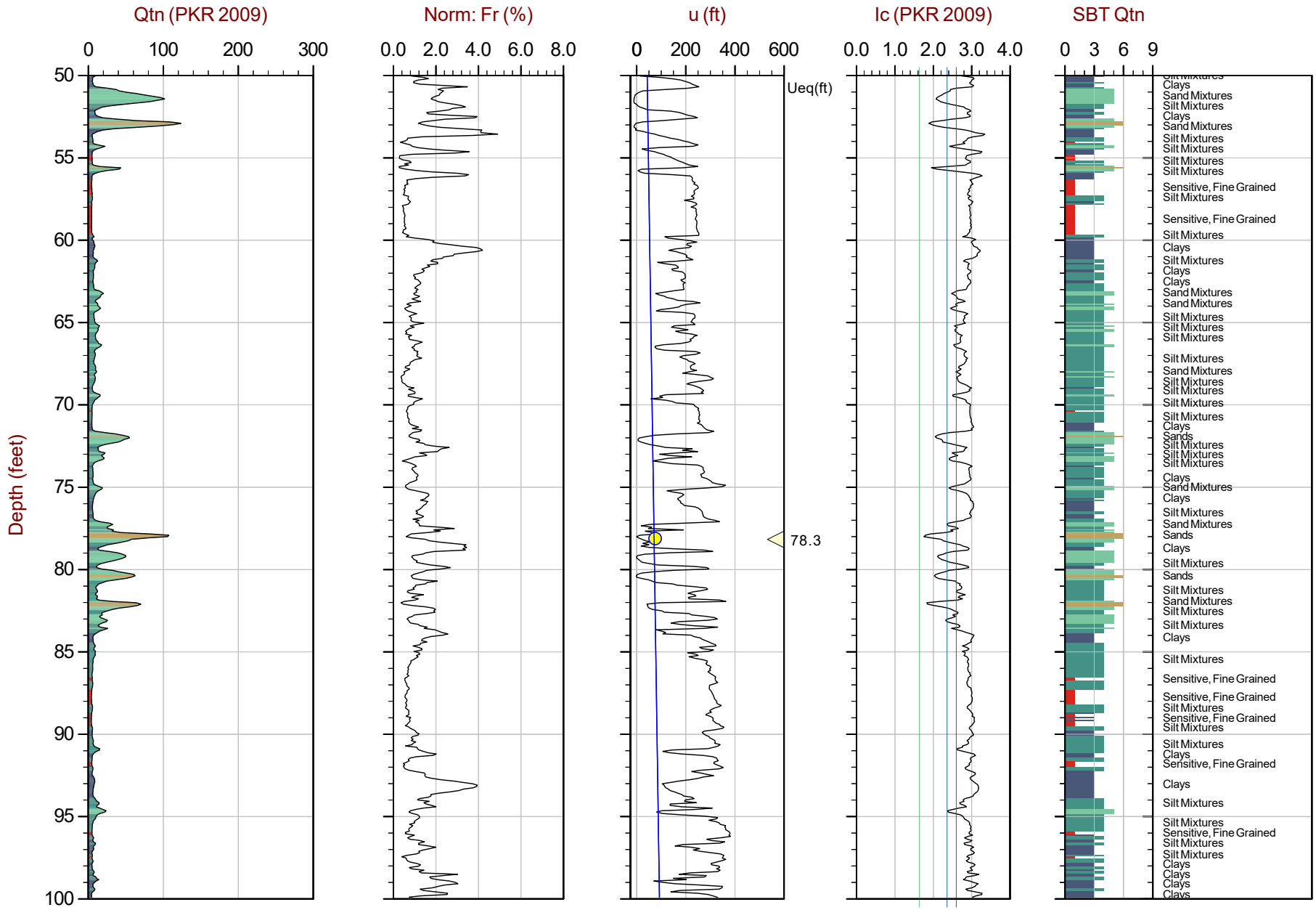
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-22 13:28
Site: Influent Tunnel

Sounding: CP20-IS-05
Cone: 657:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-05.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.803181 Long: -111.932459

00 31 32-236

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

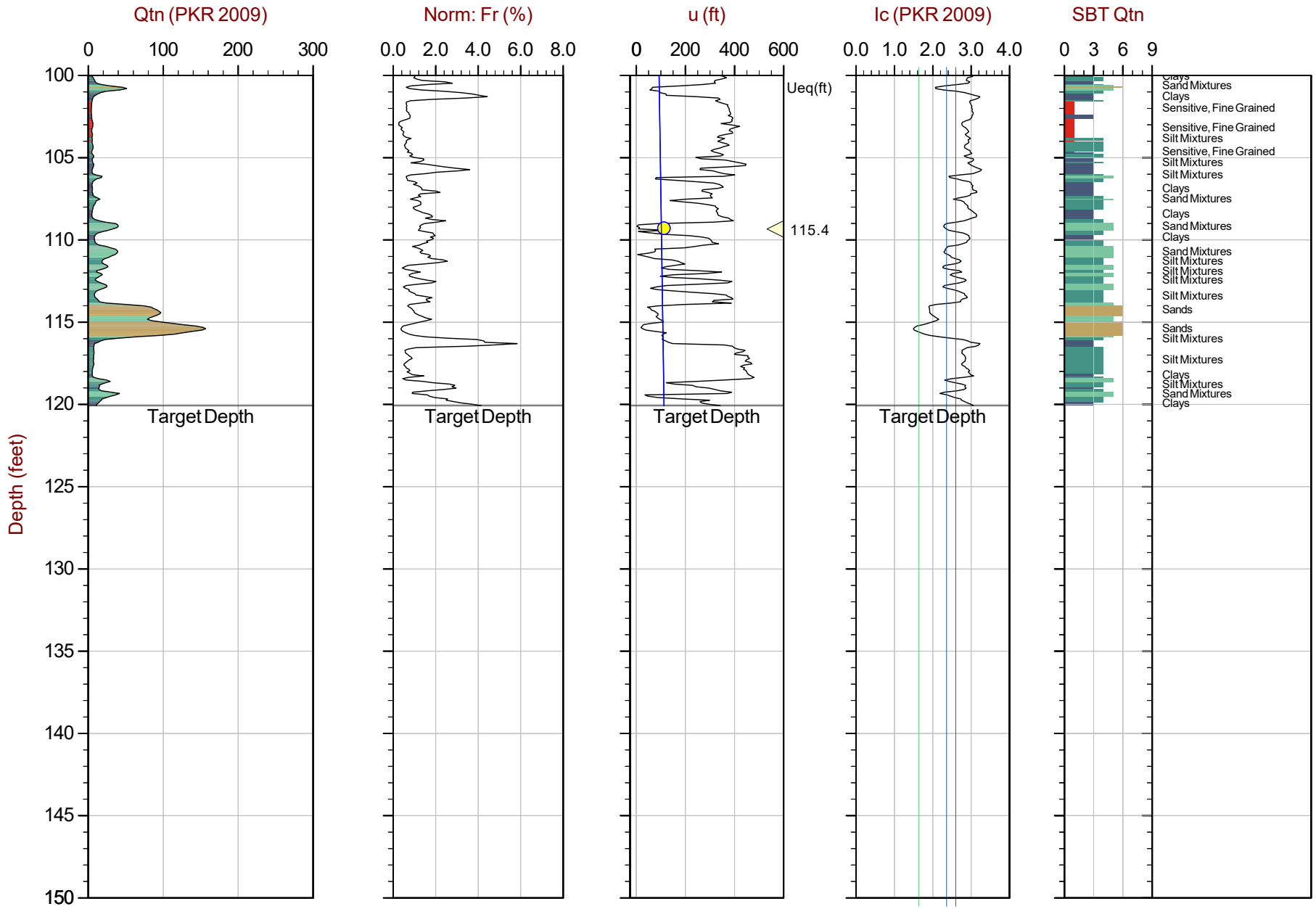
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2020-12-22 13:28
Site: Influent Tunnel

Sounding: CP20-IS-05
Cone: 657:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP20-IS-05.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.803181 Long: -111.932459

00 31 32-237

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

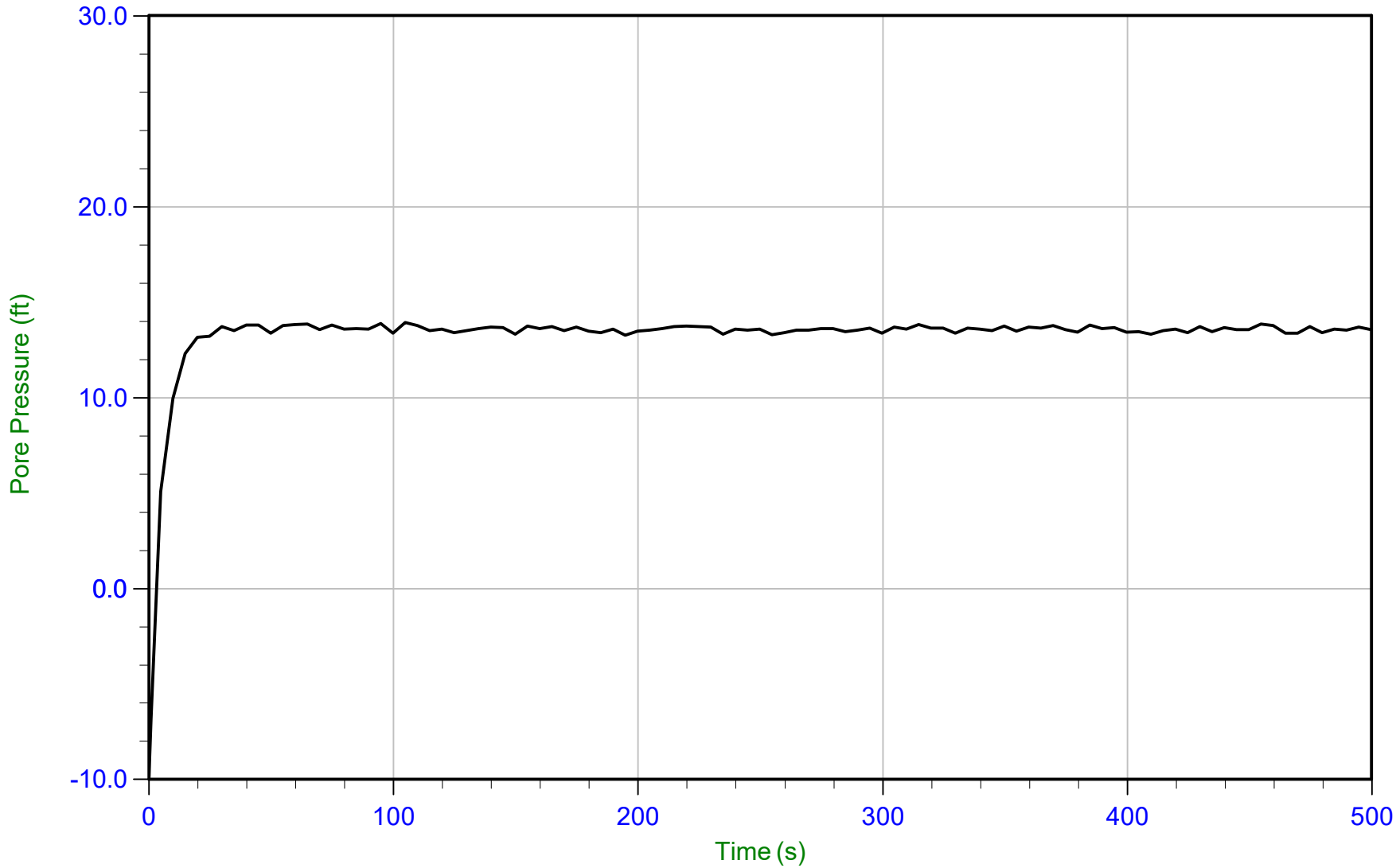
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/22/2020 13:28
Site: Influent Tunnel

Sounding: CP20-IS-05
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-05.PPF
Depth: 6.175 m / 20.259 ft
Duration: 500.0 s

u Min: -9.8 ft
u Max: 13.9 ft
u Final: 13.6 ft

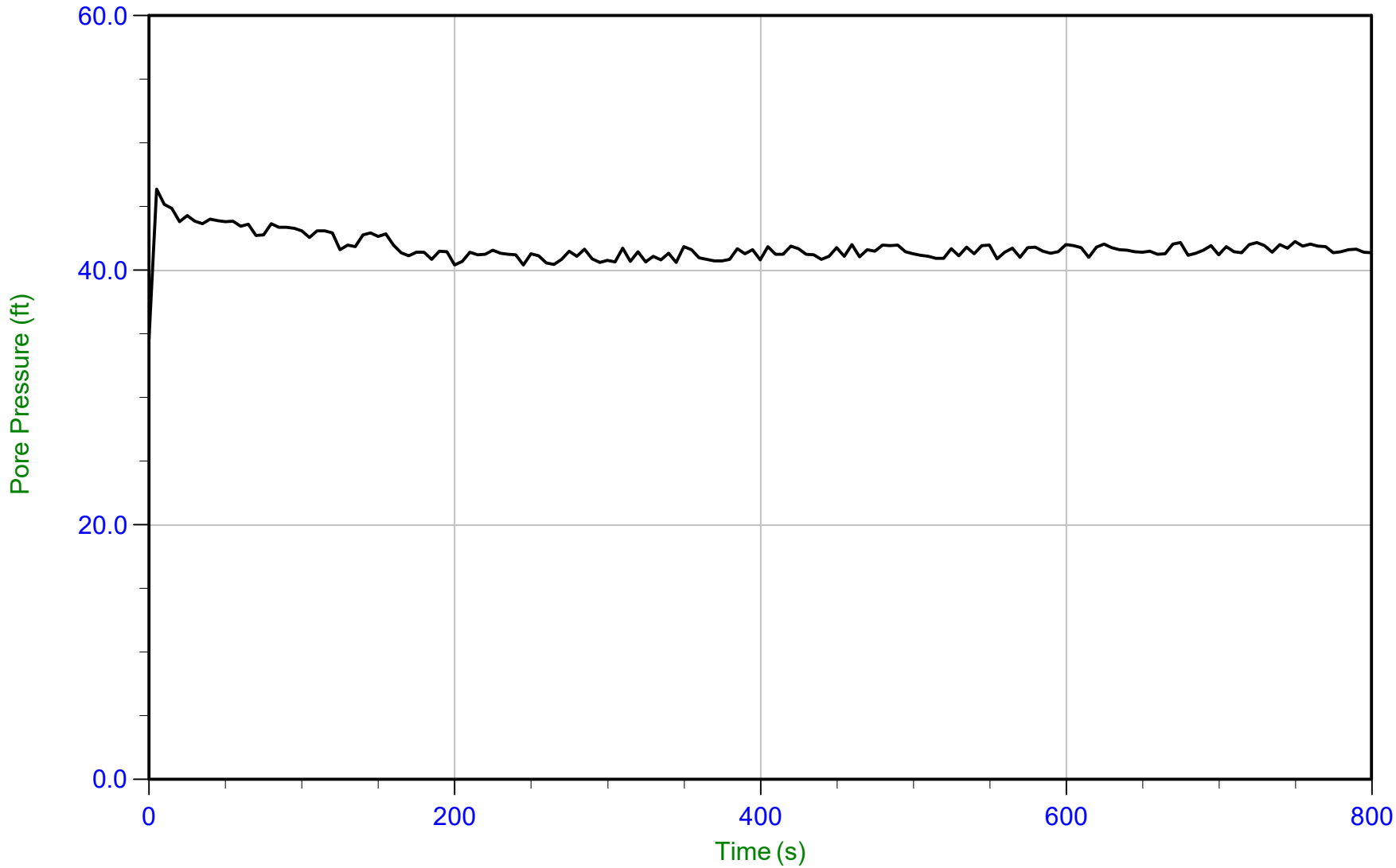
WT: 2.020 m / 6.627 ft
Ueq: 13.6 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/22/2020 13:28
Site: Influent Tunnel

Sounding: CP20-IS-05
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-05.PPF
Depth: 13.850 m / 45.439 ft
Duration: 800.0 s

u Min: 34.6 ft
u Max: 46.4 ft
u Final: 41.4 ft

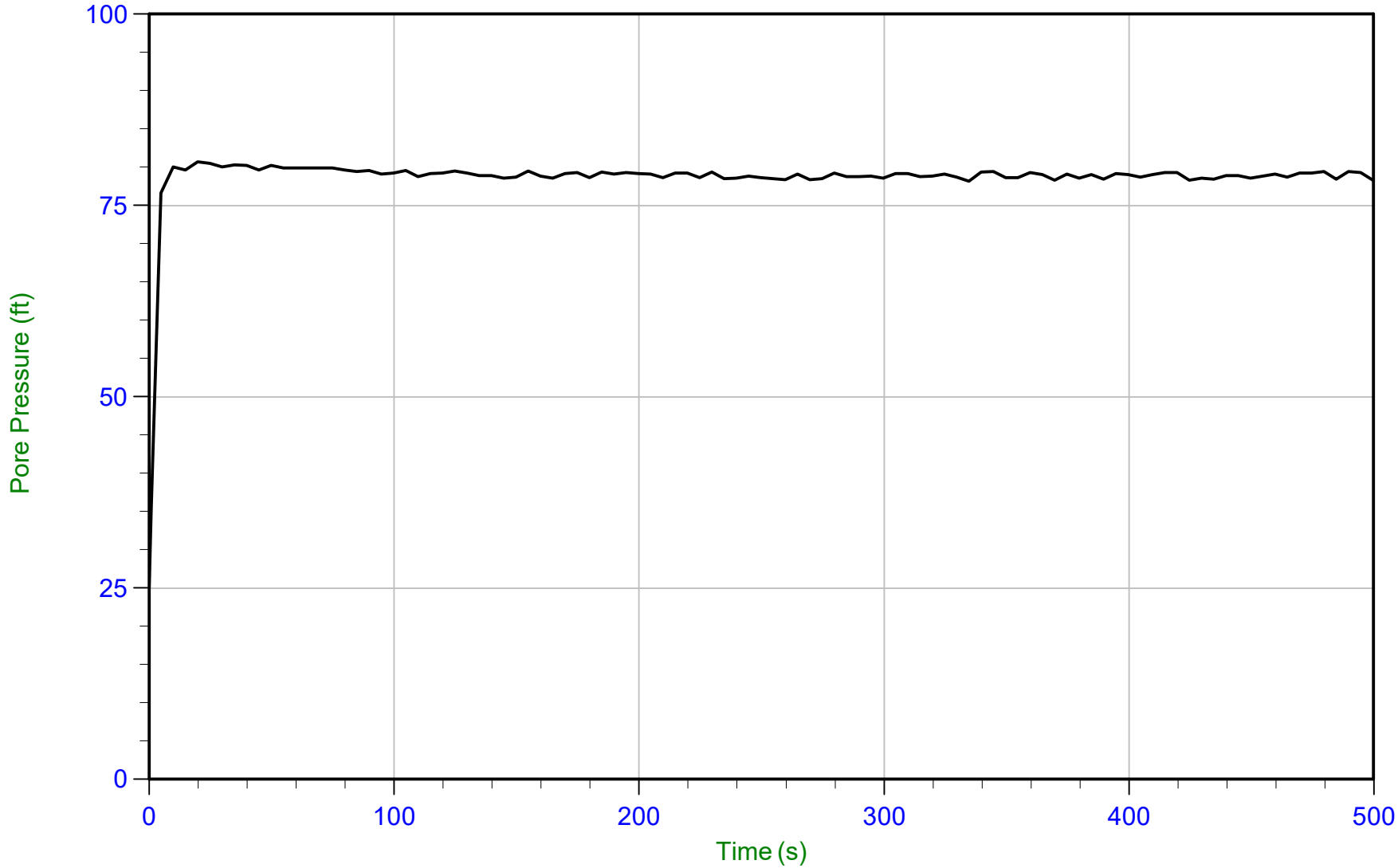
WT: 1.231 m / 4.039 ft
Ueq: 41.4 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/22/2020 13:28
Site: Influent Tunnel

Sounding: CP20-IS-05
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-05.PPF
Depth: 23.825 m / 78.165 ft
Duration: 500.0 s

u Min: 25.1 ft
u Max: 80.7 ft
u Final: 78.3 ft

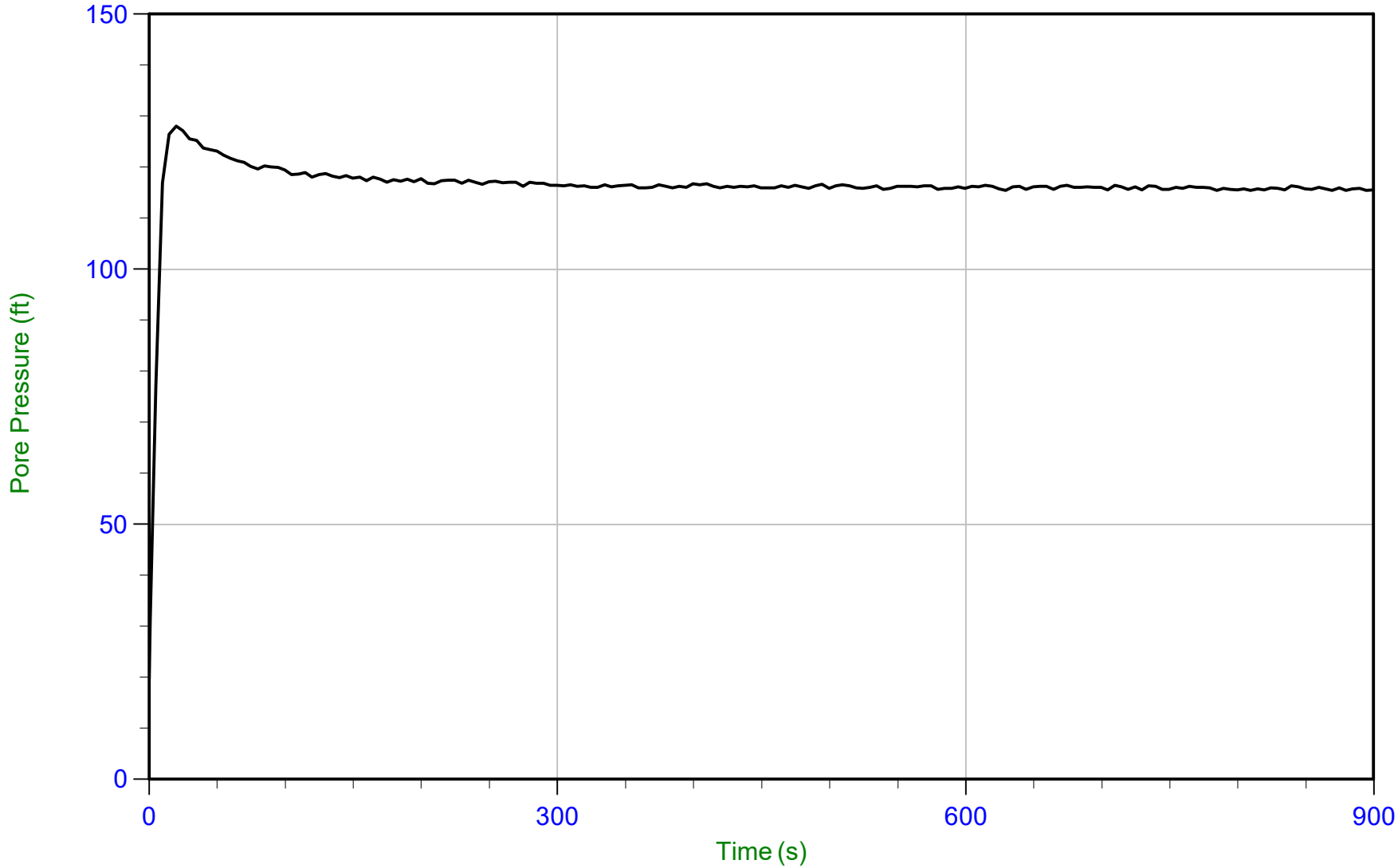
WT: -0.054 m / -0.177 ft
Ueq: 78.3 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 12/22/2020 13:28
Site: Influent Tunnel

Sounding: CP20-IS-05
Cone: 657:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP20-IS-05.PPF
Depth: 33.325 m / 109.333 ft
Duration: 900.0 s

u Min: 19.7 ft
u Max: 128.0 ft
u Final: 115.5 ft

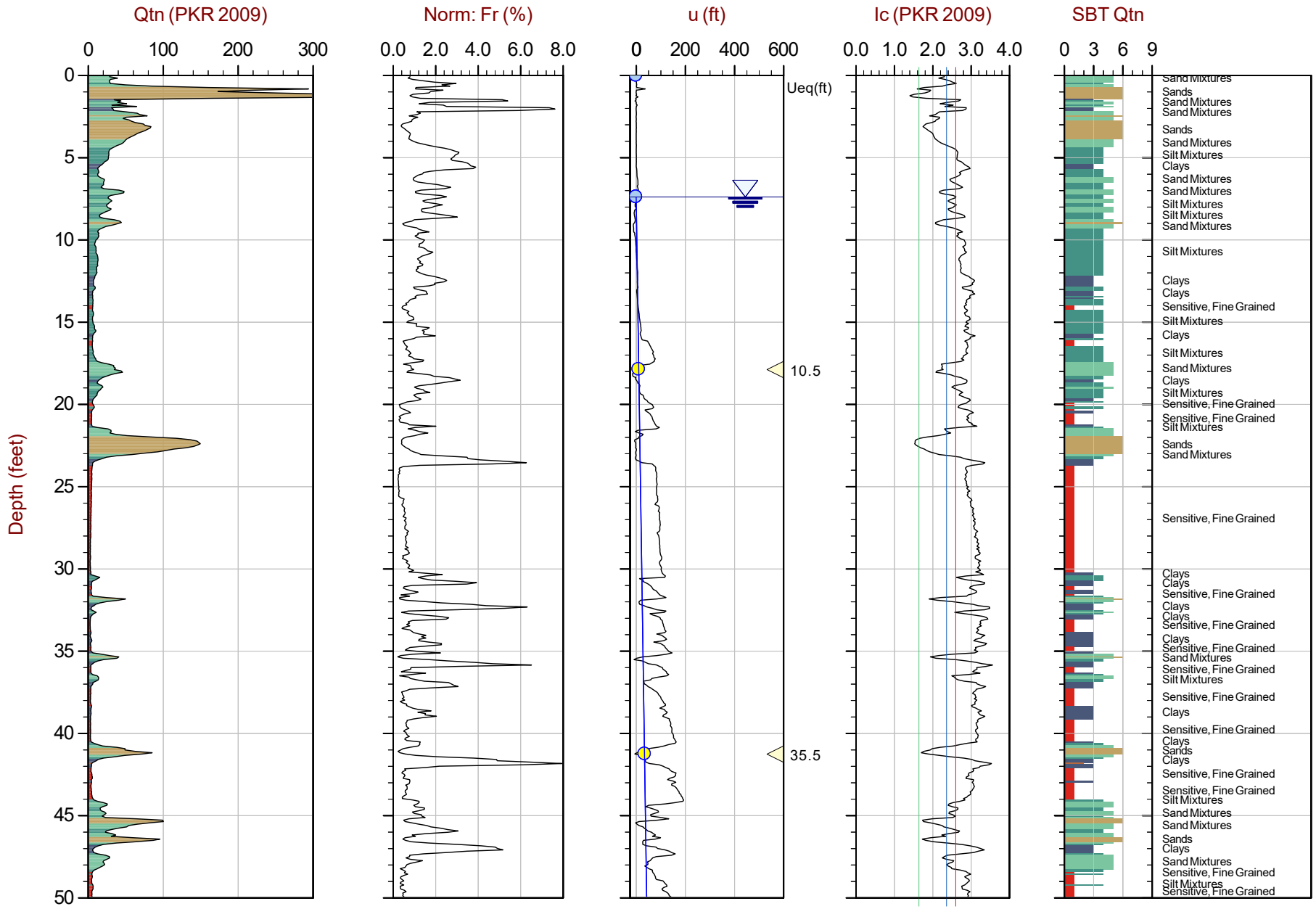
WT: -1.879 m / -6.165 ft
Ueq: 115.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-07 11:26
Site: Influent Tunnel

Sounding: CP21-IS-06
Cone: 418:T1500F15U500



Max Depth: 37.750 m / 123.85 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-06.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.805001 Long: -111.933029

00 31 32-242

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

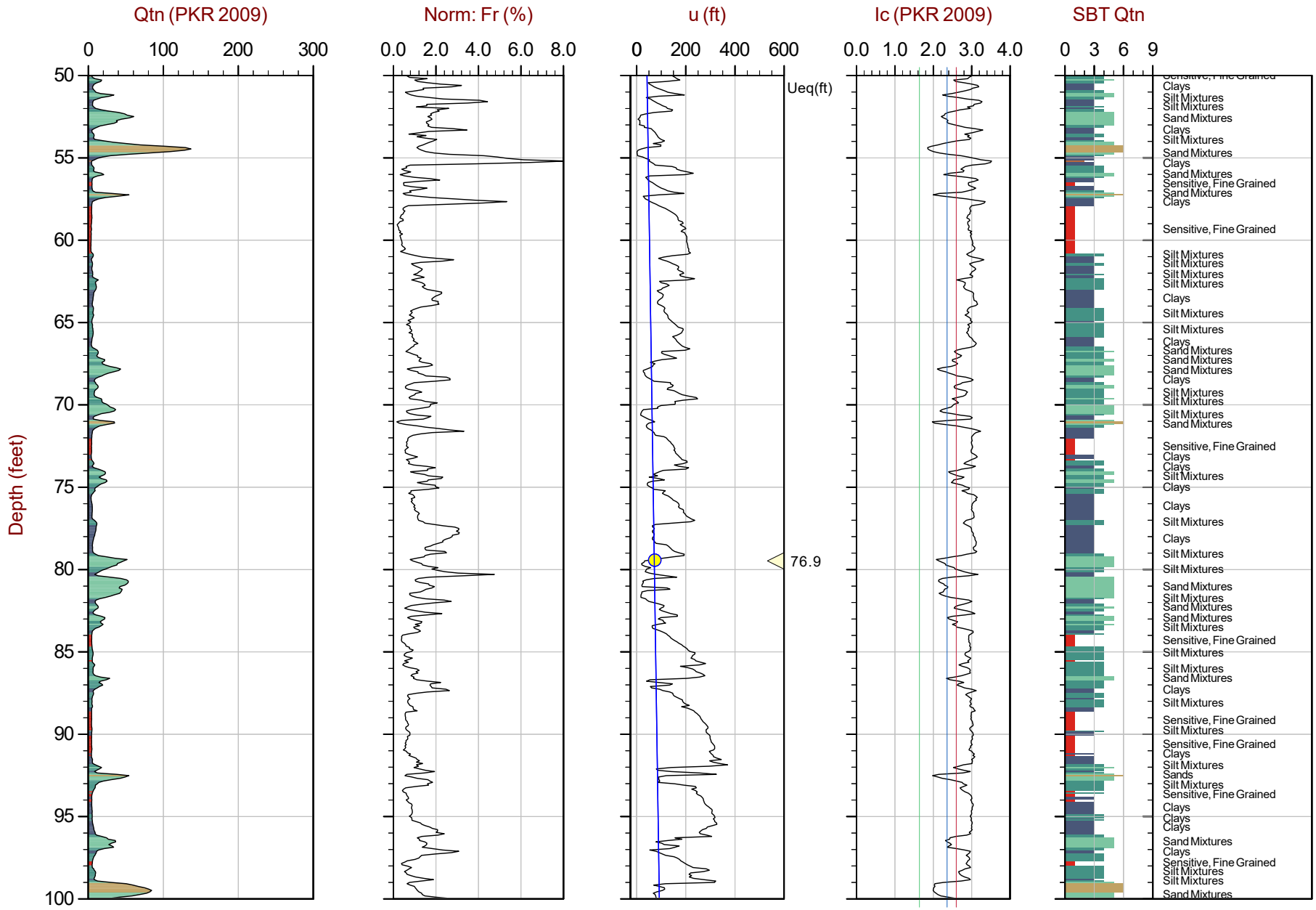
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-07 11:26
Site: Influent Tunnel

Sounding: CP21-IS-06
Cone: 418:T1500F15U500



Max Depth: 37.750 m / 123.85 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-06.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.805001 Long: -111.933029

00 31 32-243

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

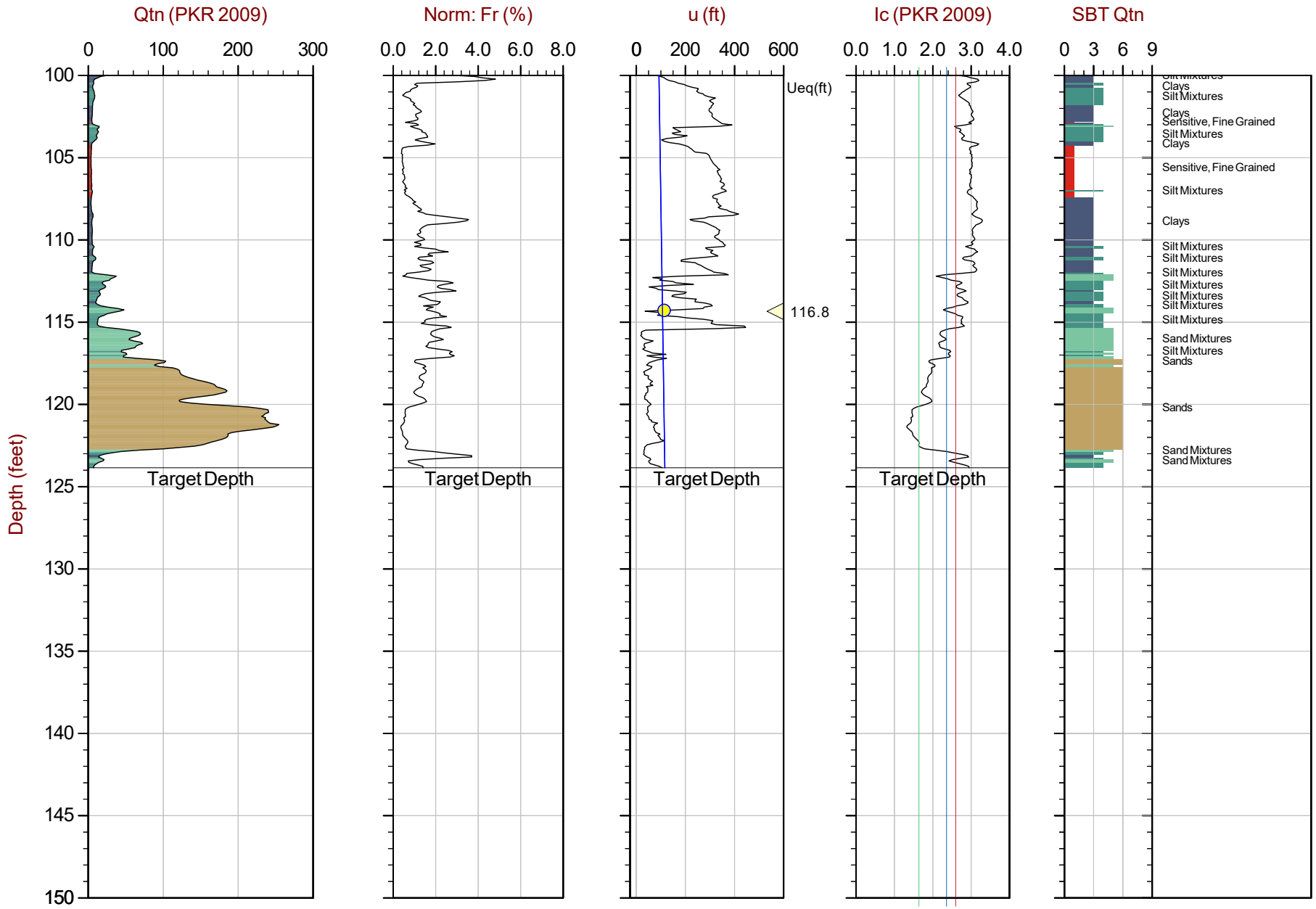
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-07 11:26
Site: Influent Tunnel

Sounding: CP21-IS-06
Cone: 418:T1500F15U500



Max Depth: 37.750 m / 123.85 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-06.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.805001 Long: -111.933029

00 31 32-244

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

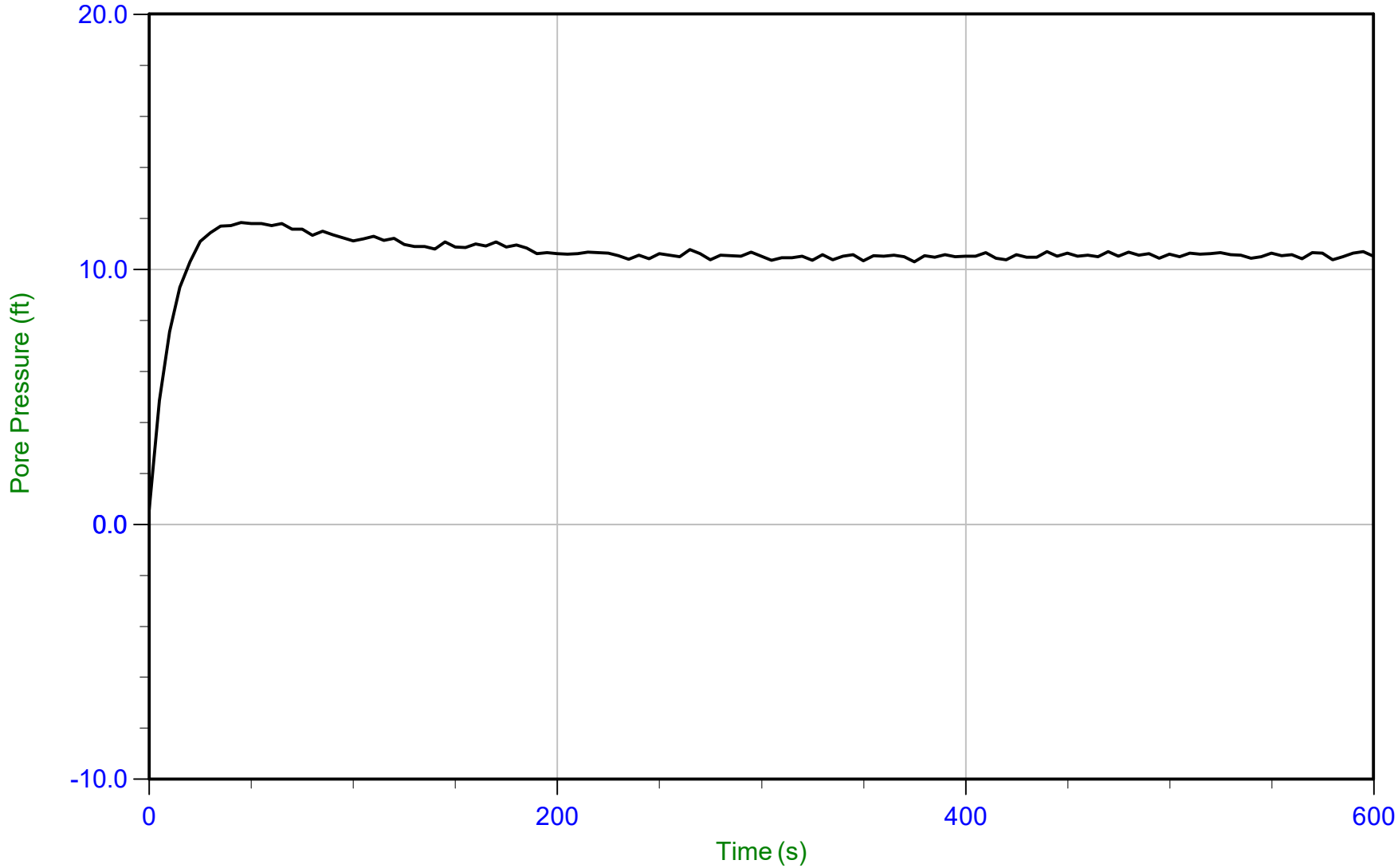
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 11:26
Site: Influent Tunnel

Sounding: CP21-IS-06
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-06.PPF
Depth: 5.450 m / 17.880 ft
Duration: 600.0 s

u Min: 0.6 ft
u Max: 11.8 ft
u Final: 10.5 ft

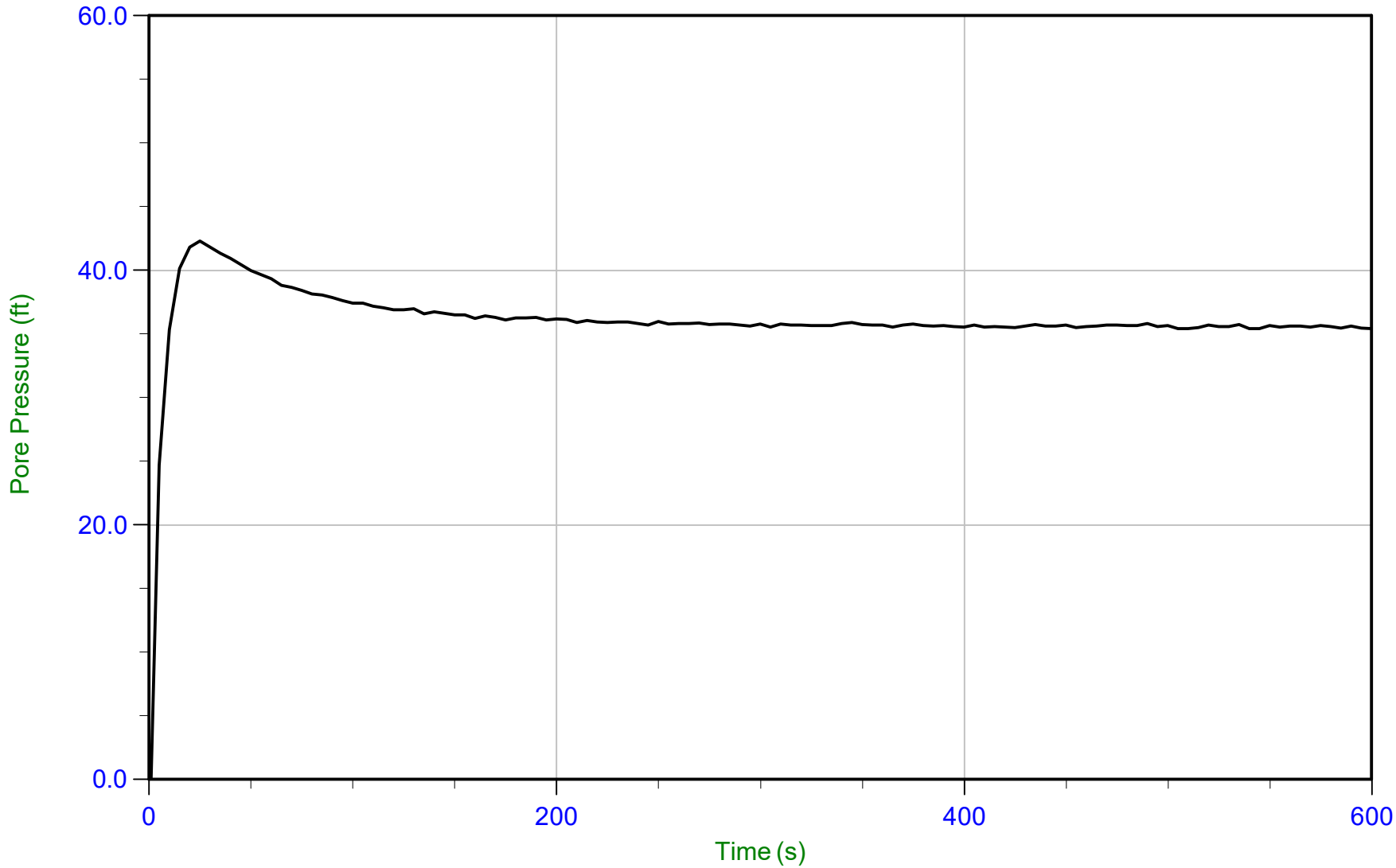
WT: 2.253 m / 7.392 ft
Ueq: 10.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 11:26
Site: Influent Tunnel

Sounding: CP21-IS-06
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-06.PPF
Depth: 12.575 m / 41.256 ft
Duration: 600.0 s

u Min: -6.5 ft
u Max: 42.3 ft
u Final: 35.4 ft

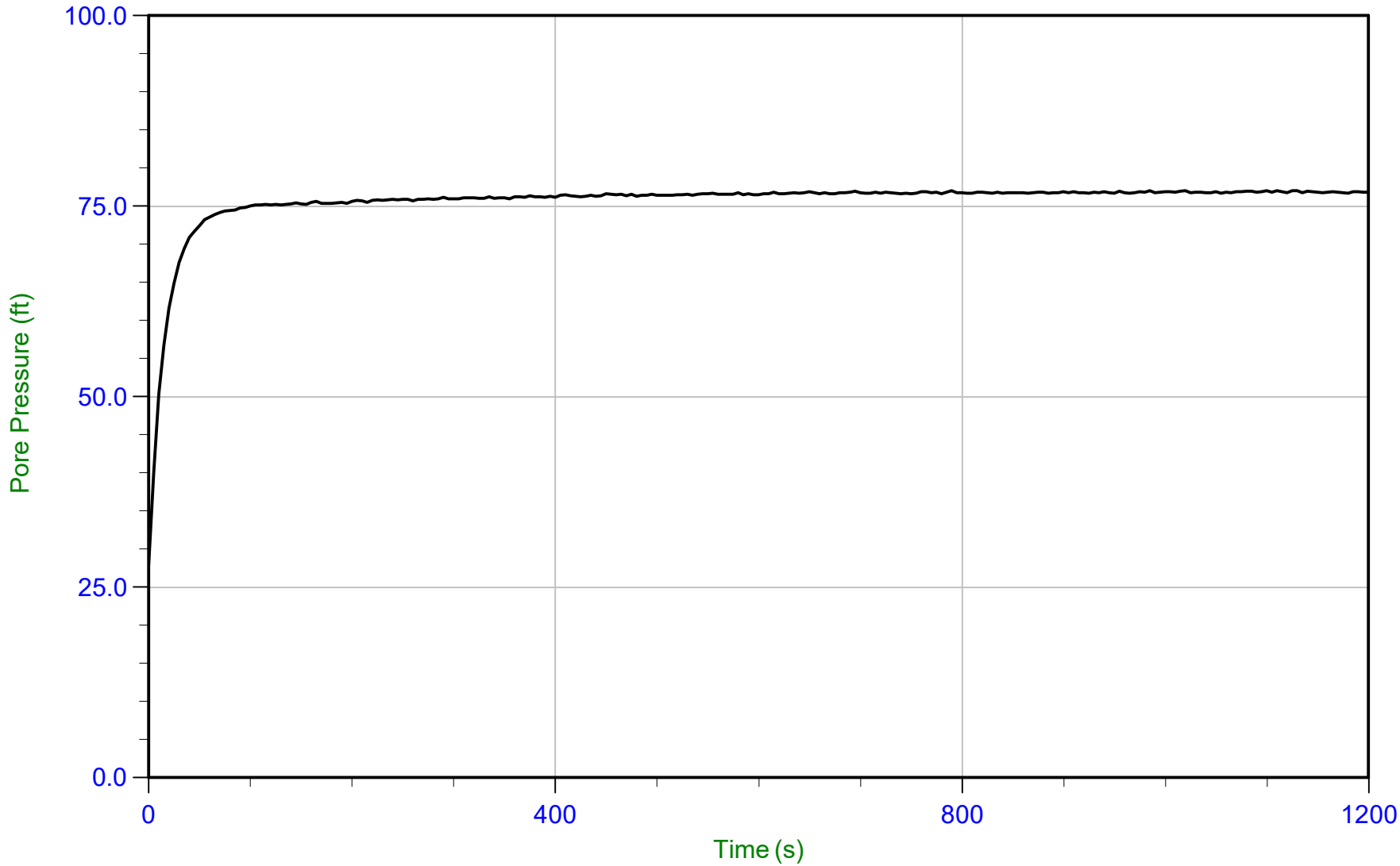
WT: 1.761 m / 5.777 ft
Ueq: 35.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 11:26
Site: Influent Tunnel

Sounding: CP21-IS-06
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-06.PPF
Depth: 24.225 m / 79.477 ft
Duration: 1200.0 s

u Min: 27.9 ft
u Max: 77.1 ft
u Final: 76.9 ft

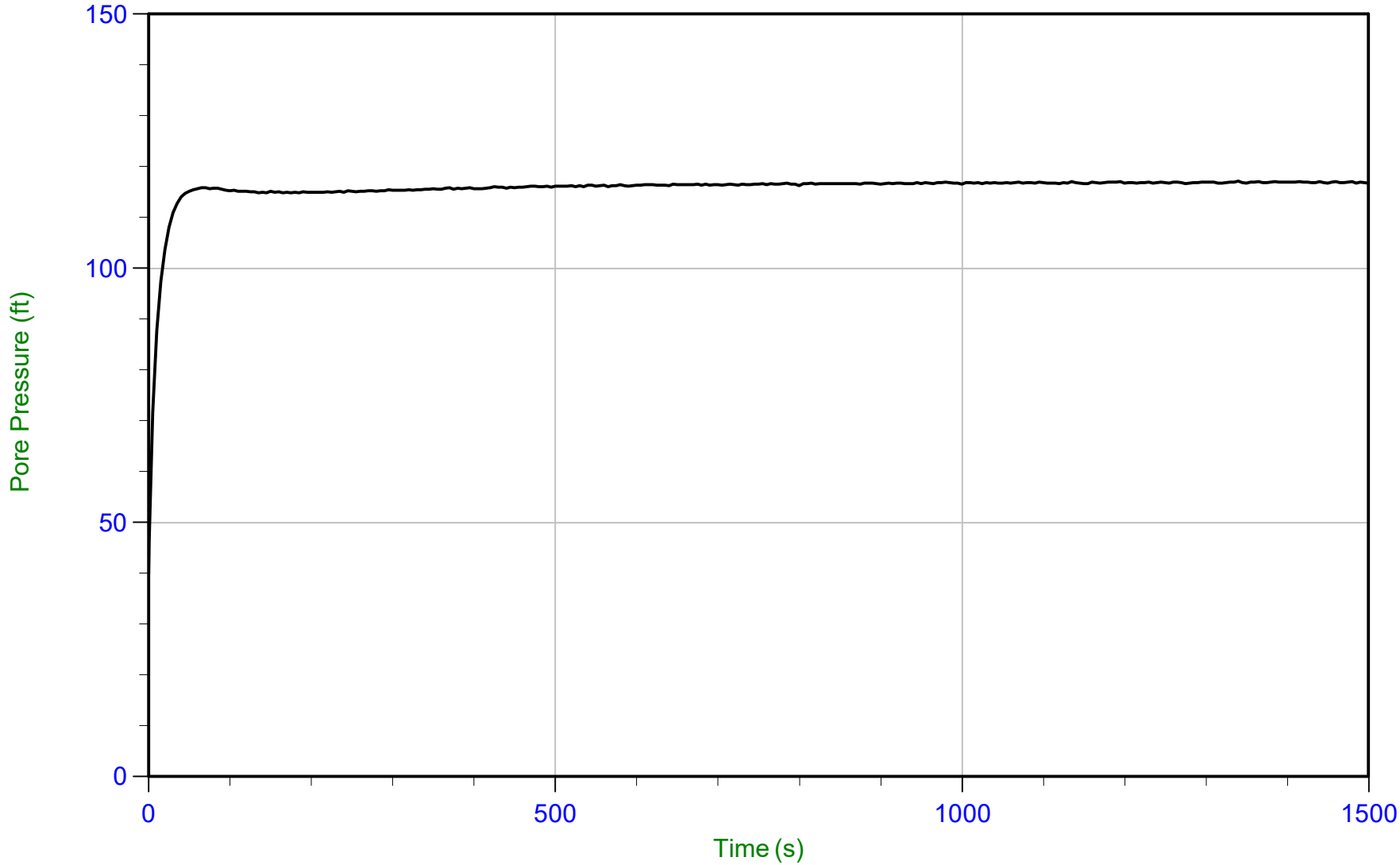
WT: 0.773 m / 2.536 ft
Ueq: 76.9 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 11:26
Site: Influent Tunnel

Sounding: CP21-IS-06
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-06.PPF
Depth: 34.850 m / 114.336 ft
Duration: 1500.0 s

u Min: 39.9 ft
u Max: 117.1 ft
u Final: 116.8 ft

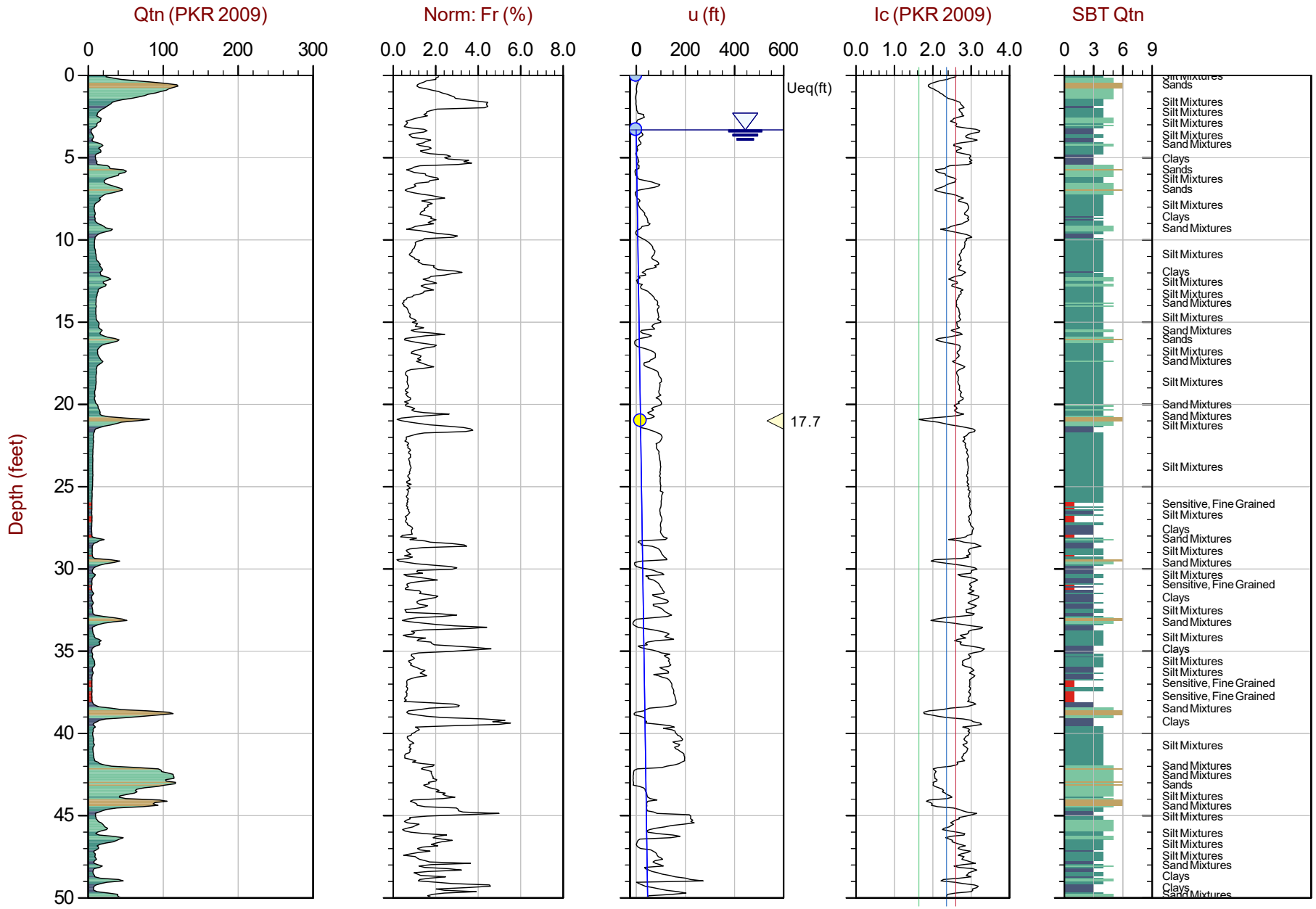
WT: -0.781 m / -2.562 ft
Ueq: 116.9 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-07 11:25
Site: Influent Tunnel

Sounding: CP21-IS-07
Cone: 458:T1500F15U500



Max Depth: 37.200 m / 122.05 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-07.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.806740 Long: -111.933610

00 31 32-249

Equilibrium Pore Pressure (Ueq) ○ Assumed Ueq ◁ Dissipation, Ueq achieved ◁ Dissipation, Ueq not achieved — Hydrostatic Line

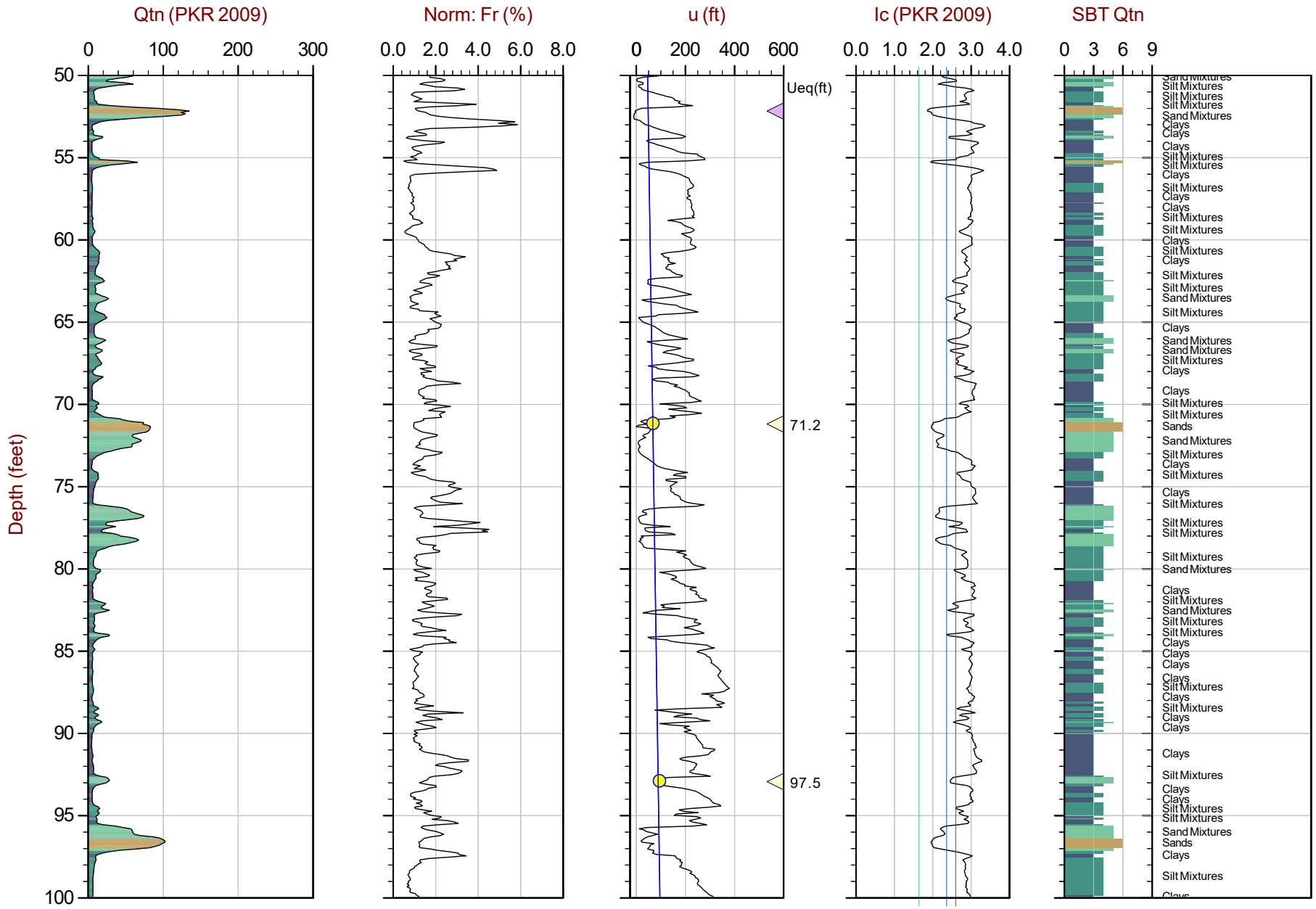
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-07 11:25
Site: Influent Tunnel

Sounding: CP21-IS-07
Cone: 458:T1500F15U500



Max Depth: 37.200 m / 122.05 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-07.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.806740 Long: -111.933610

00 31 32-250

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

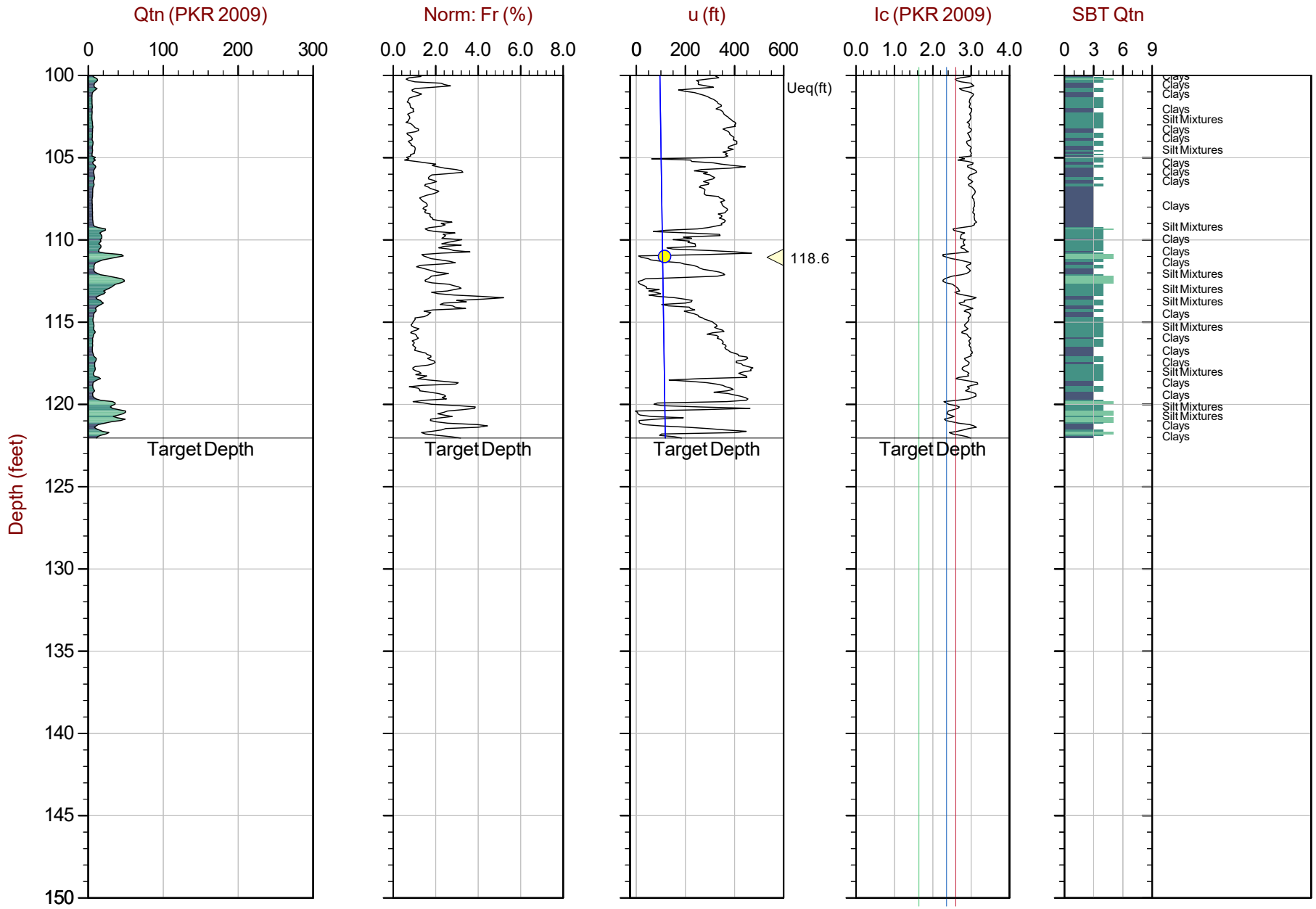
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-07 11:25
Site: Influent Tunnel

Sounding: CP21-IS-07
Cone: 458:T1500F15U500



Max Depth: 37.200 m / 122.05 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-07.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.806740 Long: -111.933610

00 31 32-251

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

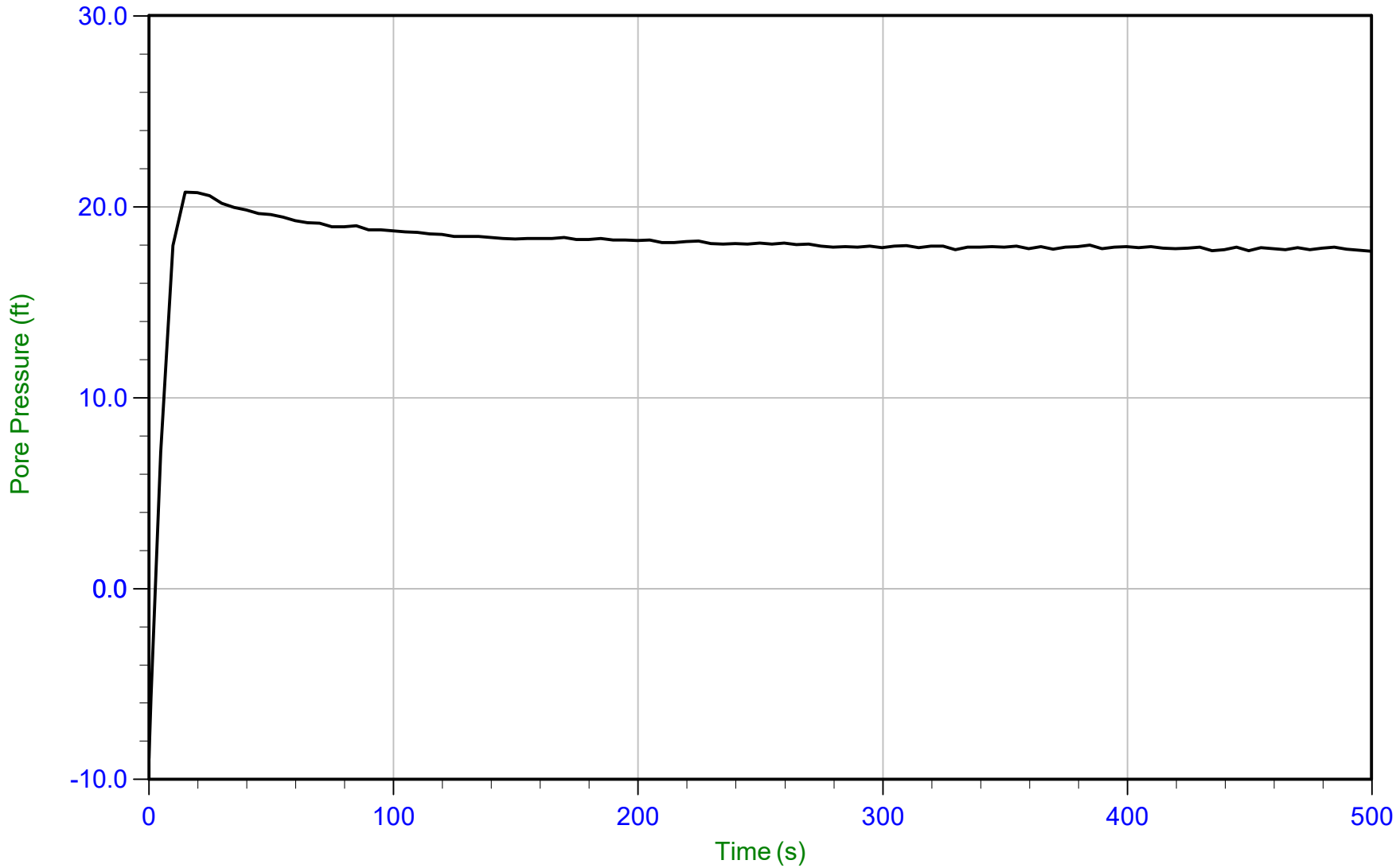
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 11:25
Site: Influent Tunnel

Sounding: CP21-IS-07
Cone: 458:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-07.PPF
Depth: 6.400 m / 20.997 ft
Duration: 500.0 s

u Min: -8.9 ft
u Max: 20.8 ft
u Final: 17.7 ft

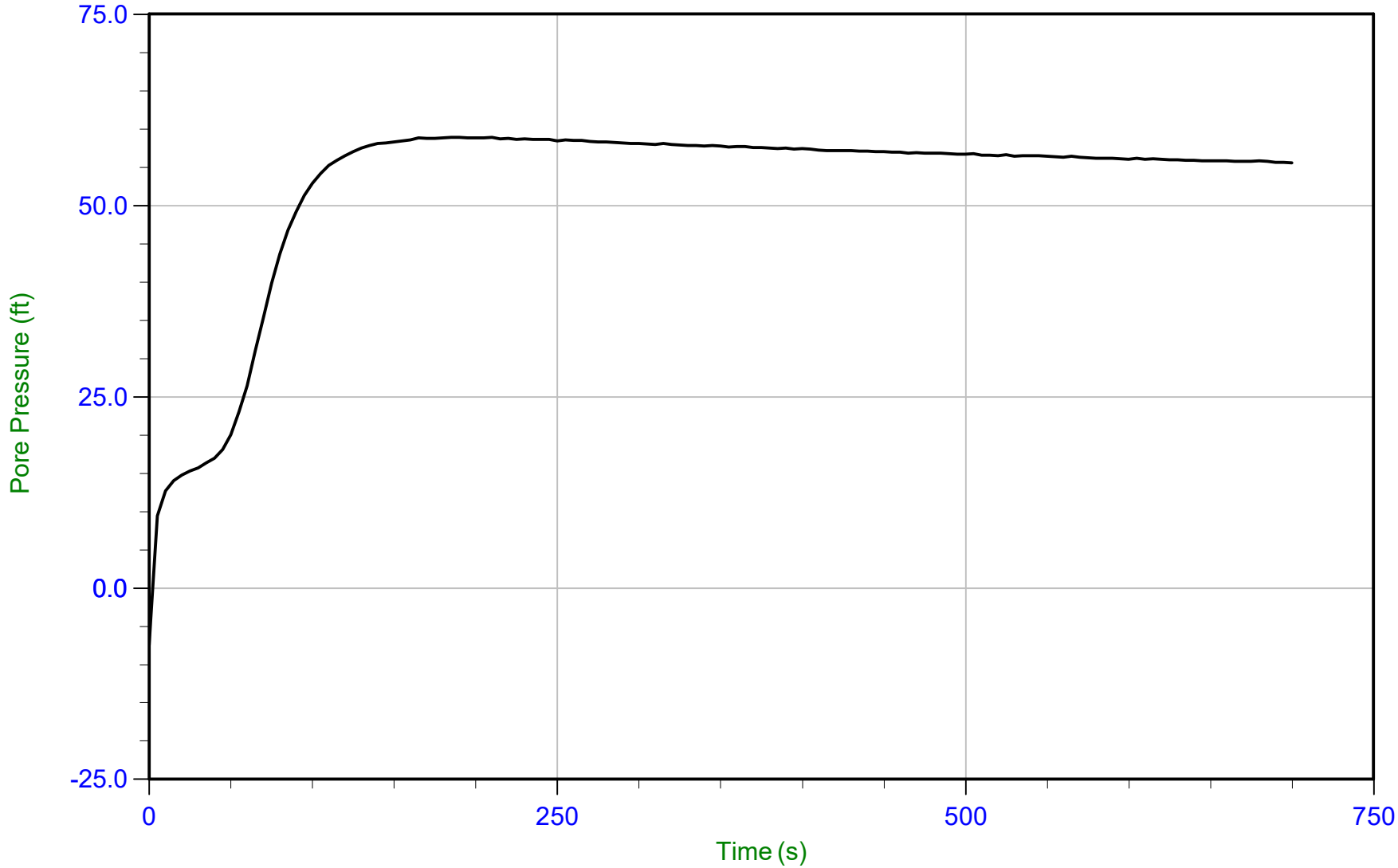
WT: 1.009 m / 3.310 ft
Ueq: 17.7 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 11:25
Site: Influent Tunnel

Sounding: CP21-IS-07
Cone: 458:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-07.PPF
Depth: 15.900 m / 52.165 ft
Duration: 700.0 s

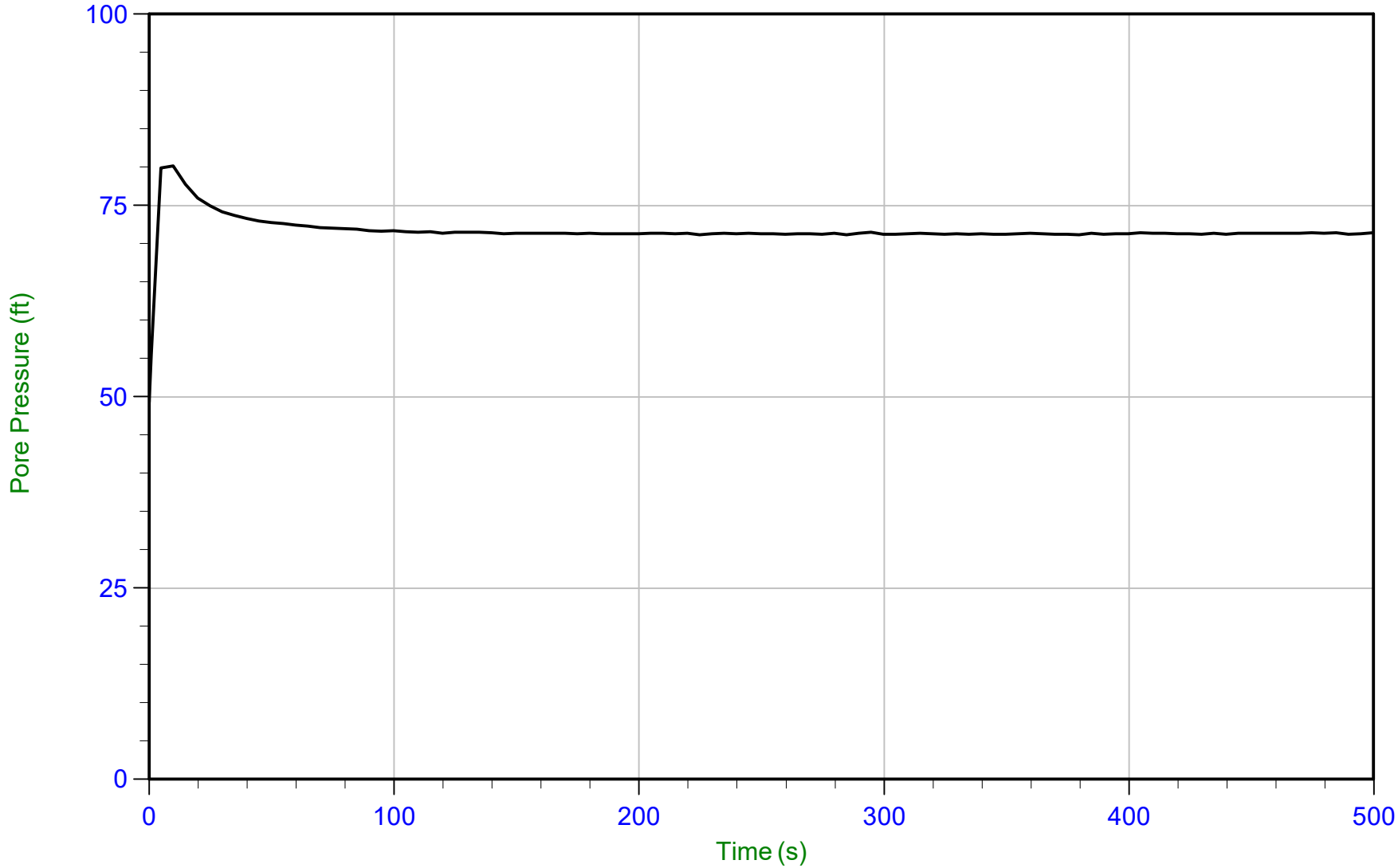
u Min: -7.4 ft
u Max: 58.9 ft
u Final: 55.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 11:25
Site: Influent Tunnel

Sounding: CP21-IS-07
Cone: 458:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-07.PPF
Depth: 21.700 m / 71.193 ft
Duration: 500.0 s

u Min: 49.3 ft
u Max: 80.2 ft
u Final: 71.4 ft

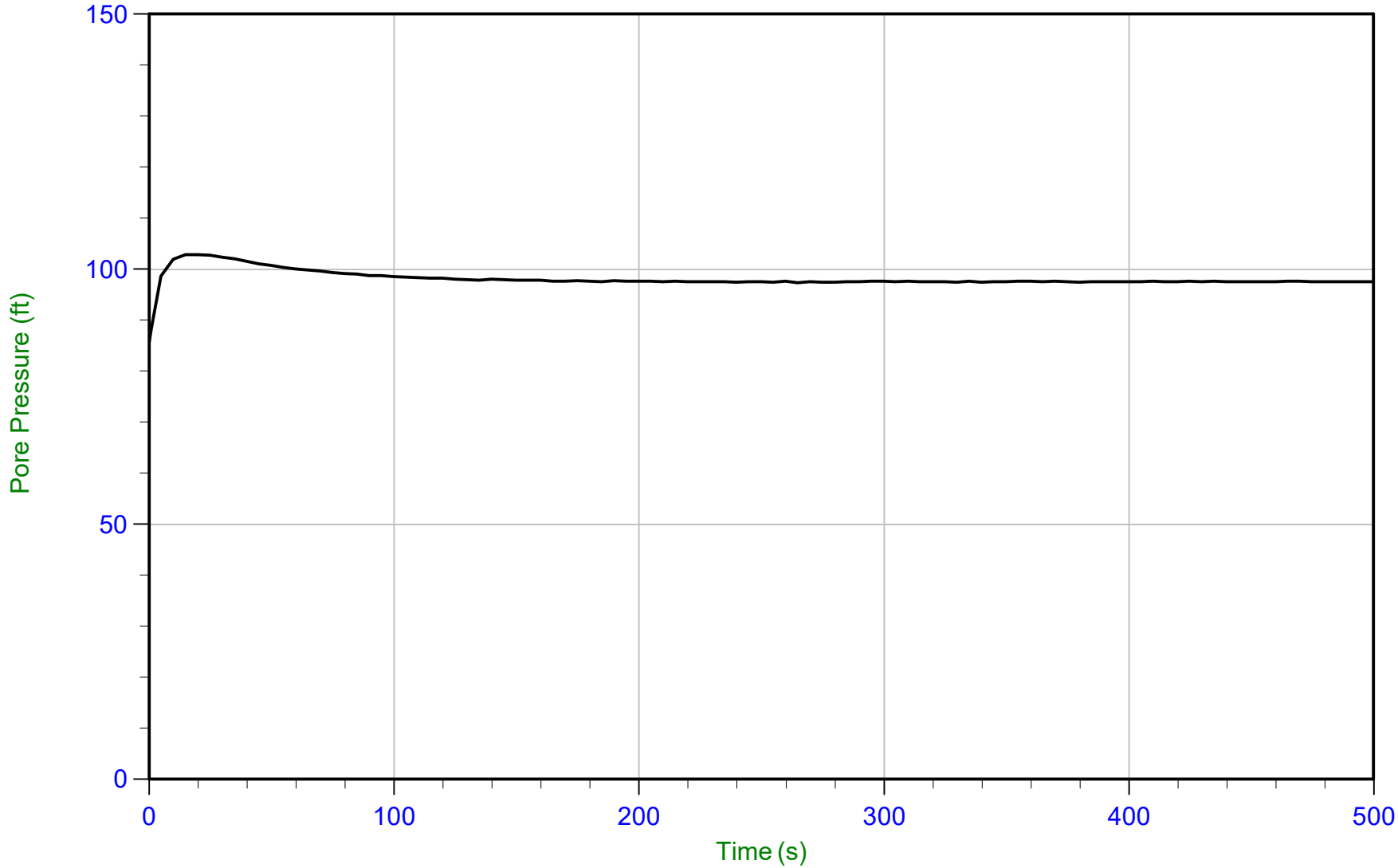
WT: -0.024 m / -0.079 ft
Ueq: 71.3 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 11:25
Site: Influent Tunnel

Sounding: CP21-IS-07
Cone: 458:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-07.PPF
Depth: 28.325 m / 92.929 ft
Duration: 500.0 s

u Min: 85.6 ft
u Max: 102.9 ft
u Final: 97.6 ft

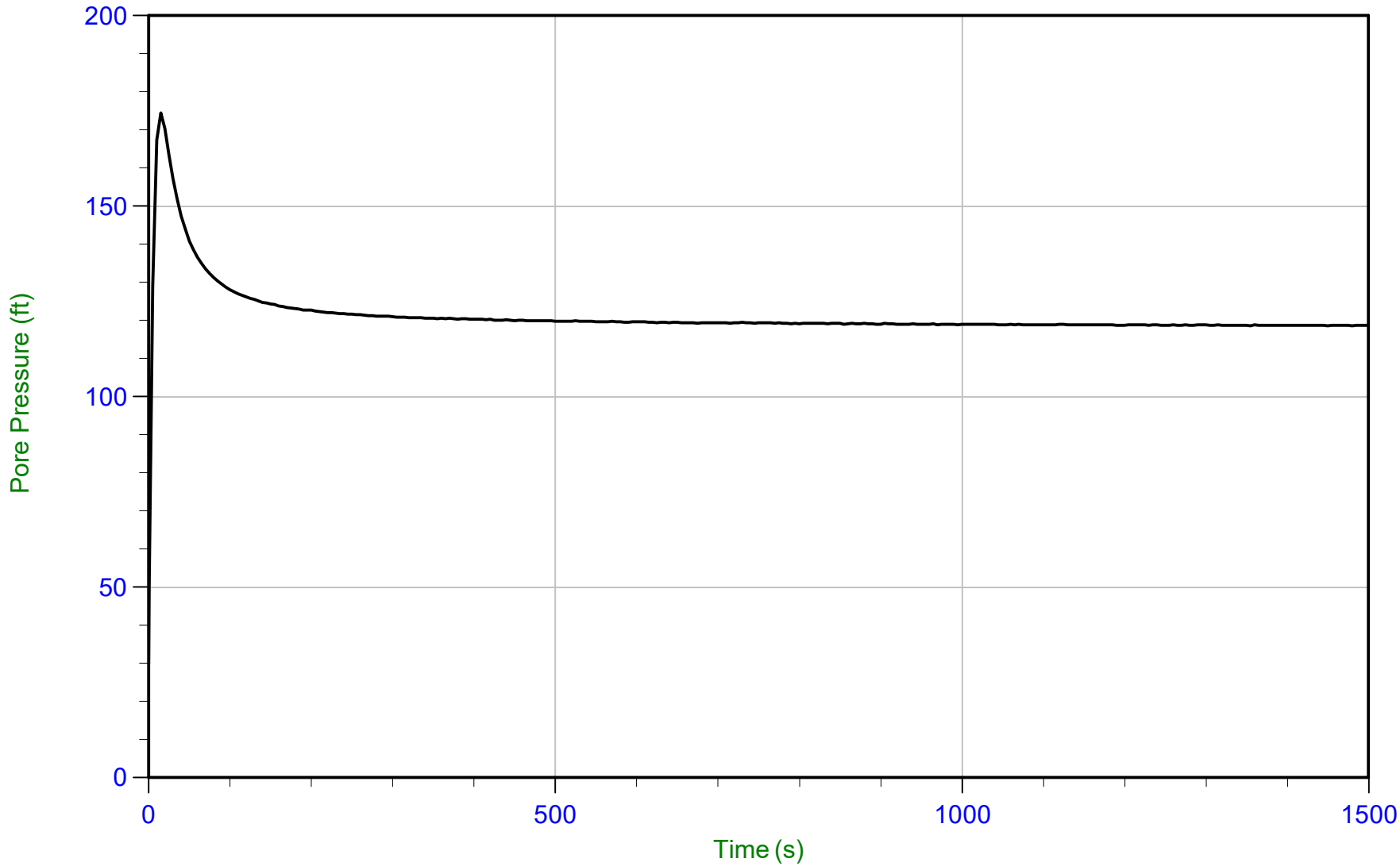
WT: -1.398 m / -4.587 ft
Ueq: 97.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 11:25
Site: Influent Tunnel

Sounding: CP21-IS-07
Cone: 458:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-07.PPF
Depth: 33.850 m / 111.055 ft
Duration: 1500.0 s

u Min: 29.8 ft
u Max: 174.5 ft
u Final: 118.7 ft

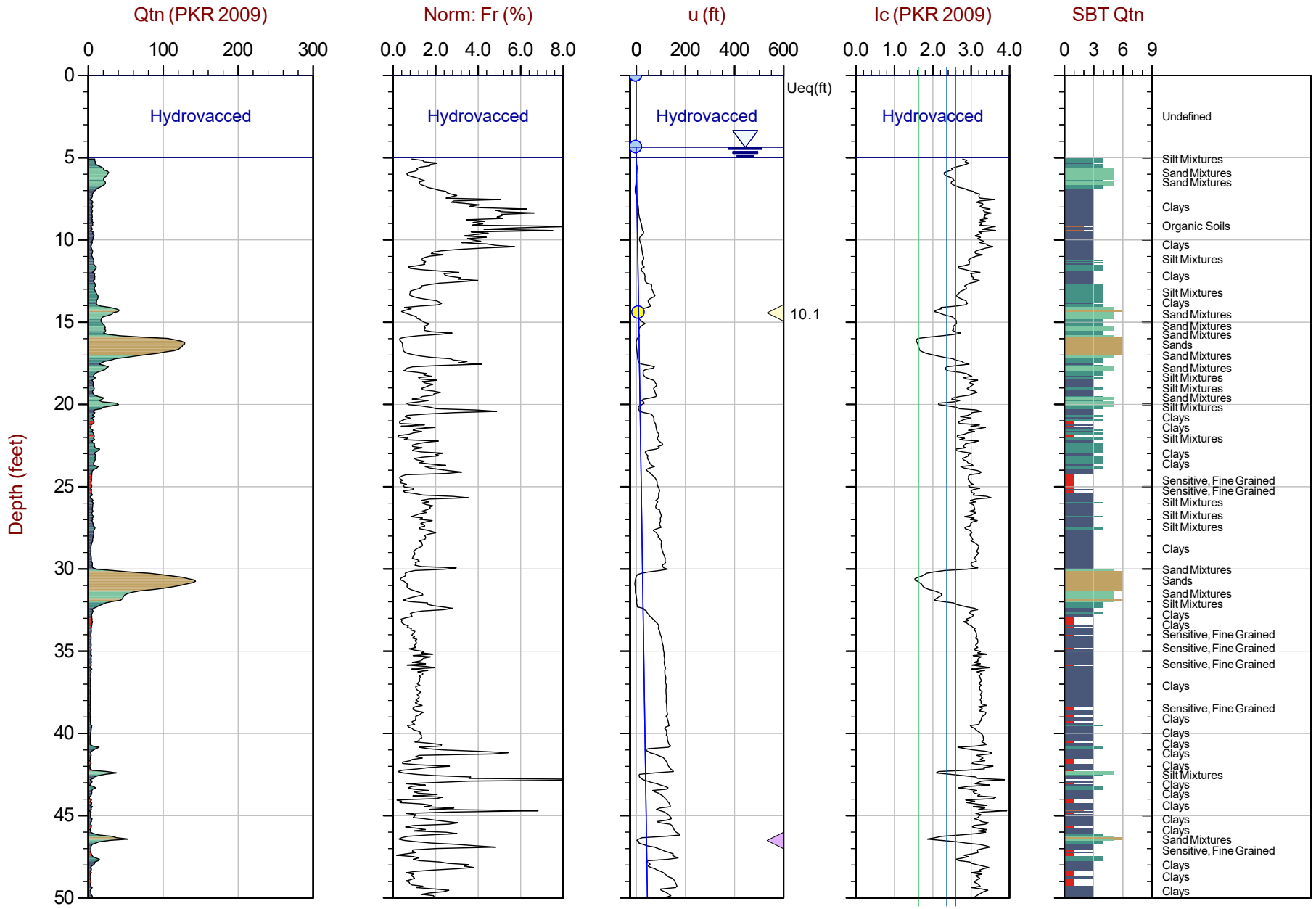
WT: -2.325 m / -7.628 ft
Ueq: 118.7 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-06 08:38
Site: Influent Tunnel

Sounding: CP21-IS-08
Cone: 418:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-08.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.807873 Long: -111.936260

00 31 32-257

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

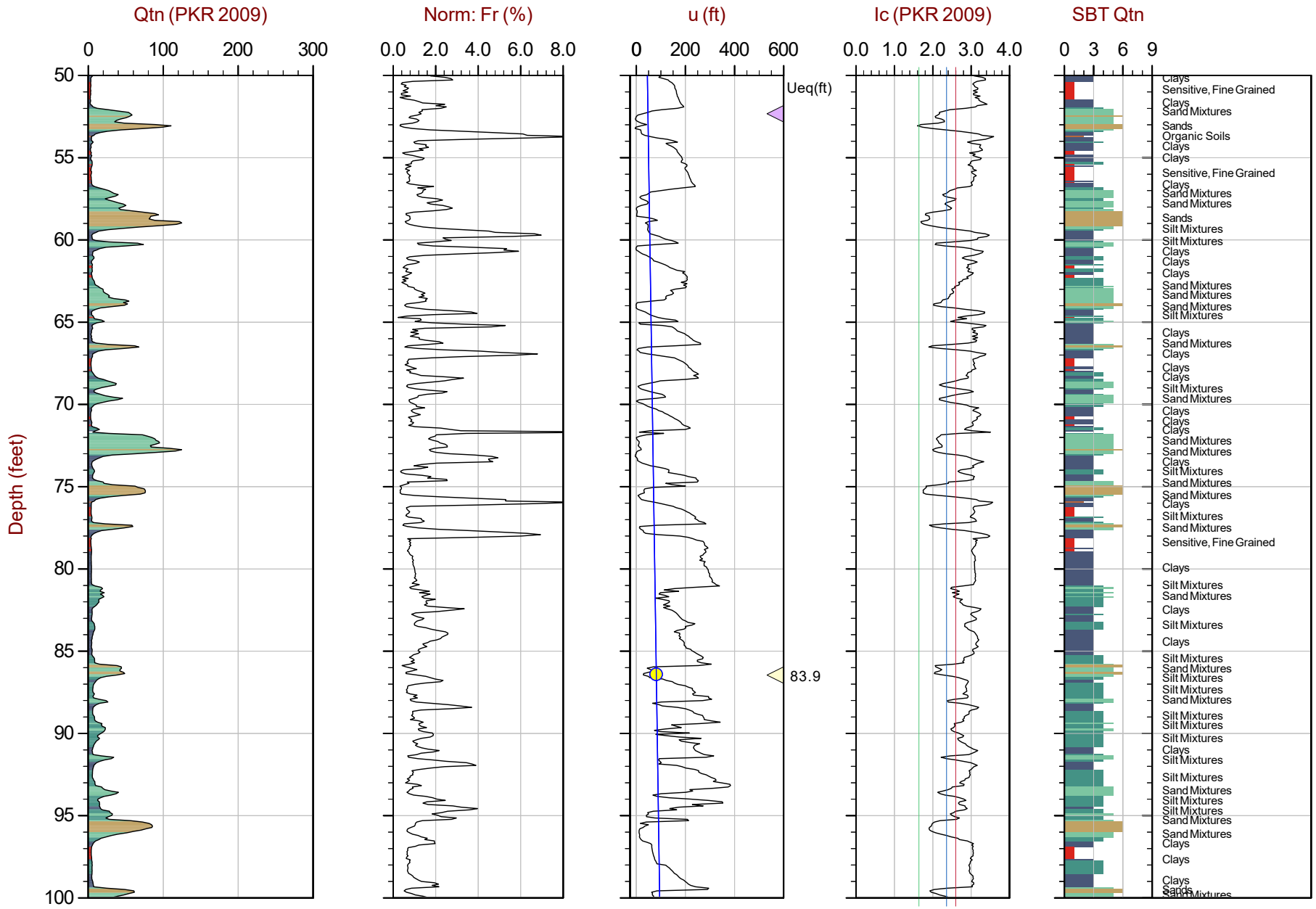
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-06 08:38
Site: Influent Tunnel

Sounding: CP21-IS-08
Cone: 418:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-08.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.807873 Long: -111.936260

00 31 32-258

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

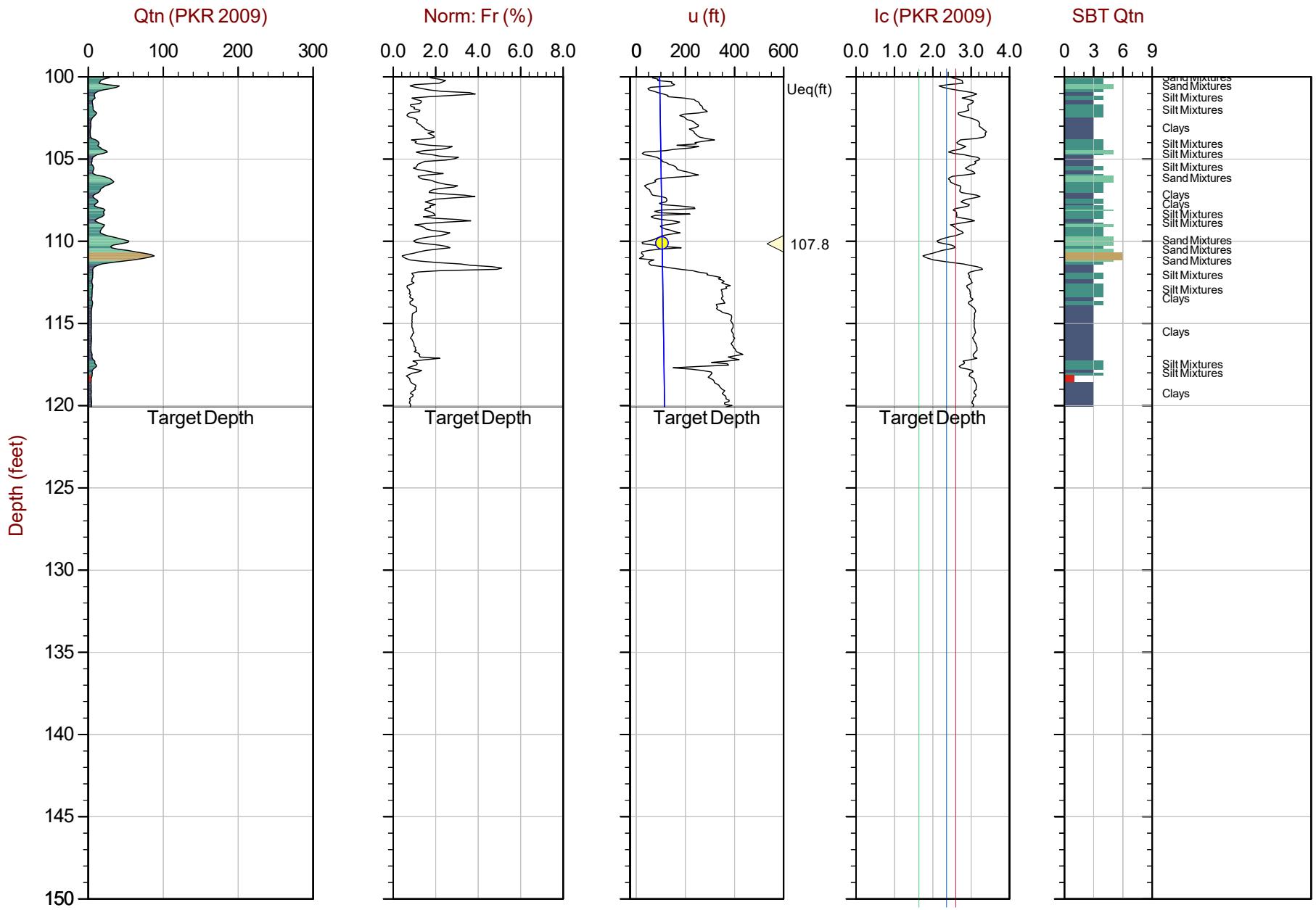
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-06 08:38
Site: Influent Tunnel

Sounding: CP21-IS-08
Cone: 418:T1500F15U500



Max Depth: 36.600 m / 120.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-08.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.807873 Long: -111.936260

00 31 32-259

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

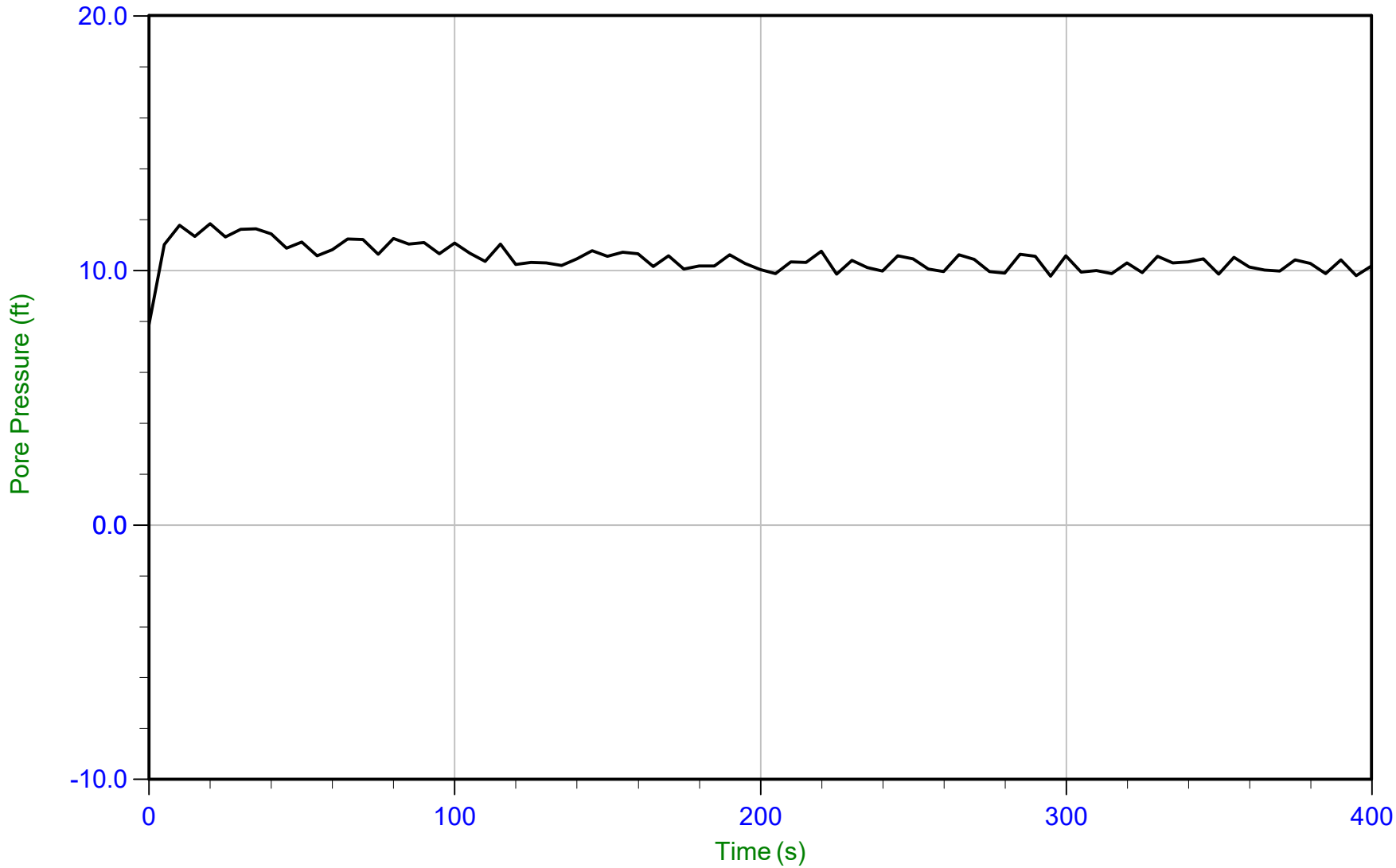
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/06/2021 08:38
Site: Influent Tunnel

Sounding: CP21-IS-08
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-08.PPF
Depth: 4.400 m / 14.436 ft
Duration: 400.0 s

u Min: 7.9 ft
u Max: 11.8 ft
u Final: 10.2 ft

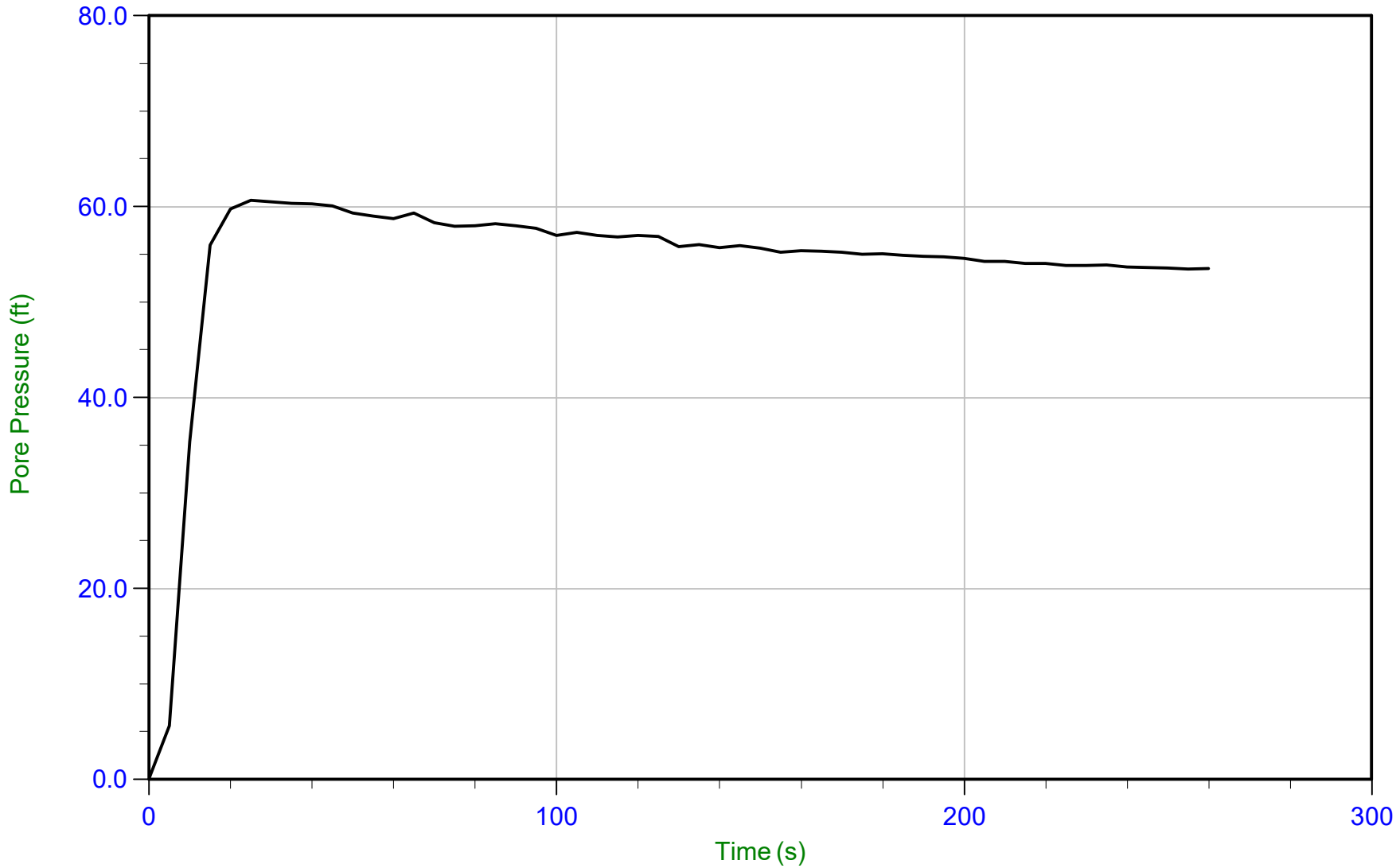
WT: 1.333 m / 4.373 ft
Ueq: 10.1 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/06/2021 08:38
Site: Influent Tunnel

Sounding: CP21-IS-08
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-08.PPF
Depth: 14.175 m / 46.505 ft
Duration: 260.0 s

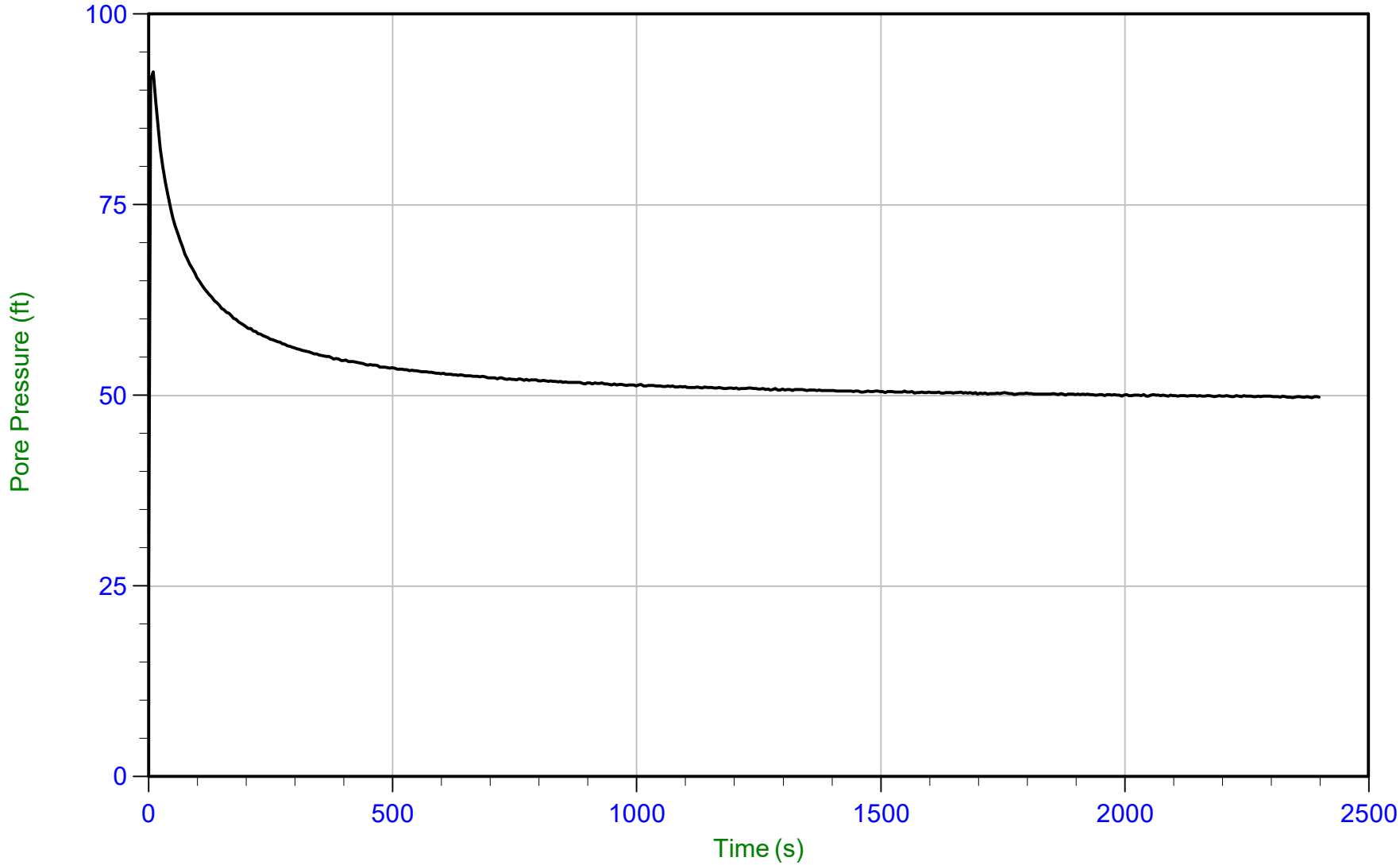
u Min: 0.1 ft
u Max: 60.7 ft
u Final: 53.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/06/2021 08:38
Site: Influent Tunnel

Sounding: CP21-IS-08
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-08.PPF
Depth: 15.950 m / 52.329 ft
Duration: 2400.0 s

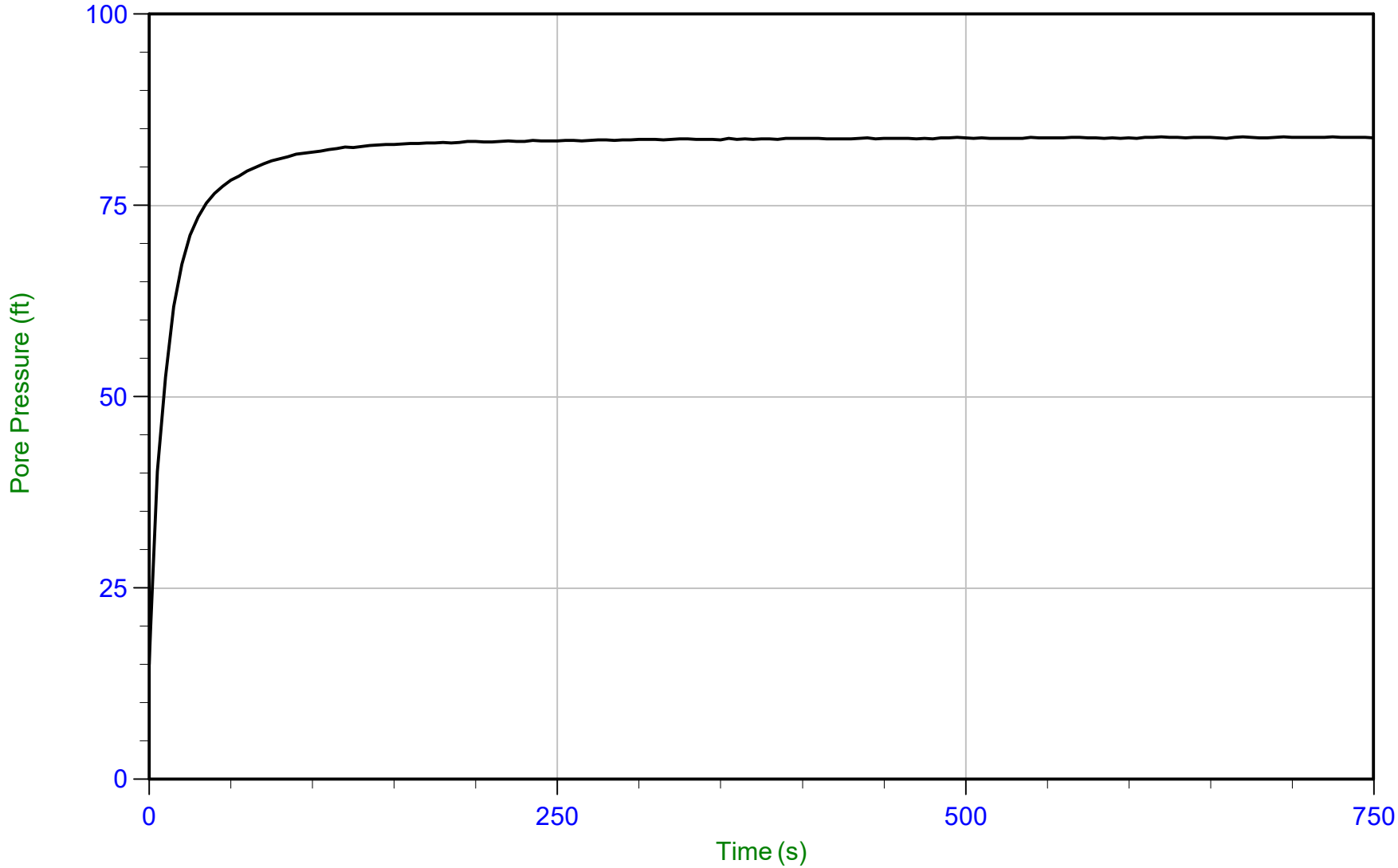
u Min: 9.3 ft
u Max: 92.4 ft
u Final: 49.8 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/06/2021 08:38
Site: Influent Tunnel

Sounding: CP21-IS-08
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-08.PPF
Depth: 26.350 m / 86.449 ft
Duration: 750.0 s

u Min: 15.0 ft
u Max: 84.0 ft
u Final: 83.9 ft

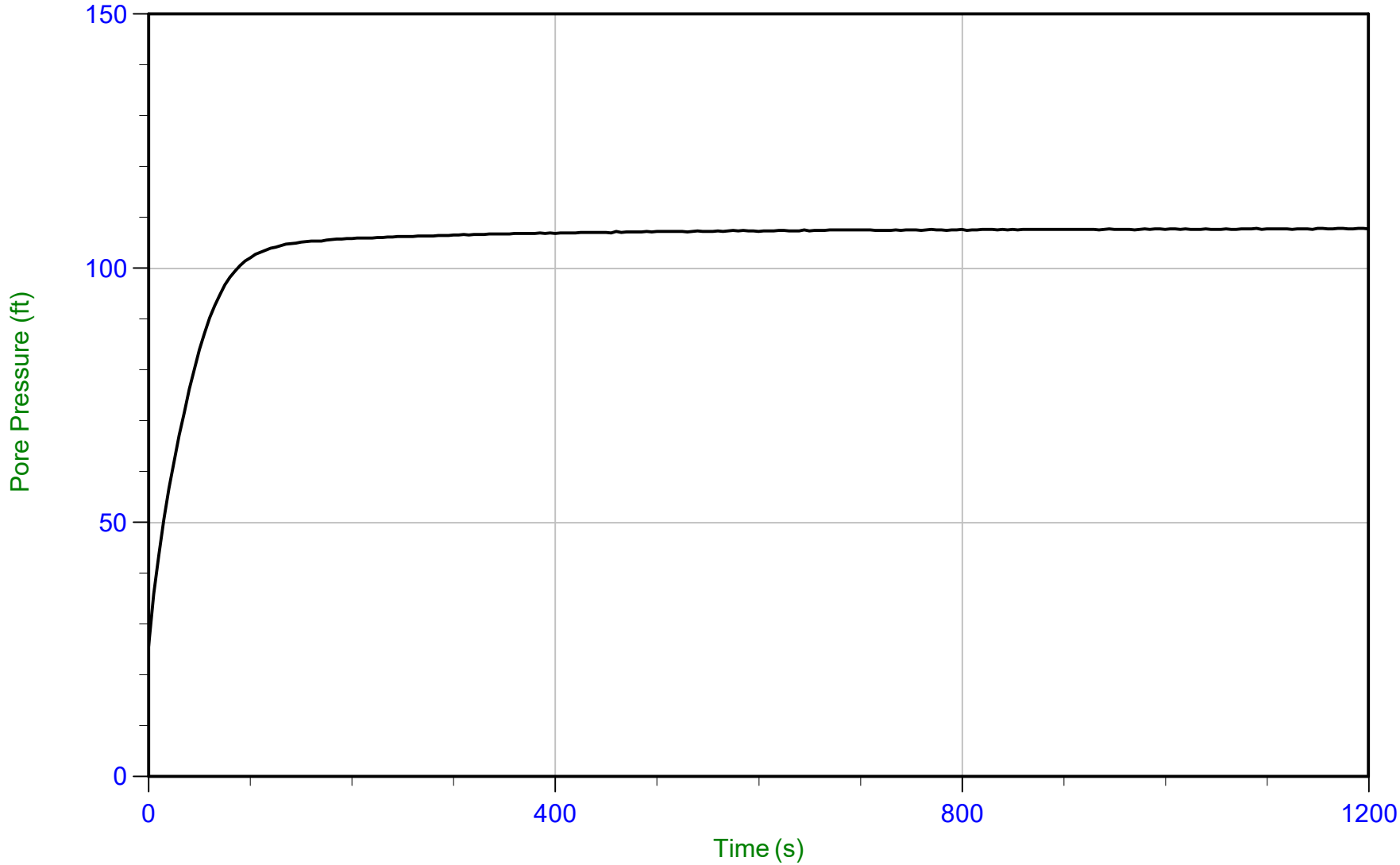
WT: 0.772 m / 2.533 ft
Ueq: 83.9 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/06/2021 08:38
Site: Influent Tunnel

Sounding: CP21-IS-08
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-08.PPF
Depth: 33.575 m / 110.153 ft
Duration: 1200.0 s

u Min: 25.7 ft
u Max: 107.9 ft
u Final: 107.8 ft

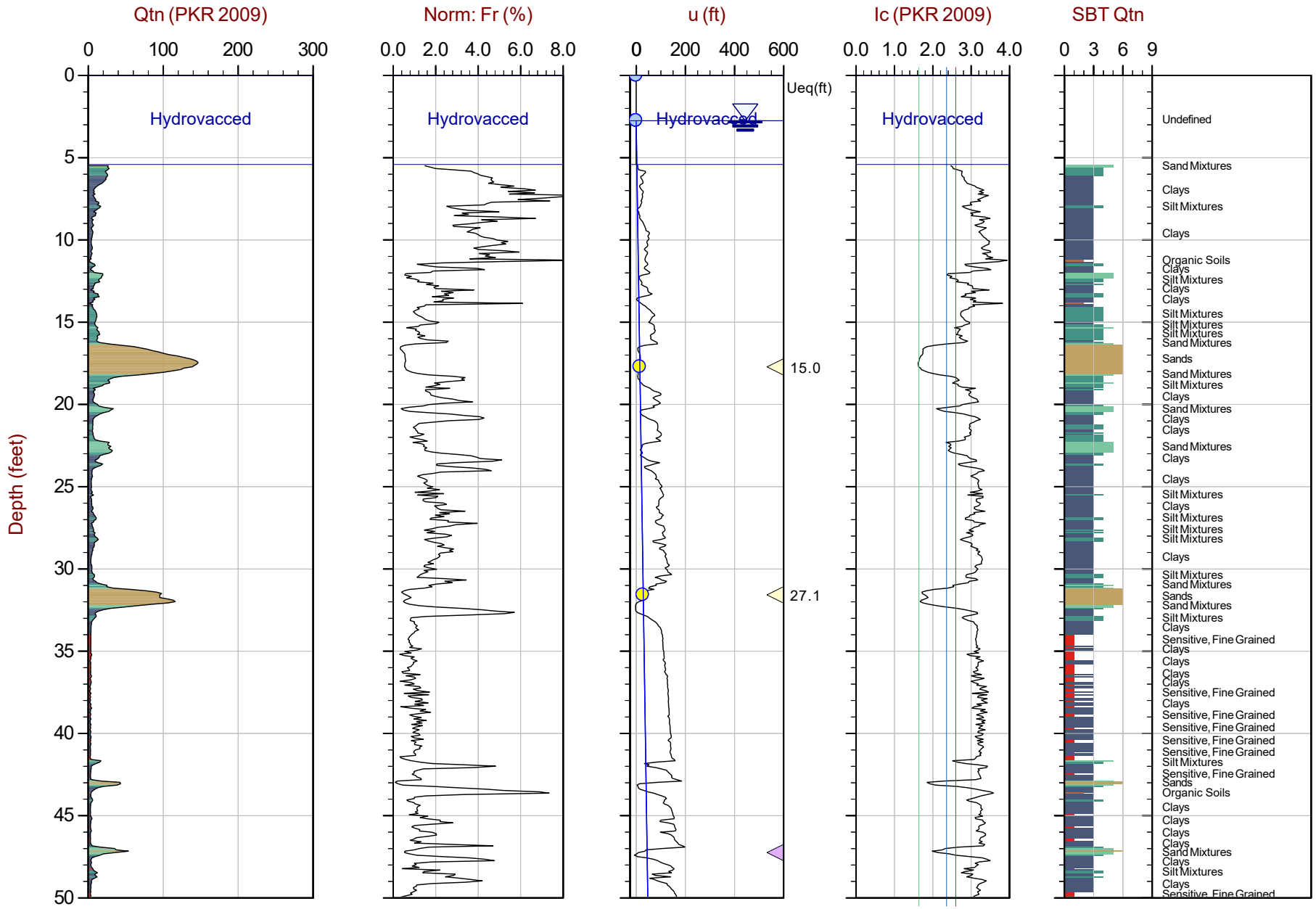
WT: 0.701 m / 2.300 ft
Ueq: 107.9 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-06 11:21
Site: Influent Tunnel

Sounding: CP21-IS-09
Cone: 418:T1500F15U500



Max Depth: 22.975 m / 75.38 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-09.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.808622 Long: -111.936211

00 31 32-265

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

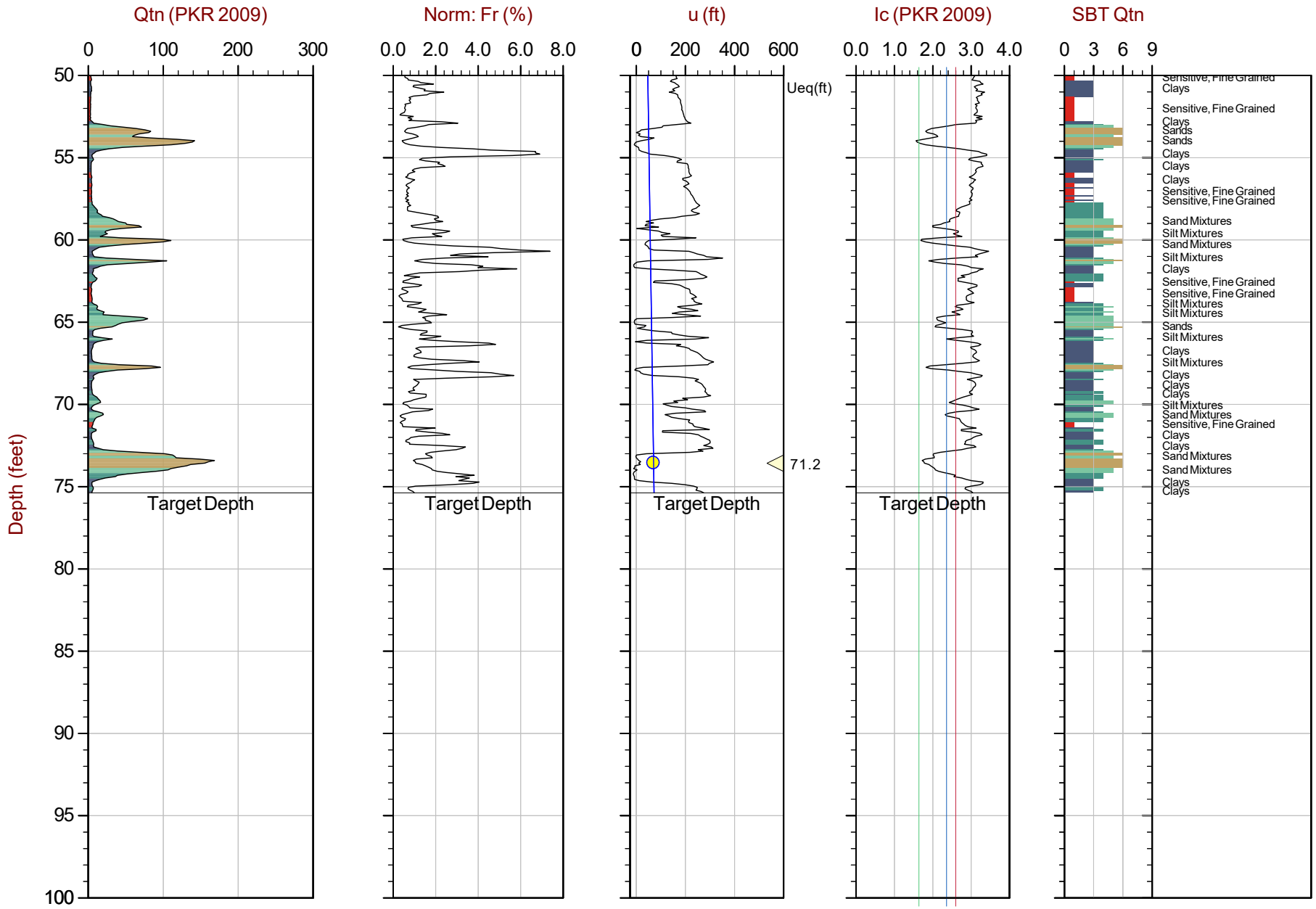
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-06 11:21
Site: Influent Tunnel

Sounding: CP21-IS-09
Cone: 418:T1500F15U500



Max Depth: 22.975 m / 75.38 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-09.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.808622 Long: -111.936211

00 31 32-266

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

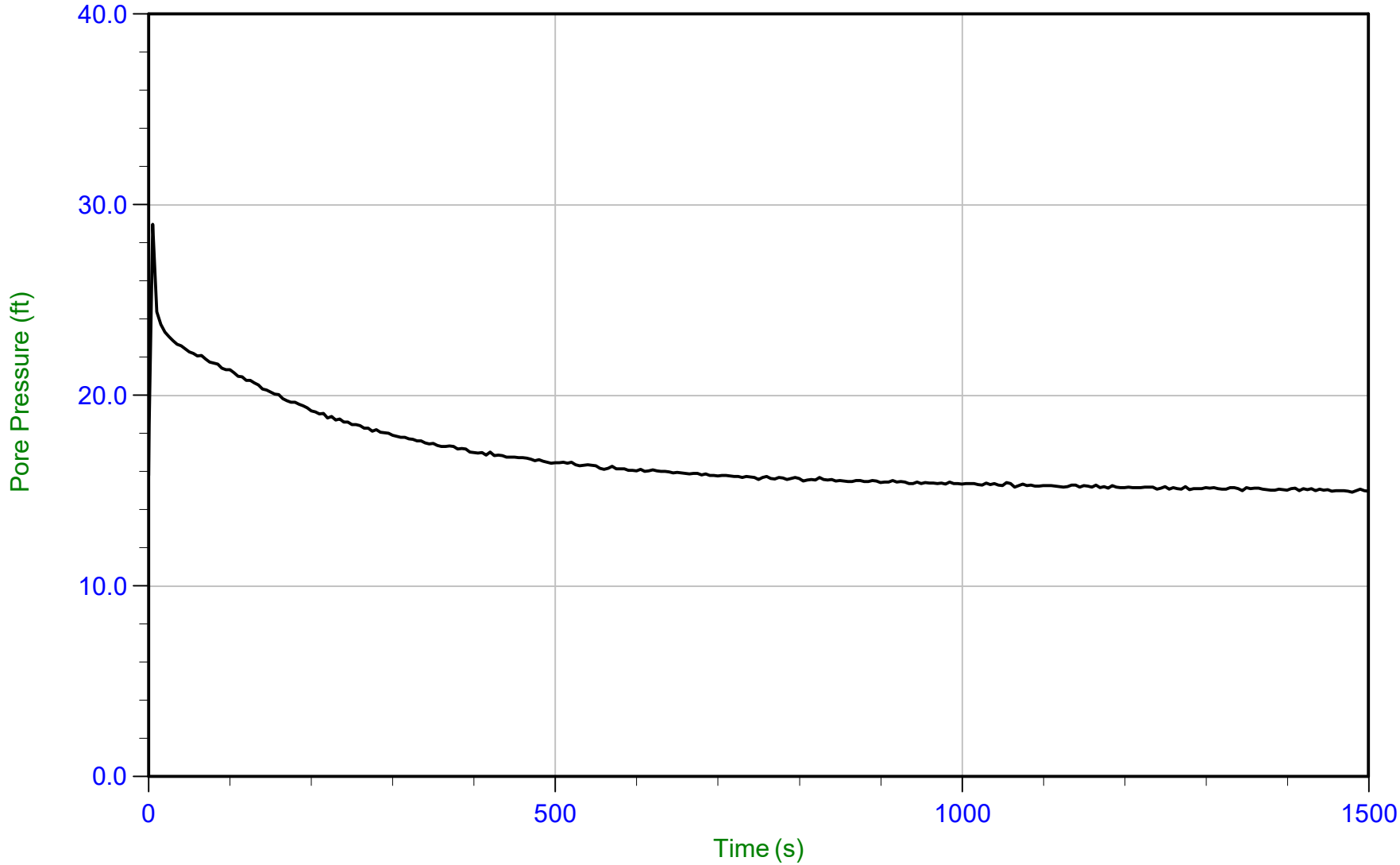
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/06/2021 11:21
Site: Influent Tunnel

Sounding: CP21-IS-09
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-09.PPF
Depth: 5.400 m / 17.716 ft
Duration: 1500.0 s

u Min: 14.9 ft
u Max: 29.0 ft
u Final: 15.0 ft

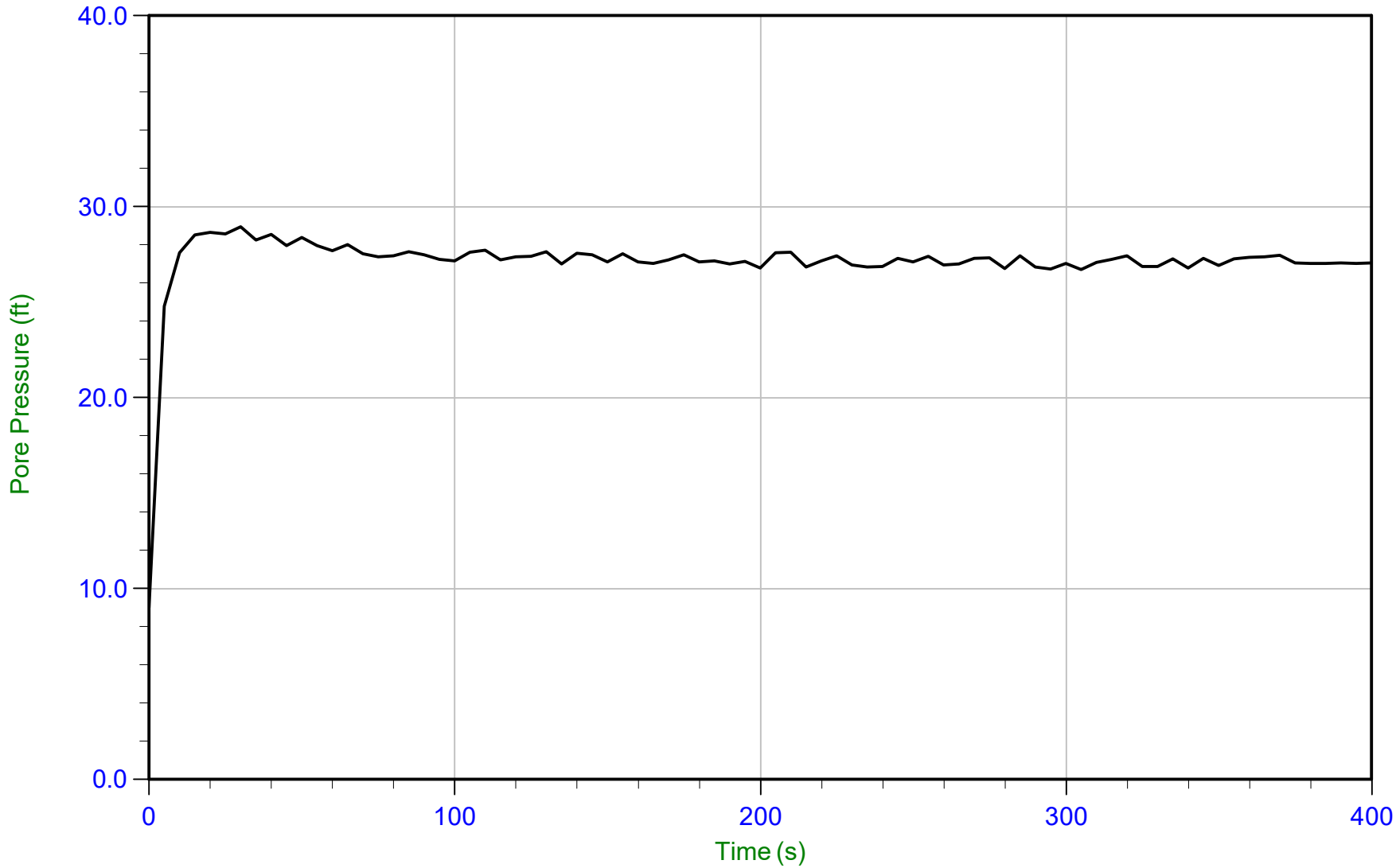
WT: 0.838 m / 2.749 ft
Ueq: 15.0 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/06/2021 11:21
Site: Influent Tunnel

Sounding: CP21-IS-09
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-09.PPF
Depth: 9.625 m / 31.578 ft
Duration: 400.0 s

u Min: 9.0 ft
u Max: 28.9 ft
u Final: 27.0 ft

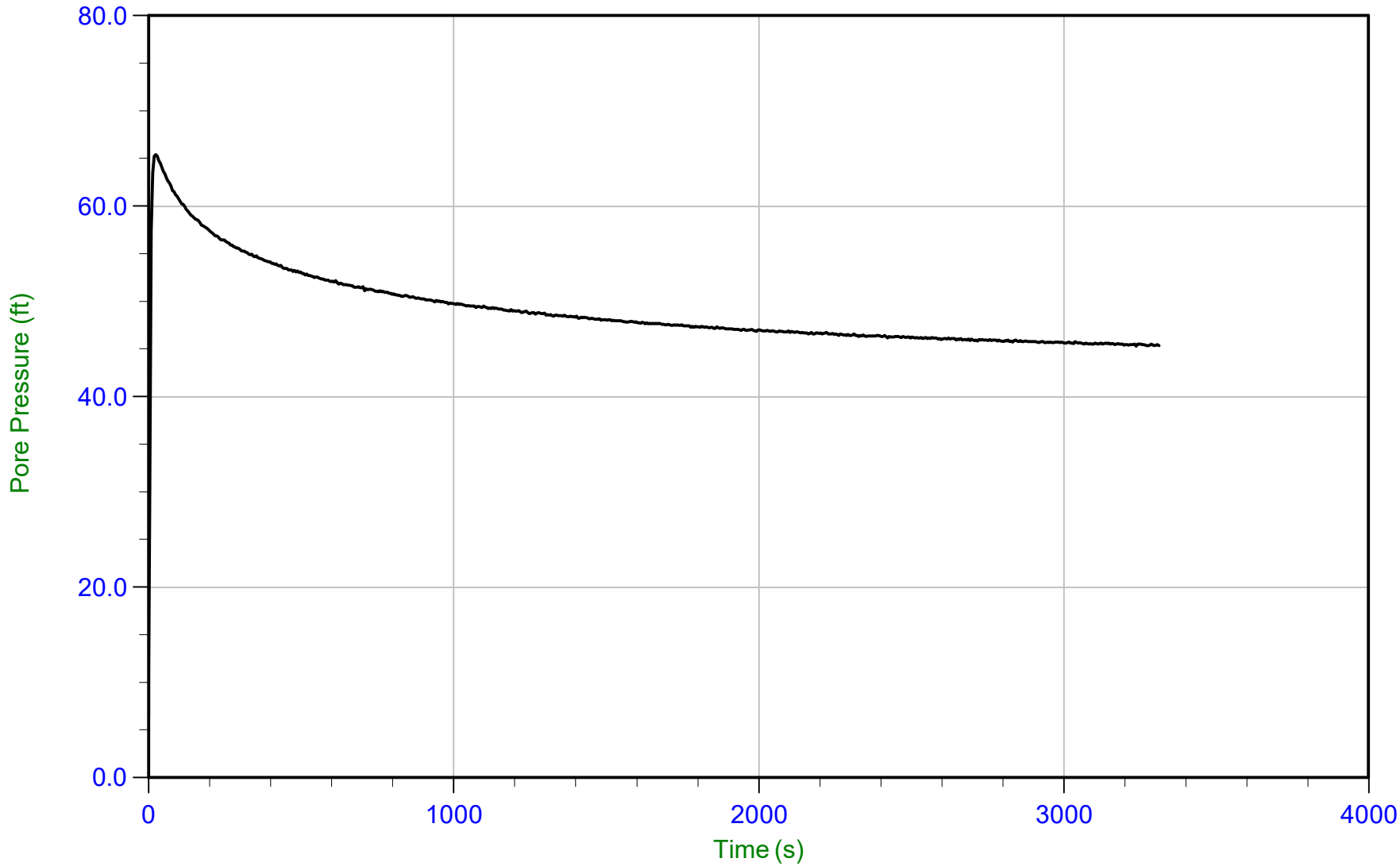
WT: 1.374 m / 4.508 ft
Ueq: 27.1 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/06/2021 11:21
Site: Influent Tunnel

Sounding: CP21-IS-09
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-09.PPF
Depth: 14.400 m / 47.244 ft
Duration: 3315.0 s

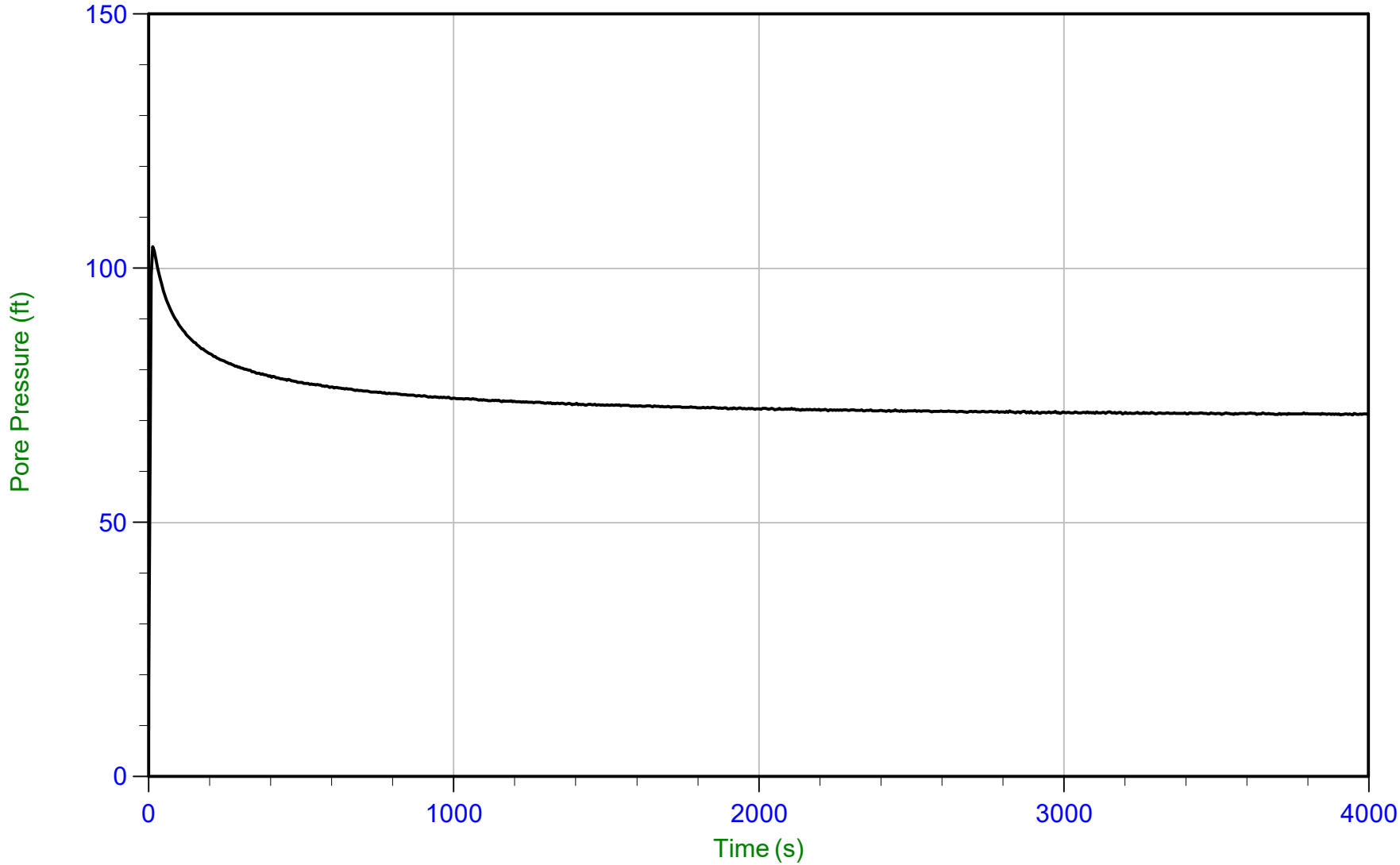
u Min: 6.4 ft
u Max: 65.4 ft
u Final: 45.3 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/06/2021 11:21
Site: Influent Tunnel

Sounding: CP21-IS-09
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-09.PPF
Depth: 22.425 m / 73.572 ft
Duration: 4000.0 s

u Min: 9.2 ft
u Max: 104.2 ft
u Final: 71.2 ft

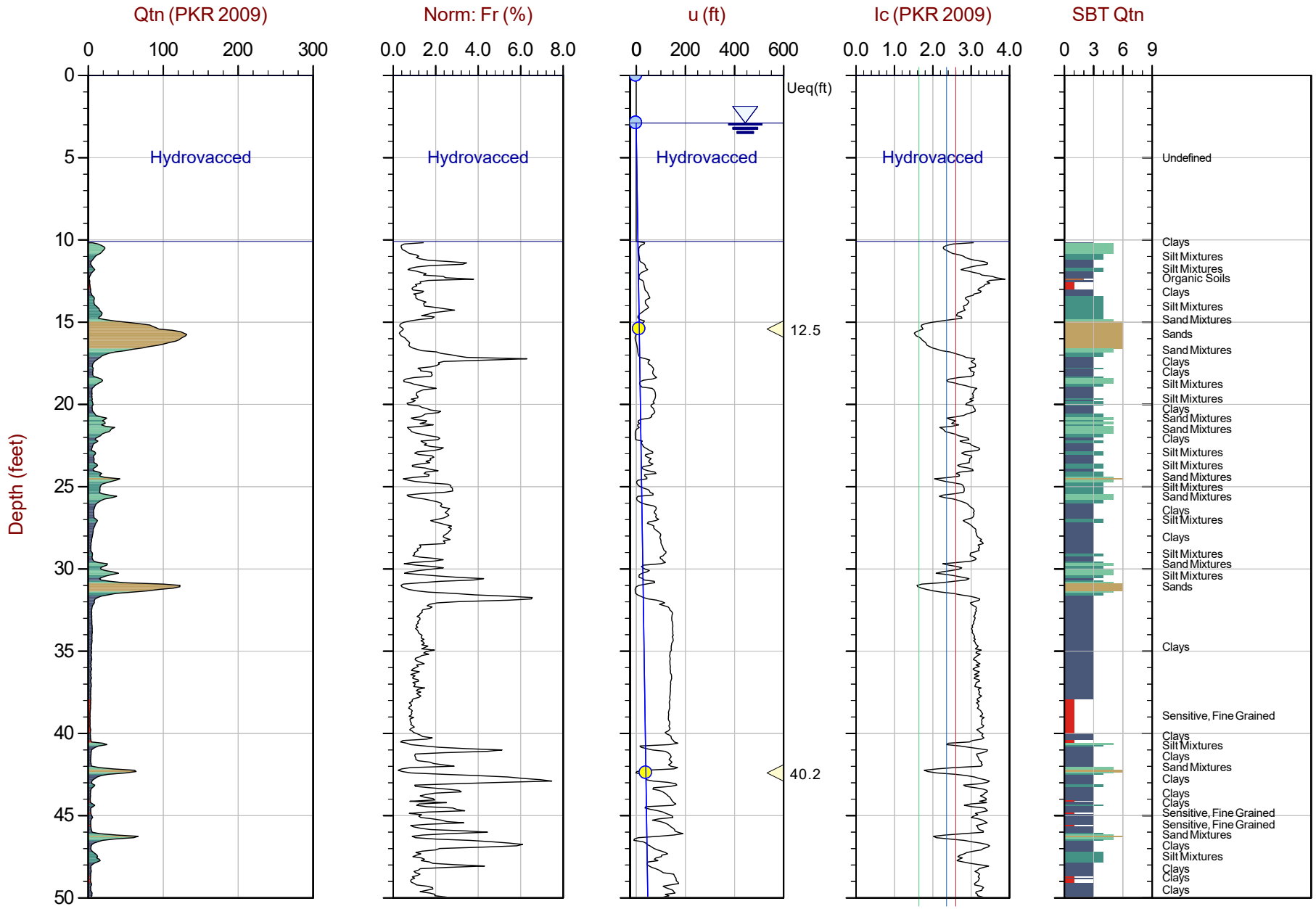
WT: 0.720 m / 2.362 ft
Ueq: 71.2 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-07 08:04
Site: Influent Tunnel

Sounding: CP21-IS-10
Cone: 418:T1500F15U500



Max Depth: 36.675 m / 120.32 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-10.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.809440 Long: -111.935980

00 31 32-271

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

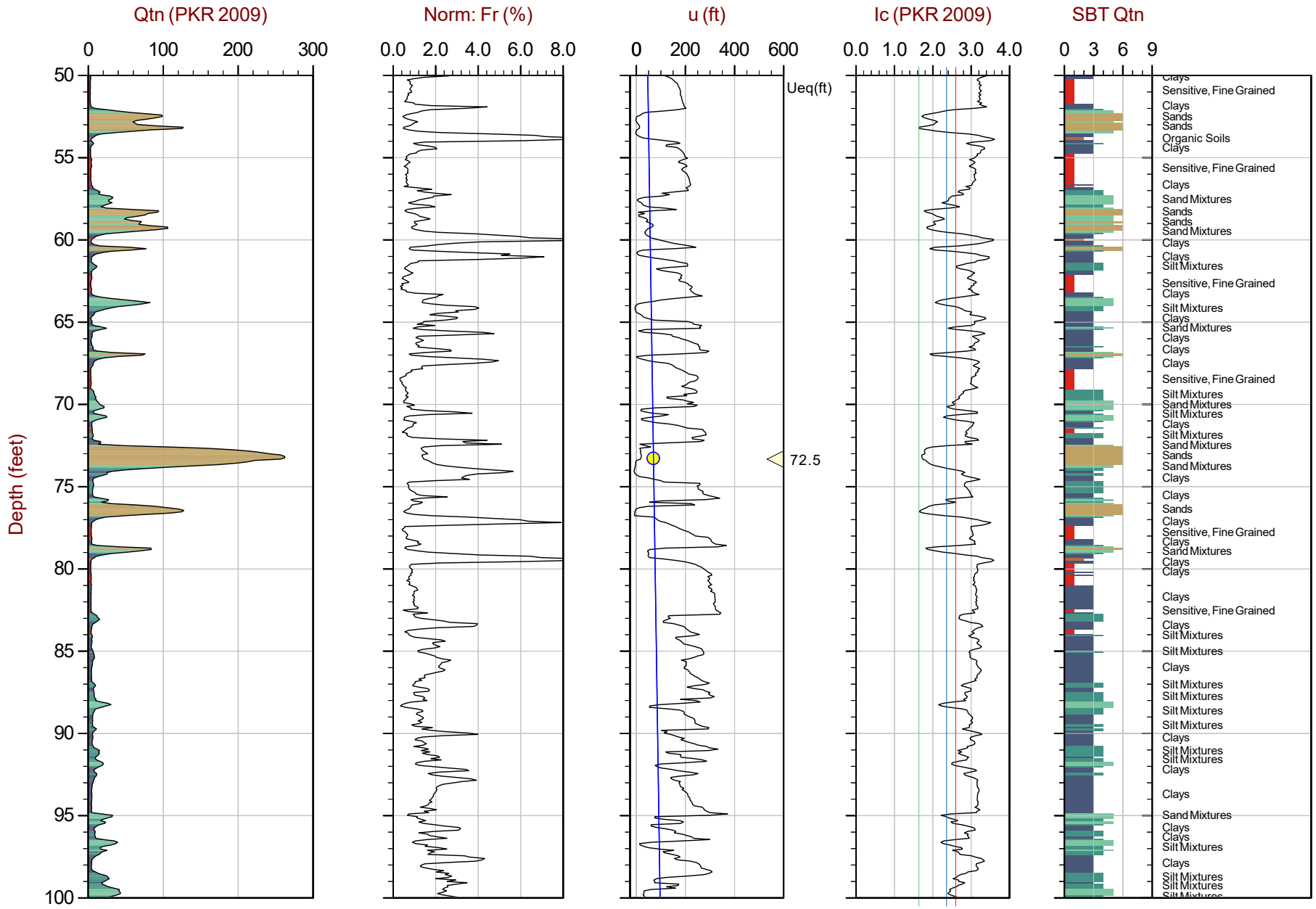
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-07 08:04
Site: Influent Tunnel

Sounding: CP21-IS-10
Cone: 418:T1500F15U500



Max Depth: 36.675 m / 120.32 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-10.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.809440 Long: -111.935980

00 31 32-272

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

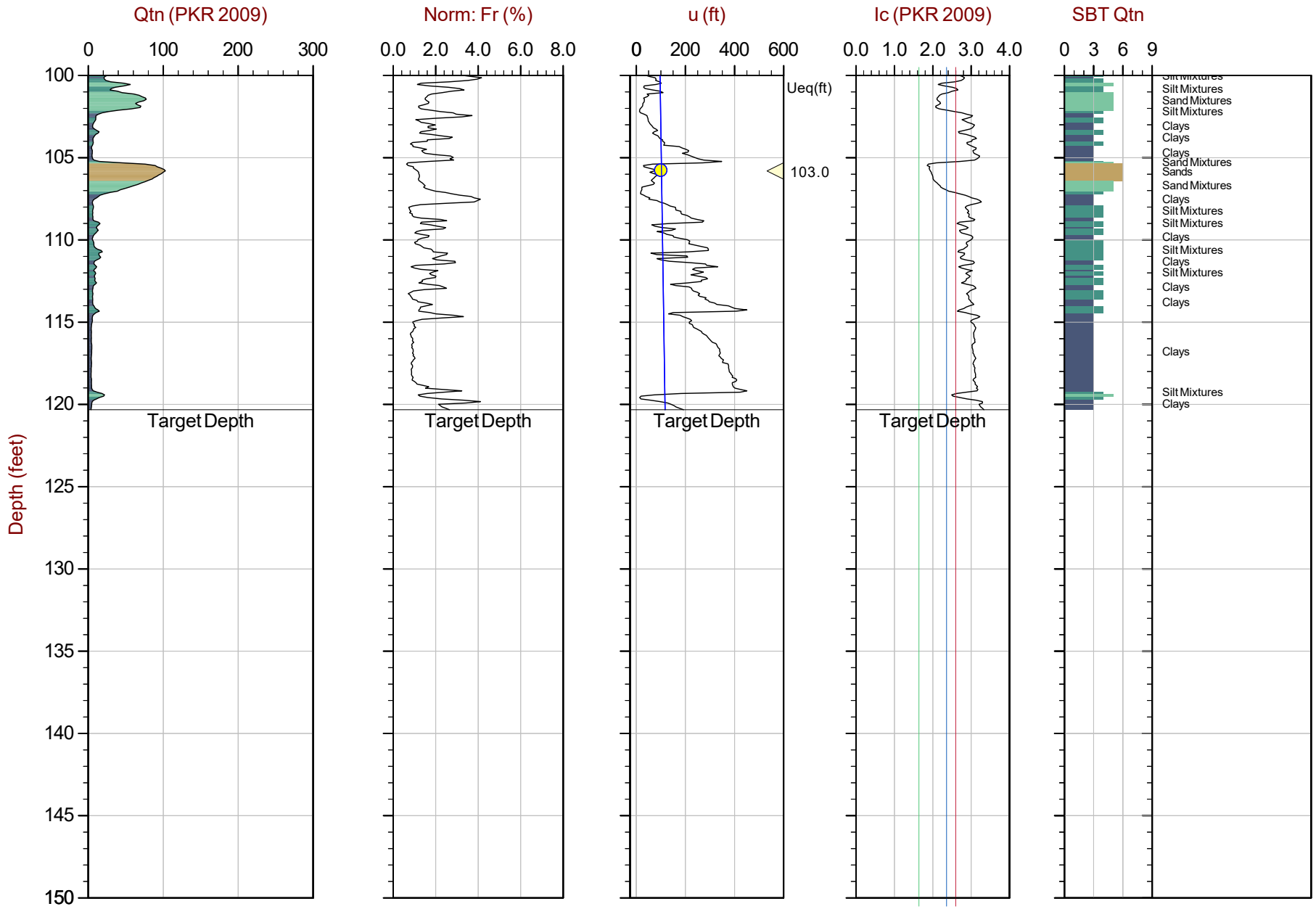
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 2021-01-07 08:04
Site: Influent Tunnel

Sounding: CP21-IS-10
Cone: 418:T1500F15U500



Max Depth: 36.675 m / 120.32 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-52-21761_CP21-IS-10.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 40.809440 Long: -111.935980

00 31 32-273

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

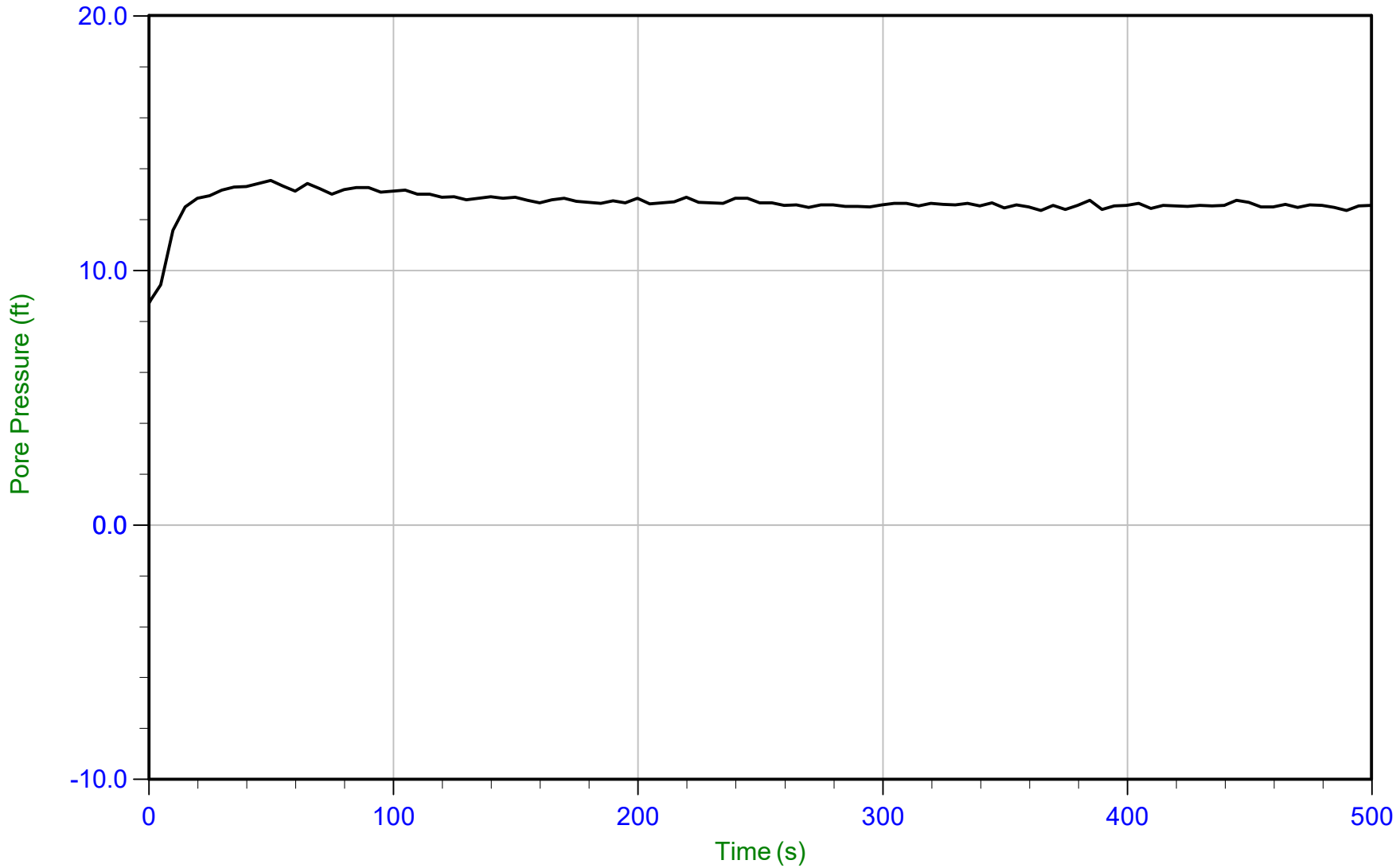
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 08:04
Site: Influent Tunnel

Sounding: CP21-IS-10
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-10.PPF
Depth: 4.700 m / 15.420 ft
Duration: 500.0 s

u Min: 8.7 ft
u Max: 13.5 ft
u Final: 12.5 ft

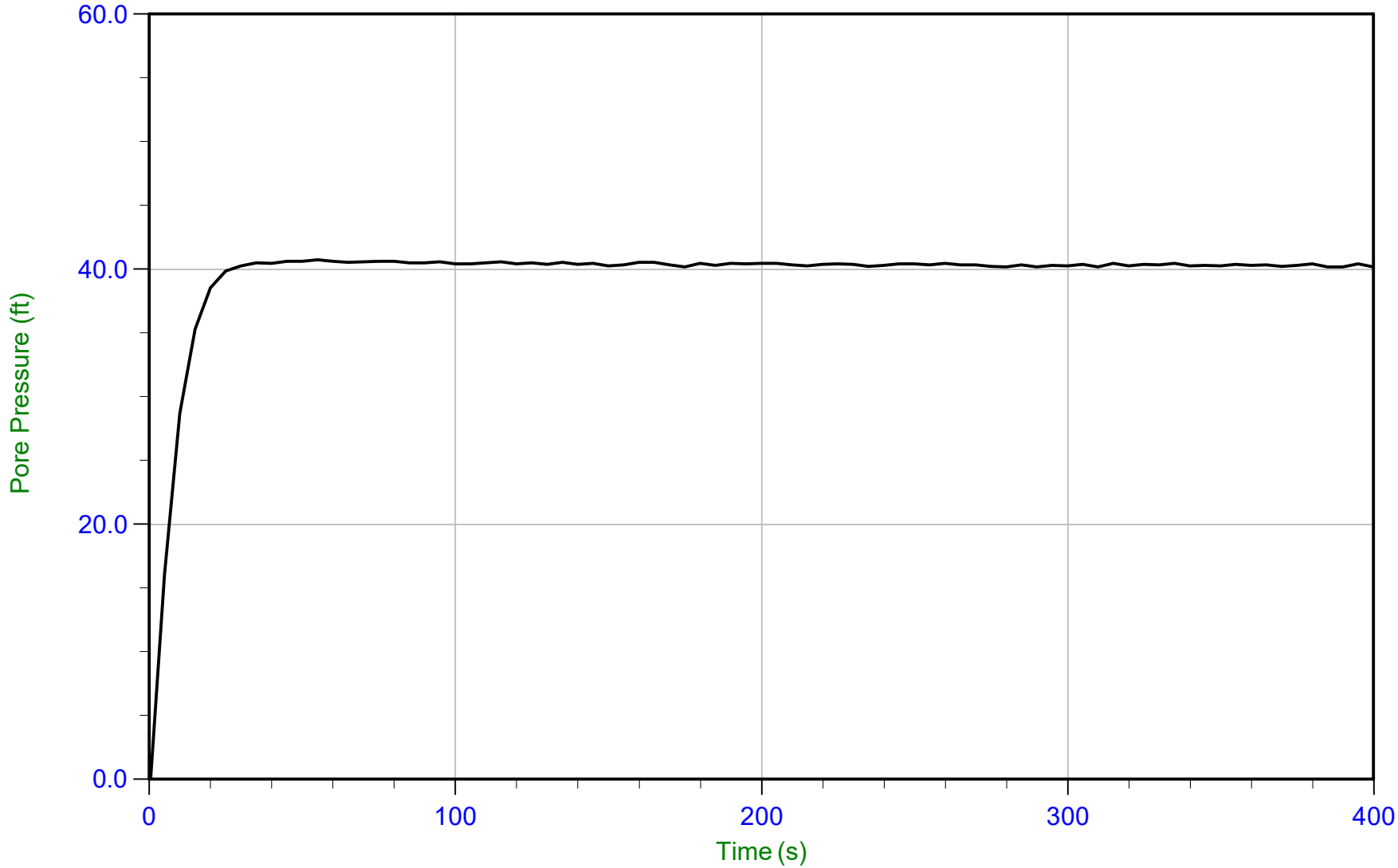
WT: 0.882 m / 2.894 ft
Ueq: 12.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 08:04
Site: Influent Tunnel

Sounding: CP21-IS-10
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-10.PPF
Depth: 12.925 m / 42.404 ft
Duration: 400.0 s

u Min: -1.6 ft
u Max: 40.7 ft
u Final: 40.2 ft

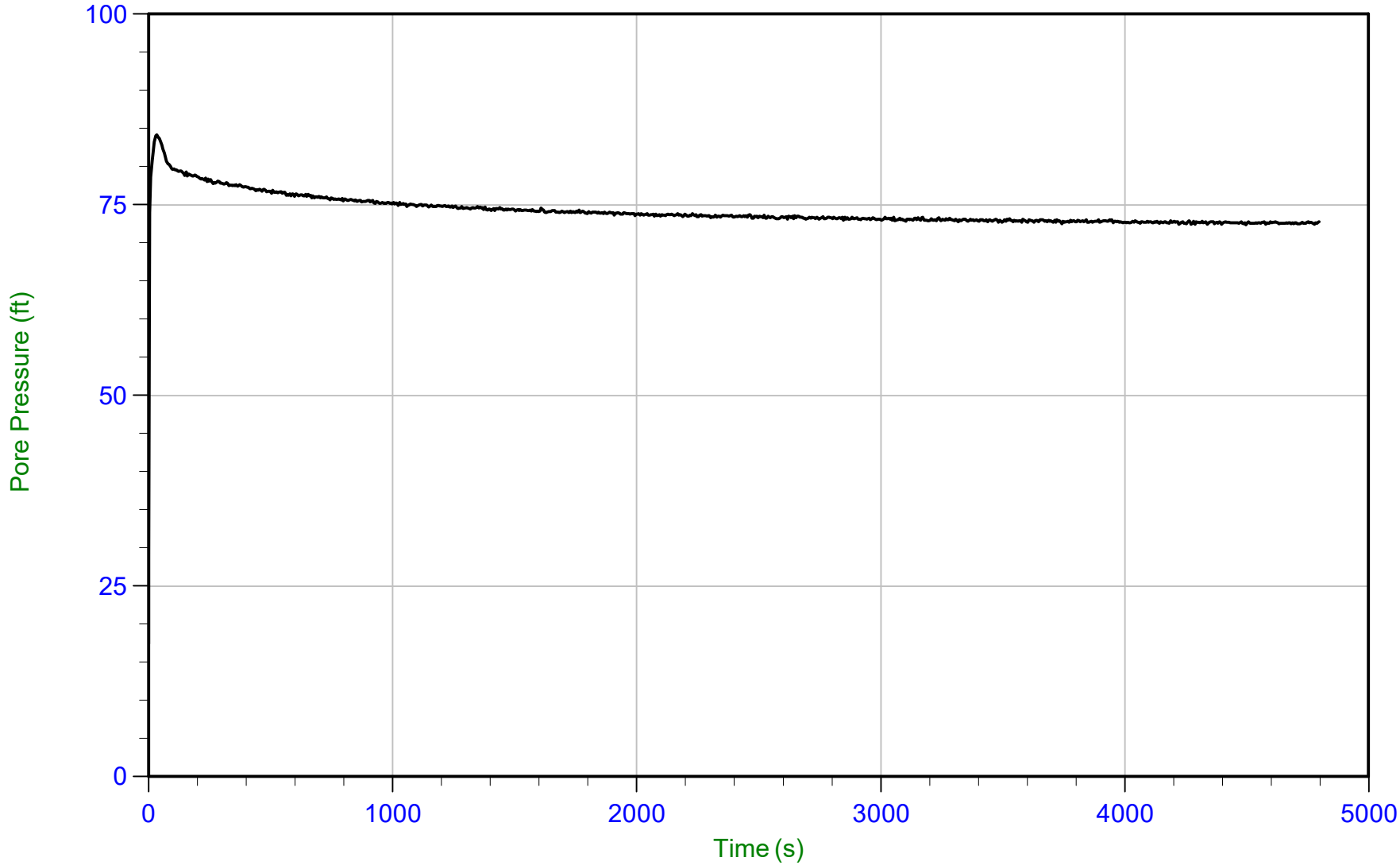
WT: 0.675 m / 2.215 ft
Ueq: 40.2 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 08:04
Site: Influent Tunnel

Sounding: CP21-IS-10
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-10.PPF
Depth: 22.350 m / 73.326 ft
Duration: 4800.0 s

u Min: 17.5 ft
u Max: 84.2 ft
u Final: 72.7 ft

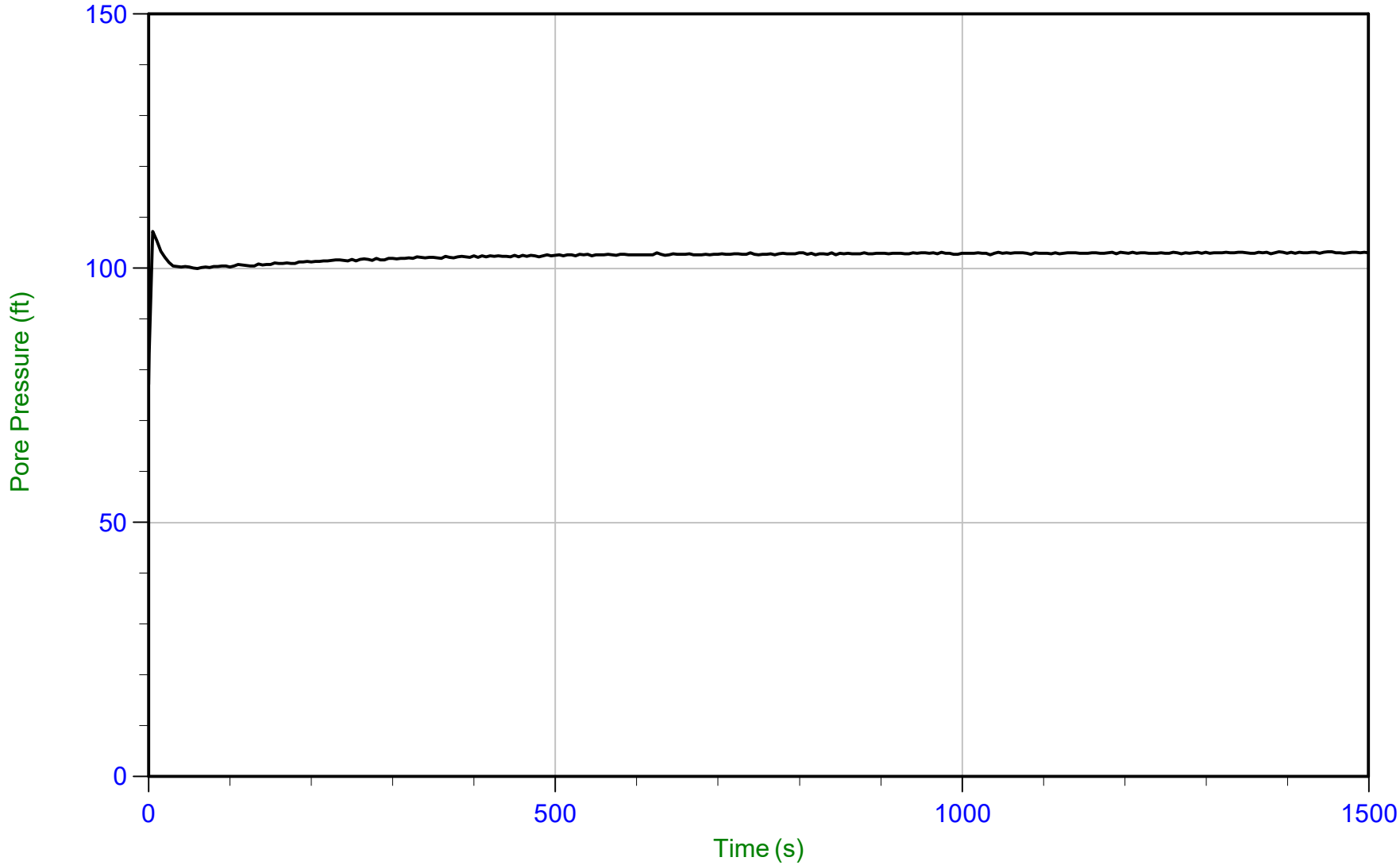
WT: 0.237 m / 0.778 ft
Ueq: 72.5 ft

CONETEC

AECOM

Job No: 20-52-21761
Date: 01/07/2021 08:04
Site: Influent Tunnel

Sounding: CP21-IS-10
Cone: 418:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-52-21761_CP21-IS-10.PPF
Depth: 32.250 m / 105.806 ft
Duration: 1500.0 s

u Min: 77.2 ft
u Max: 107.2 ft
u Final: 103.0 ft

WT: 0.825 m / 2.707 ft
Ueq: 103.1 ft

Appendix D GEOVision Geophysical Services Report, Surface Wave Measurements, Salt Lake City Water Reclamation Plant

REPORT

SURFACE WAVE MEASUREMENTS

SALT LAKE CITY WATER RECLAMATION PLANT
SALT LAKE CITY, UTAH

GEO*Vision* Project No. 18369

Prepared for

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Prepared by

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Report 18369-01

October 10, 2018

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1 INTRODUCTION

In-situ seismic measurements using active and passive surface wave techniques were performed at the Salt Lake City Water Reclamation Plant in Salt Lake City, Utah from October 12 to 15, 2018. The purpose of this investigation was to provide shear (S) wave velocity profiles to a depth of over 100 m (328 ft) and estimate the average S-wave velocity of the upper 30 m (V_{S30}) at six (6) locations on site (Arrays 1 to 6). The active surface wave technique utilized during this investigation consisted of the multi-channel analysis of surface waves (MASW) method. The passive surface wave techniques consisted of the array microtremor methods. The locations of the active and passive source surface wave arrays are shown on Figure 1.

V_{S30} is used in the NEHRP provisions and the Uniform Building Code (UBC) to separate sites into classes for earthquake engineering design (BSSC, 2003). The average shear wave velocity of the upper 100 ft (V_{S100ft}) is used in the International Building Code (IBC) for site classification. These site classes are as follows:

Class A – hard rock – $V_{S30} > 1500$ m/s (UBC) or $V_{S100ft} > 5{,}000$ ft/s (IBC)
Class B – rock – $760 < V_{S30} \leq 1500$ m/s (UBC) or $2{,}500 < V_{S100ft} \leq 5{,}000$ ft/s (IBC)
Class C – very dense soil and soft rock – $360 < V_{S30} \leq 760$ m/s (UBC)
or $1{,}200 < V_{S100ft} \leq 2{,}500$ ft/s (IBC)
Class D – stiff soil – $180 < V_{S30} \leq 360$ m/s (UBC) or $600 < V_{S100ft} \leq 1{,}200$ ft/s (IBC)
Class E – soft soil – $V_{S30} < 180$ m/s (UBC) or $V_{S100ft} < 600$ ft/s (IBC)
Class F – soils requiring site-specific evaluation

At many sites, active surface wave techniques (MASW) with the utilization of portable energy sources, such as hammers and weight drops, are sufficient to obtain a 30 m (100 ft) S-wave velocity sounding. At sites with high ambient noise levels and/or very soft soils, these energy sources may not be sufficient to image to 30 m and a larger energy source, such as a bulldozer, is necessary. Alternatively, passive surface wave techniques, such as the array microtremor technique can be used to extend the depth of investigation at sites that have adequate ambient noise conditions. It should be noted that two-dimensional passive-source surface wave arrays (e.g. triangular, circular, or L-shaped arrays) are expected to perform better than linear arrays.

This report contains the results of the active and passive surface wave measurements conducted at the site. An overview of the surface wave methods is given in Section 2. Field and data reduction and modeling procedures are discussed in Sections 3 and 4, respectively. Interpretation and results are presented in Section 5 and Conclusions in Section 6. References and our professional certification are presented in Sections 7 and 8, respectively.

2 OVERVIEW OF SURFACE WAVE TECHNIQUES

2.1 Introduction

Active and passive source (ambient vibration) surface wave techniques are routinely utilized for site characterization. Active surface wave techniques include the spectral analysis of surface waves (SASW) and multi-channel array surface wave (MASW) methods. Passive surface wave techniques include the horizontal over vertical spectral ratio (HVSR) technique and the array and refraction microtremor methods.

The basis of surface wave methods is the dispersive characteristic of Rayleigh and Love waves when propagating in a layered medium. Surface waves of different wavelengths (λ) or frequencies (f) sample different depth. As a result of the variance in the shear stiffness of the distinct layers, waves with different wavelengths propagate at different phase velocities; hence, dispersion. A surface wave dispersion curve is the variation of V_R or V_L with λ or f. The Rayleigh wave phase velocity (V_R) depends primarily on the material properties (V_S, mass density, and Poisson's ratio or compression wave velocity) over a depth of approximately one wavelength. The Love wave phase velocity (V_L) depends primarily on V_S and mass density. Rayleigh and Love wave propagation are also affected by damping or seismic quality factor (Q). Rayleigh wave techniques are utilized to measure vertically polarized S-waves (S_V-wave); whereas, Love wave techniques are utilized to measure horizontally polarized S-waves (S_H-wave).

2.2 Surface Wave Techniques

The MASW and array microtremor techniques were utilized during this investigation and are discussed below. The MASW and array microtremor surveys were designed to measure Rayleigh wave propagation.

2.2.1 MASW Technique

A description of the MASW method is given by Park, 1999a and 1999b and Foti, 2000. Ground motions are typically recorded by 24, or more, geophones typically spaced 1 to 3 m apart along a linear array and connected to a seismograph. Energy sources for shallow investigations include various sized hammers and vehicle mounted weight drops. When applying the MASW technique to develop a one-dimensional (1-D) V_S model, the surface-wave data, preferably, are acquired using multiple-source offsets at both ends of the array. The most commonly applied MASW technique is the Rayleigh-wave based MASW method, which we refer to as MAS_RW to distinguish from Love-wave based MASW (MAS_LW). MAS_RW and MAS_LW acquisition can easily be combined with P- and S-wave seismic refraction acquisition, respectively. MAS_RW data are generally recorded using a vertical source and vertical geophone but may also be recorded using a horizontal geophone with radial (in-line) orientation. MAS_LW data are recorded using transversely orientated horizontal source and transverse horizontal geophone.

A wavefield transform is applied to the time-history data to convert the seismic record from time-offset space to frequency-wavenumber (f-k) space in which the fundamental or higher

surface-wave modes can be easily identified as energy maxima and picked. Frequency and/or wavenumber can easily be mapped to phase velocity, slowness, or wavelength using the following properties: $k = 2\pi/\lambda$, $\lambda = v/f$. Common wave-field transforms include: the f-k transform (a 2D fast Fourier transform), slant-stack transform (also referred to as intercept-slowness or τ-p transform and equivalent to linear Radon transform), frequency domain beamformer, and phase-shift transform. The minimum wavelength that can be recovered from an MASW data set without spatial aliasing is equal to the minimum receiver spacing. Occasionally, SASW analysis procedures are used to extract surface wave dispersion data, from fixed receiver pairs, at smaller wavelengths than can be recovered by wavefield transformation. Construction of a dispersion curve over the wide frequency/wavelength range necessary to develop a robust V_S model while also limiting the maximum wavelength based on an established near-field criterion (e.g. Yoon and Rix, 2009; Li and Rosenblad, 2011), generally requires multiple source offsets.

Although the clear majority of MASW surveys record Rayleigh waves, it has been shown that Love wave techniques can be more effective in some environments, particularly shallow rock sites and sites with a highly attenuative, low velocity surface layer (Xia, et al., 2012; **GEO***Vision*, 2012; Yong, et al., 2013; Martin, et al., 2014). Rayleigh wave techniques, however, are generally more effective at sites where velocity gradually increases with depth because larger energy sources are readily available for generation of Rayleigh waves. Rayleigh wave techniques are also more applicable to sites with high velocity layers and/or velocity inversions because the presence of such structures is more apparent in the Rayleigh wave dispersion curves than in Love wave dispersion curves. Rayleigh wave techniques are preferable at sites with a high velocity surface layer because Love waves do not theoretically exist in such environments. Occasionally, the horizontal radial component of a Rayleigh wave may yield higher quality dispersion data than the vertical component because different modes of propagation may have more energy in one component than the other. Recording both the vertical and horizontal components of the Rayleigh wave is particularly useful at sites with complex modes of propagation or when attempting to recover multiple Rayleigh wave modes for multi-mode modeling as demonstrated in Dal Moro, et al, 2015. Joint inversion of Rayleigh and Love wave data may yield more accurate V_S models and also offer a means to investigate anisotropy, where S_V- and S_H-wave velocity are not equal, as shown in Dal Moro and Ferigo, 2011.

2.2.2 Array Microtremor Technique

A detailed discussion of the array microtremor method can be found in Okada, 2003. Unlike active source techniques which use an active energy source (i.e. hammer), the array microtremor technique (also referred to as passive surface wave or array ambient vibration method) records background noise (ambient vibrations) emanating from ocean wave activity, wind noise, traffic, industrial activity, construction, etc. The technique uses 4, or more, receivers aligned in a 2-dimensional array. Triangle, circle, semi-circle, and "L" shaped arrays are commonly used, although any 2-dimensional arrangement of receivers can be used. For investigation of the upper 100 m, receivers typically consist of 1 to 4.5 Hz geophones. For deeper investigations, 5 to 120 second seismometers are generally utilized. The nested triangle array, which consists of several embedded equilateral triangles, is popular as it provides accurate dispersion curves with a relatively small number of geophones. The "L" array is useful at sites located at the corner of intersecting streets. The maximum receiver separation in an array should be at a minimum equal to the desired depth of investigation. Typically, 15 to 60 minutes of ambient vibration data is

recorded depending on the size of the array, desired depth of investigation, and noise conditions. Investigations to depths on the order of 1 km may require that ambient vibrations are recorded for a much longer duration. The surface wave dispersion curve is typically estimated from array microtremor data using various f-k methods such as beam-forming (Lacoss, et al., 1969), and maximum-likelihood (Capon, 1969), and the spatial-autocorrelation (SPAC) method. The beam-forming and maximum-likelihood methods are generally referred to as the frequency wavenumber (FK) and high-resolution frequency wavenumber (HRFK or HFK) methods. The SPAC method was originally based on work by Aki, 1957 and has since been extended and modified (Ling and Okada, 1993 and Ohori *et al*., 2002) to permit the use of noncircular arrays, and is now collectively referred to as extended spatial autocorrelation (ESPAC or ESAC). Further modifications to the SPAC method permit the use of irregular or random arrays (Bettig *et al*., 2001). Although it is common to apply SPAC methods to obtain a surface wave dispersion curve for modeling, other approaches involve direct modeling of the coherency data, also referred to as SPAC coefficients (Asten, 2006 and Asten, *et al*., 2015).

FK and HRFK methods are generally expected to perform better when ambient vibration sources are not azimuthally well-distributed (e.g. rural area where primary noise source is a large industrial facility). SPAC methods are expected to perform better when noise sources are azimuthally well-distributed (e.g. in a large urbanized area).

The minimum and maximum wavelength surface wave that can be extracted from an array microtremor dataset acquired utilizing a symmetric array is typically set equal to the minimum and twice the maximum receiver spacings, respectively.

2.3 Surface Wave Dispersion Curve Modeling

The dispersion curves generated from the active and passive surface wave soundings are generally combined and modeled using iterative forward and inverse modeling routines. The final model profile is assumed to represent actual site conditions. The theoretical model used to interpret the dispersion curve assumes horizontally layered, laterally invariant, homogeneous-isotropic material. Although these conditions are seldom strictly met at a site, the results of active and/or passive surface wave testing provide a good "global" estimate of the material properties along the array. The results may be more representative of the site than a borehole "point" estimate.

The surface wave forward problem is typically solved using the Thomson-Haskell transfer-matrix (Thomson, 1950; Haskell, 1953) later modified by Dunkin (1965) and Knopoff (1964), dynamic stiffness matrix (Kausel and Roësset, 1981), or reflection and transmission coefficient (Kennett, 1974) methods. All of these methods can determine fundamental- and higher-mode phase velocities, which correspond to plane waves in 2-D space. The transfer-matrix method is often used in MASW and passive surface-wave software packages, whereas the dynamic stiffness matrix is utilized in many SASW software packages. MAS_RW and/or passive surface-wave modeling may involve modeling of the fundamental mode, some form of effective mode, or multiple individual modes (multi-mode). As outlined in Roësset et al. (1991), several options exist for forward modeling of Rayleigh wave SASW data. One formulation takes into account only fundamental mode plane Rayleigh-wave motion (called the 2-D solution), whereas another includes all stress waves (e.g. body, fundamental, and higher mode surface waves) and incorporates a generalized receiver geometry (3-D global solution) or actual receiver geometry

(3-D array solution).

The fundamental mode assumption is generally applicable to modeling Rayleigh-wave dispersion data collected at normally dispersive sites, providing there are not abrupt increases in velocity or steep velocity gradients. Effective-mode or multi-mode approaches are often required for irregularly dispersive sites and sites with steep velocity gradients at shallow depth. If active and passive surface wave data are combined or $MASW$ data are combined from multiple seismic records with different source offsets and receiver gathers, then effective-mode computations are limited to algorithms that assume far-field plane Rayleigh wave propagation. Local search (e.g. linearized matrix inversion methods) or global search methods (e.g., Monte Carlo approaches such as simulated annealing, generic algorithms and neighborhood algorithm) are typically used to solve the inverse problem.

The maximum wavelength (λ_{max}) recovered from a surface wave data set is typically used to estimate depth of investigation although a sensitivity analysis of the V_S models would be a more robust means to estimate depth of investigation. For normally dispersive velocity profiles with a gradual increase in V_S with depth, maximum depth of investigation is on the order of $\lambda_{max}/2$ for both Rayleigh and Love wave dispersion data. Velocity profiles with an abrupt increase in V_S at depth, maximum depth of investigation is on the order of $\lambda_{max}/3$ for Rayleigh wave dispersion data but less than $\lambda_{max}/3$ for Love wave dispersion data. Depth of investigation can be highly variable for sites with complex velocity structure (e.g. high velocity layers).

As with all surface geophysical methods, inversion of surface wave dispersion data does not yield a unique V_S model and there are multiple possible solutions that equally well fit the observed data. Based on our experience at other sites, the shear wave velocity models (V_S and layer thicknesses) determined by surface wave testing are within 20% of the velocities and layer thicknesses that would be determined by other seismic methods (Brown, 1998). The average velocity of the upper 30 m or 100 ft, however, is much more accurate, often to better than 5%, because it is not sensitive to the layering in the model. V_{S30} does not appear to suffer from the non-uniqueness inherent in V_S models derived from surface wave dispersion curves (Martin et al., 2006, Comina et al., 2011). Therefore, V_{S30} is more accurately estimated from inversion of surface wave dispersion data than the resulting V_S models.

It may not always be possible to develop a coherent, fundamental mode dispersion curve over sufficient frequency range for modeling due to dominant higher modes with the higher modes not clearly identifiable for multi-mode modeling. It may, however, be possible to identify the Rayleigh wave phase velocity of the fundamental mode at 40 m wavelength (V_{R40}) in which case V_{S30} can at least be estimated using the Brown et al., 2000 relationship:

$$V_{S30} = 1.045V_{R40}$$

This relationship was established based on statistical analysis of a large number of surface wave data sets from sites with control by velocities measured in nearby boreholes and has been further evaluated by Martin and Diehl, 2004, and Albarello and Gargani, 2010. Further investigation of this approach has revealed that V_{S30} is generally between V_{R40} and V_{R45} with V_{R40} often being most appropriate for shallow groundwater sites and V_{R45} for deep ground water sites. A detailed study of such an approach for Love wave dispersion data has not been conducted; however,

preliminary analysis demonstrates that V_{S30} is generally between V_{L50} and V_{L55}. Although we do not recommend that these empirical V_{S30} estimates replace modeling of surface wave dispersion data, they do offer a means of cost effectively evaluating V_{S30} over a large area. V_{R40} or V_{L55} can also be used to quantify error in V_{S30} by evaluating the scatter in the dispersion data at these wavelengths.

3 FIELD PROCEDURES

The active and passive source surface wave sounding locations at the site were established by **GEO***Vision* personnel and are shown in Figure 1. Four types of surface wave data were acquired at the site: a MASW survey to characterize near-surface velocity structure, a small aperture microtremor array using a minimum of thirty-seven 4.5 Hz geophones in an L-shaped or nested triangle configuration to characterize shallow to intermediate depth velocity structure, a small aperture microtremor array using nine (9) 1 Hz geophones in an L-shaped configuration to characterize intermediate depth velocity structure, and a large aperture microtremor array using ten (10) 1 Hz geophones to characterize deep velocity structure.

Active source surface wave data were acquired along Arrays 1 to 6 using the MASW technique with either a constant geophone spacing (Arrays 1 and 4) or variable geophone spacing (Arrays 2, 3, 5 and 6). Passive surface wave data were acquired on two (2) arrays, a small L-shaped array and large circular array, using the array microtremor method. The small L-shaped microtremor array (Array 1) consisted of a 48, 4.5 Hz geophones spaced 5 m apart and aligned along two orthogonal linear arrays as shown on Figure 2.

MASW Array 1 consisted of 48 geophones spaced 2 m (6.6 ft) apart for a length of 94 m (308 ft). Array 4 consisted of 48 geophones spaced 1 m (3.3ft) apart for a length of 47 m (154 ft). Arrays 2, 3, 5, and 6 consisted of 28 to 29 4.5 Hz geophones with a variable geophone spacing between 2 and 6 m (6.6 and 19.7 ft) for a length of 126 to 132 m (413 to 433 ft).

MASW equipment used during this investigation consisted of two Geometrics Geode signal enhancement seismographs, 4.5 Hz vertical geophones, seismic cable, a 4 lb hammer, 12 and 20 lb sledgehammers, and a 240 lb accelerated weight drop (AWD). Shot points were located between 1 and 30 m (3.3 and 98 ft) from the end geophone locations, as possible, and multiple locations within the interior of the array. The 4 lb hammer and 10 lb sledgehammer were used for the near offset and interior source locations. The 20 lb sledgehammer was used for all off-end source locations on Array 4. The AWD was used for all off-end source locations and selected interior source locations on Arrays 1, 2, 3, 5, and 6. Data from the transient impacts (hammers) were generally averaged 10 times to improve the signal-to-noise ratio. All field data were saved to hard disk and documented on field data acquisition forms.

The passive surface wave equipment consisted of two Geometrics Geode signal enhancement seismographs, 10 Geometrics Atom single channel wireless seismographs, 1 Hz vertical geophones, 4.5 Hz vertical geophones, and seismic cables.

The six (6), small aperture microtremor arrays consisted either an L-shaped array (Arrays 1, 2, 3, 5, and 6) or nested triangle array (Array 4). The first L-shaped array (Array 1) consisted of 48 4.5 Hz geophones spaced 6 m apart with the lengths of the sides of the array being 138 and 144 m, respectively. Field inspection of the surface wave dispersion data indicated that subsurface sediments had very low S-wave velocity and that lower frequency geophones were required to maximize depth of investigation. Therefore, passive surface wave data were also acquired along Array 1 with 10 1-Hz geophones spaced between 12 and 36 m apart. A variable geophone spacing (2 to 6 m) was utilized on one leg of the remaining L-shaped arrays to allow coincident

MASW data acquisition. The legs of these arrays had lengths between 120 and 132 m. With the exception of Array 2, which only utilized 4.5 Hz geophones, passive surface wave data were acquired along these arrays with 39 4.5 Hz geophones and 9 1 Hz geophones to maximize depth of investigation while also maximized field efficiency. Array 4 consisted of 37, 4.5 Hz geophones distributed along three nested triangles. Due to limited space, the maximum receiver offset in this array was only 48 m (158 ft) and there was no need to deploy 1 Hz geophones. Ambient vibration measurements were typically made along these arrays for 45 to 60 minutes at a 2 ms sample rate (90 to 120, 30 second records). All passive surface wave data were stored on a laptop computer for later processing. The field geometry and associated files names were documented in field data acquisition forms.

The large aperture microtremor array consisted of two (2), ten channel double-circle arrays with diameters of about 100 and 200, and 200 and 400 m, respectively (Figure 1). These arrays consisted of 10, 1 Hz geophones connected to Geometrics Atom wireless seismographs with a sensor at the center of the array and four or five sensors distributed around each of the two circular arrays. Passive surface wave measurements were made for a minimum of 60 minutes on each array. Each sensor location was surveyed using a sub foot accuracy GPS prior to data acquisition. Seismic data stored on the Atom seismographs were downloaded to a laptop computer at the end of the survey.

4 DATA REDUCTION AND MODELING

4.1 Data Reduction

Prior to data reduction, seismic records were reviewed to identify relevant geologic structures that could be constrained during data modeling. Based on review of the seismic records from MASW Array 4, the "seismic" water table was anchored at an approximate depth of 3 m (-9.8 ft) during modeling of the surface wave dispersion data for all sounding locations. Minor changes in the depth of the saturated zone and P-wave velocity of the saturated zone will not significantly impact the modeling of the surface wave dispersion data.

The MASW data were reduced using the software Seismic Pro Surface V9.0 developed by Geogiga and multiple in-house scripts for various data extraction and formatting tasks, with all data reduction documented in a Microsoft Excel spreadsheet.

The following steps were used for data reduction:

- Input seismic records to be used for analysis into software package.
- Check and correct source and receiver geometry as necessary.
- Select offset range used for analysis (multiple offset ranges utilized for each seismic record as discussed below) and document in spreadsheet.
- Apply phase shift transform to seismic record to convert the data from time – offset to frequency – phase velocity space.
- Identify, pick, save, and document dispersion curve.
- Change the receiver offset range and repeat process.
- Repeat process for all seismic records.
- Use in-house script to apply near-field criteria with maximum wavelength set equal to lesser of 40 m (source frequency limitation) or 1 times the source to midpoint of receiver array distance.
- Use in-house script to merge multiple dispersion curves extracted from the MASW data collected along each seismic line for a specific source type (different source locations, different receiver offset ranges, etc.).
- Edit dispersion data, as necessary (e.g. delete poor quality curves and outliers).
- Calculate a representative dispersion curve at equal log-frequency or log-wavelength spacing for the MASW dispersion data using a moving average, polynomial curve fitting routine.

This unique data reduction strategy, which can involve a combination of over 100 dispersion curves for a 1D sounding, is designed for characterizing sites with complex velocity structure that do not yield surface wave dispersion data over a wide frequency range from a single source type or source location. The data reduction strategy ensures that the dispersion curve selected for modeling is representative of average conditions beneath the array and spans as broad a frequency/wavelength range as possible while considering near field effects.

The array microtremor data were reduced using the Seisimager software package developed by Oyo Corporation/Geometrics, Inc. and the following steps:

The processing sequence for implementation of the ESAC method in the SeisImager software package is as follows:

- Use in-house script to separate 1 Hz and 4.5 Hz seismic records from combined data sets, as needed.
- Input all seismic records for a dataset into software.
- Load receiver geometry (x and y positions) for each channel in seismic record.
- Apply time-segmentation routine, as necessary, to break data file into multiple seismic records. Time segmentation is not necessary for smaller arrays where data is acquired as 30 s records. For the large array, data was divided into multiple approximate 80 s time windows for analysis.
- Calculate the SPAC coefficients for each seismic record and average.
- Optionally, combine SPAC coefficients from different arrays (e.g. multiple double circle arrays from large array).
- For each frequency calculate the RMS error between the SPAC coefficients and a Bessel function of the first kind and order zero over a user defined phase velocity range and velocity step.
- Plot an image of RMS error as a function for frequency (f) and phase velocity (v).
- Identify and pick the dispersion curve as the continuous trend on the f-v image with the lowest RMS error.
- Repeat process for all arrays and time blocks.
- Use in-house script to convert dispersion curves to appropriate format for editing.
- Edit dispersion data, as necessary, and use in-house script to combine all dispersion data after setting maximum wavelength to about 2 to 2.5 times the maximum receiver spacing (2 times maximum receiver spacing approximately equivalent to $k_{min}/2$ for a symmetrical array).
- Calculate a representative dispersion curve for the passive dispersion data from each array using a moving average polynomial curve fitting routine.

The Array 1 dispersion curve consisted of Rayleigh wave phase velocity data from a MASW array, a L-shaped passive array with 48 4.5 Hz geophones at 6 m intervals, and an L-shaped passive array with 10 1 Hz geophones with variable (12 to 36 m) spacing. The Array 2 dispersion curve consisted of Rayleigh wave phase velocity data from a MASW array, an L-shaped passive array with 48 4.5 Hz geophones at 2 to 6 m intervals, and the large aperture double circle arrays. The Array 3, 5, and 6 dispersion curves consisted of Rayleigh wave phase velocity data from a MASW array, a L-shaped passive array with 39 4.5 Hz geophones at variable intervals, and an L-shaped passive array with 9 1 Hz geophones at variable (18 to 42 m) intervals. The Array 4 dispersion curve consisted of Rayleigh wave phase velocity data from a MASW array and a nested triangle array with 48 m outer dimension and 37 geophones distributed at 6 m intervals around three nested triangles and at the center of the array.

The representative dispersion curves from the active and passive surface wave data were combined and the moving average polynomial curve fitting routine in WinSASW V3 was used to generate a composite representative dispersion curve for modeling. During this process the active and passive source surface wave data were given equal weights. An equal logarithmically

spaced wavelength sample rate was used for the representative dispersion curve to reflect the gradual loss in model resolution with depth.

4.2 DATA MODELING

Review of the surface wave dispersion data indicated that a stiff, compacted fill layer was located beneath many of the test locations (e.g. dirt roads, asphalt covered lots). Such velocity structure typically excites dominant higher mode Rayleigh waves at high frequencies/small wavelengths and it is not possible to model the data using the fundamental mode assumption. In such velocity structure, it is necessary to model the surface wave dispersion data using a multi-mode or effective mode solution.

The effective mode inverse modeling routine in Geometrics, Inc. Seisimager (WaveEq module) software package was used to generate an S-wave velocity model for Arrays 1, 2, 3, 5, and 6. Array 4 was modeled using the fundamental mode assumption as this location did not have fill with higher velocity that the underlying sediments. During this process the final composite representative dispersion curve was loaded into the modeling software package and an initial velocity model was generated based on general characteristics of the dispersion curve. The theoretical dispersion curve was then generated using the effective mode routine and compared to the field dispersion curve. The inverse modeling routine iteratively adjusted layer velocities until an acceptable fit to the field data was obtained. Data inputs into the modeling software include layer thickness, S-wave velocity, P-wave velocity or Poisson's ratio, and mass density. P-wave velocity and mass density only have a very small influence (i.e. less than 10%) on the S-wave velocity model generated from a surface wave dispersion curve. However, realistic assumptions for P-wave velocity, which is significantly impacted by the location of the saturated zone, and mass density will slightly improve the accuracy of the S-wave velocity model.

Constant mass density values of 1.6 to 2.05 g/cm^3 (100 to 128 lb/ft^3) were used in the profiles for subsurface soils/rock depending on P- and S-wave velocity. Within the normal range encountered in geotechnical engineering, variation in mass density has a negligible (±2%) effect on the estimated V_S from surface wave dispersion data. During modeling of Rayleigh wave dispersion data, the compression wave velocity, V_P, for unsaturated sediments was estimated using a Poisson's ratio, ν, of 0.333 and the relationship:

$$V_P = V_S \left[(2(1-\nu))/(1-2\nu)\right]^{0.5}$$

Poisson's ratio has a larger affect than density on the estimated V_S from Rayleigh wave dispersion data. Achenbach (1973) provides approximate relationship between Rayleigh wave velocity (V_R), V_S and ν:

$$V_R = V_S \left[(0.862 + 1.14\,\nu)/(1+\nu)\right]$$

Using this relationship, it can be shown that V_S derived from V_R only varies by about 10% over possible 0 to 0.5 range for Poisson's ratio where:

$V_S = 1.16V_R$ for $\nu = 0$
$V_S = 1.05V_R$ for $\nu = 0.5$

The realistic range of the Poisson's ratio for typical unsaturated sediments is about 0.25 to 0.35. Over this range, V_S derived from modeling of Rayleigh wave dispersion data will vary by about 5%. An intermediate Poisson's ratio of 0.333 was selected for modeling.

To reduce errors associated with expected high Poisson's ratio of saturated sediments, the saturated zone was anchored at a depth of 3 m, based on inspection of seismic refraction first arrival data from Array 4 seismic records. V_P of the saturated zone was set to a minimum velocity of about 1,475 m/s (4,839 ft/s) and allowed to gradually increase with depth as V_S increased.

5 INTERPRETATION AND RESULTS

The fit of the theoretical dispersion curve to the experimental data collected at the site and the modeled V_S profiles for Arrays 1 to 6 are presented in Figures 2 to 7. The resolution decreases gradually with depth due to the loss of sensitivity of the dispersion curve to changes in V_S at greater depth. The V_S profiles used to match the field data are provided in tabular form in both metric and imperial units as Tables 2 to 13. The velocity models for Arrays 1, 2, 3, 5, 6 were developed using layer contacts at similar depths to facilitate assessment of lateral velocity variability beneath the site. Array 4 was located on a different facility and, therefore, layer depths were not constrained to those of the other arrays. The V_S models from the six arrays are summarized in Figure 8.

The Rayleigh wave phase velocities from the passive surface wave measurements made using double circle, L-shaped, and nested triangle arrays are generally in excellent agreement with those from the MASW data in the regions of overlapping wavelength. There is typically about 20 - 30 m/s (66 - 89 ft/s) scatter in the surface wave dispersion data, which is likely the result of lateral velocity variation beneath each array.

The estimated depth of investigation for the combined active and passive surface wave soundings is about 125 m (410 ft) for Arrays 1, 3, 5, and 6; 225 m (738 ft) for Array 2 and 60 m (197 ft) for Array 4.

Arrays 1 to 3, 5, and 6 are all located on the Salt Lake City Water Reclamation Plant (Figure 1). The V_S models for these arrays have a fill sediment layer up to about 3 m (9.8 ft) thick with highly variable V_S between about 164 and 287 m/s (537 and 940 ft/s). Between a depth of 3 and 11 m (9.8 and 36 ft) is a low velocity layer with V_S typically between 133 and 171 m/s (435 and 562 ft/s). Array 6 has slightly higher V_S over this depth range. Below a depth of 11 m (36 ft) V_S gradually increases with depth from 174 to 188 m/s (571 to 616 ft/s) at about 11 m (36 ft) to 433 to 504 m/s (1,419 to 1,653 ft/s) at 116 m (381 ft) depth. V_S between the five models is very similar between a depth of about 11 and 76 m (36 and 249 ft) and within an approximate 15% velocity range at greater depths. The V_S model for Array 2 extends to a depth of about 225 m (738 ft) as the dispersion data from the large aperture double circle arrays was utilized for modeling. Modeled V_S for this array is 461 m/s (1,514 ft/s) and 531 m/s (1,743 ft/s) at depths of 116 and 176 m (381 and 577 ft), respectively.

Array 4 is located about 1 km (3280 ft) south of the Salt Lake City Water Reclamation Plant (Figure 1). There is no evidence of near-surface compacted fill beneath this array and V_S ranges from 122 to 157 m/s (401 to 515 ft/s) in the upper 11 m (36 ft). Below a depth of 11 m V_S gradually increases with depth from 213 m/s (699 ft/s) to 296 m/s (970 ft/s) at a depth of about 51 m (167 ft). Depth of investigation was limited to about 60 m (197 ft) beneath this array.

V_{S30} is 174, 184, 190, 184, 189, and 201 m/s for Arrays 1 to 6, respectively with V_{S30} for Arrays 1 to 5 being within 5% of the 180 m/s NEHRP Site Class D and E boundary. V_{S100ft} is 573, 607, 624, 605, 622, and 662 ft/s for Arrays 1 to 6, respectively.

6 CONCLUSIONS

Active and passive source surface wave measurements using the MASW and array microtremor techniques were made at six (6) locations at the Salt Lake City Water Reclamation Plant in Salt Lake City, Utah to characterize shear-wave velocity of the upper 100 m (328 ft), or more. The locations of surface wave arrays are presented in Figure 1 and Table 1. The shear wave velocity depth profiles determined by these methods are presented as Figures 2 through 7 and in Tables 2 through 13. It should be noted that these models are not unique and multiple V_S models could be developed with different layer depths that equally well fit the observed surface wave dispersion data; however, non-uniqueness is not expected to have a significant effect on V_{S30} or site response.

A comparison of the upper 125 m (410 ft) of the V_S models for Arrays 1 to 6 is presented as Figure 8. The most significant variation in V_S between the 6 profiles occurs in the upper 11 m (36 ft), which is due to the variable V_S of the fill sediments in the upper 3 m (9.8 ft) and the effect of the fill on the V_S of the underlying sediments. Except for Array 4, located about 1 km south of the other arrays, V_S is almost identical over the 11 to 76 m (36 to 249 ft) depth range. Below a depth of 76 m (249 ft) there is about 15% variation in V_S between the models, much of which could be accounted for by small changes to layer depths. Layer depths were kept approximately constant during modeling to more clearly identify lateral velocity variability.

V_{S30} varies from about 174 to 201 m/s (571 to 661 ft/s) beneath the 6 soundings. Therefore, according to the NEHRP provisions of the Uniform Building Code, the area in the vicinity of the surface wave arrays is classified as Class D/E, stiff/soft soil.

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8 CERTIFICATION

All geophysical data, analysis, interpretations, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by a **GEO*Vision*** California Professional Geophysicist.

Reviewed and approved by



10/10/2018

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* This geophysical investigation was conducted under the supervision of a California Professional Geophysicist using industry standard methods and equipment. A high degree of professionalism was maintained during all aspects of the project from the field investigation and data acquisition, through data processing interpretation and reporting. All original field data files, field notes and observations, and other pertinent information are maintained in the project files and are available for the client to review for a period of at least one year.

  A professional geophysicist's certification of interpreted geophysical conditions comprises a declaration of his/her professional judgment. It does not constitute a warranty or guarantee, expressed or implied, nor does it relieve any other party of its responsibility to abide by contract documents, applicable codes, standards, regulations or ordinances.

TABLES

Table 1 Location of Surface Wave Arrays

Array	Description	Northing (US ft)	Easting (US ft)	Elevation (ft)
1	SW End	7465458.7	1519694.3	4219.0
1	Corner	7465911.2	1519698.4	4219.6
1	NE End	7465906.8	1520170.7	4219.6
2	SW End	7465127.8	1520428.2	4219.0
2	Corner	7465521.2	1520433.9	4219.0
2	NE End	7465515.7	1520846.5	4220.1
3	NE End	7465507.3	1521218.6	4219.7
3	Corner	7465074.0	1521216.6	4220.4
3	SW End	7465075.3	1520842.7	4220.9
4(MASW)	West End	7460925.9	1522340.5	4219.9
4(MASW)	Center	7460925.0	1522417.5	4218.9
4(MASW)	East End	7460924.0	1522494.8	4218.1
4(Passive)	Center	7460970.7	1522419.6	4218.9
4(Passive)	North Corner	7461062.0	1522420.4	4218.5
4(Passive)	SE Corner	7460924.0	1522497.9	4218.1
4(Passive)	SW Corner	7460925.9	1522340.6	4220.0
5	NE End	7464428.9	1521508.9	4221.9
5	Corner	7464015.8	1521504.7	4220.7
5	SW End	7464018.3	1521111.3	4220.3
6	NW End	7464522.7	1520342.2	4223.1
6	Corner	7464108.9	1520340.3	4222.0
6	SE End	7464107.9	1520733.9	4222.2
Large Aperture Microtremor Array	1	7465093.9	1520427.8	4220.2
	6	7465339.8	1520430.7	4219.0
	7	7465056.1	1520670.4	4221.4
	8	7464863.7	1520343.6	4222.7
	9	7465115.6	1520182.5	4218.9
	14	7465601.0	1520447.6	4219.3
	15	7465485.4	1520729.0	4221.4
	15	7465074.6	1520917.5	4220.6
	17	7464613.3	1520326.6	4223.3
	18	7465118.1	1519936.2	4218.3
	24	7465680.5	1521219.7	4219.9
	25	7464615.6	1521288.2	4222.7
	27	7464341.9	1519794.5	4224.0
	28	7465909.0	1519882.5	4219.6

Notes: 1) Utah State Plane Central (4302), NAD83 (Conus), US Survey Feet.
2) Coordinates collected with Spectra Precision SP60 with CenterPoint RTX.

Table 2 V_S Model (Metric Units) – Array 1

Depth to Top of Layer (m)	Layer Thickness (m)	S-Wave Velocity (m/s)	Inferred P-Wave Velocity (m/s)	Inferred Poisson's Ratio	Assumed Density (g/cm^3)
0	1	224	448	0.334	1.80
1	2	216	432	0.333	1.80
3	3	140	1490	0.496	1.70
6	6	133	1483	0.496	1.70
12	7	174	1524	0.493	1.75
19	12	213	1563	0.491	1.80
31	18	237	1587	0.489	1.85
49	27	297	1647	0.483	1.90
76	40	355	1705	0.477	1.95
116	>9	433	1782	0.469	2.00

Notes: 1) Approximate depth of investigation = 125 m.
2) V_{S30} = 174 m/s.

Table 3 V_S Model (Imperial Units) - Array 1

Depth to Top of Layer (ft)	Layer Thickness (ft)	S-Wave Velocity (ft/s)	Inferred P-Wave Velocity (ft/s)	Inferred Poisson's Ratio	Assumed Density (lb/ft^3)
0.0	3.3	734	1469	0.334	112
3.3	6.6	709	1419	0.333	112
9.8	9.8	459	4888	0.496	106
19.7	19.7	435	4865	0.496	106
39.4	23.0	571	5000	0.493	109
62.3	39.4	698	5128	0.491	112
101.7	59.1	777	5206	0.489	115
160.8	88.6	975	5404	0.483	119
249.3	131.2	1166	5595	0.477	122
380.6	>29.5	1419	5848	0.469	125

Notes: 1) Approximate depth of investigation = 410 ft.
2) V_{S100ft} = 573 ft/s.

Table 4 V_S Model (Metric Units) – Array 2

Depth to Top of Layer (m)	Layer Thickness (m)	S-Wave Velocity (m/s)	Inferred P-Wave Velocity (m/s)	Inferred Poisson's Ratio	Assumed Density (g/cm^3)
0	1	182	363	0.333	1.75
1	2	164	328	0.334	1.75
3	3	150	1500	0.495	1.75
6	5	160	1510	0.494	1.75
11	8	184	1535	0.493	1.80
19	12	219	1569	0.49	1.85
31	18	246	1596	0.488	1.85
49	27	309	1659	0.482	1.90
76	40	383	1733	0.474	1.95
116	60	461	1811	0.465	2.00
176	>50	531	1881	0.457	2.05

Notes: 1) Approximate depth of investigation = 225 m.
2) V_{S30} = 184 m/s.

Table 5 V_S Model (Imperial Units) - Array 2

Depth to Top of Layer (ft)	Layer Thickness (ft)	S-Wave Velocity (ft/s)	Inferred P-Wave Velocity (ft/s)	Inferred Poisson's Ratio	Assumed Density (lb/ft^3)
0.0	3.3	595	1190	0.333	109
3.3	6.6	537	1075	0.334	109
9.8	9.8	493	4922	0.495	109
19.7	16.4	524	4953	0.494	109
36.1	26.2	605	5035	0.493	112
62.3	39.4	718	5146	0.490	115
101.7	59.1	807	5237	0.488	115
160.8	88.6	1014	5443	0.482	119
249.3	131.2	1255	5684	0.474	122
380.6	196.9	1514	5943	0.465	125
577.4	>164.0	1743	6173	0.457	128

Notes: 1) Approximate depth of investigation = 738 ft.
2) V_{S100ft} = 607 ft/s.

Table 6 V_S Model (Metric Units) – Array 3

Depth to Top of Layer (m)	Layer Thickness (m)	S-Wave Velocity (m/s)	Inferred P-Wave Velocity (m/s)	Inferred Poisson's Ratio	Assumed Density (g/cm^3)
0	1	271	543	0.334	1.85
1	2	287	574	0.334	1.85
3	3	168	1517	0.494	1.70
6	5	148	1498	0.495	1.70
11	8	187	1537	0.492	1.80
19	12	208	1558	0.491	1.80
31	18	244	1594	0.488	1.85
49	27	311	1661	0.482	1.90
76	40	396	1746	0.473	1.95
116	>9	454	1804	0.466	2.00

Notes: 1) Approximate depth of investigation = 125 m.
2) V_{S30} = 190 m/s.

Table 7 V_S Model (Imperial Units) - Array 3

Depth to Top of Layer (ft)	Layer Thickness (ft)	S-Wave Velocity (ft/s)	Inferred P-Wave Velocity (ft/s)	Inferred Poisson's Ratio	Assumed Density (lb/ft^3)
0.0	3.3	890	1783	0.334	115
3.3	6.6	940	1882	0.334	115
9.8	9.8	550	4978	0.494	106
19.7	16.4	487	4916	0.495	106
36.1	26.2	614	5043	0.492	112
62.3	39.4	683	5112	0.491	112
101.7	59.1	800	5229	0.488	115
160.8	88.6	1019	5448	0.482	119
249.3	131.2	1299	5727	0.473	122
380.6	>29.5	1488	5917	0.466	125

Notes: 1) Approximate depth of investigation = 410 ft.
2) V_{S100ft} = 624 ft/s.

Table 8 V_S Model (Metric Units) – Array 4

Depth to Top of Layer (m)	Layer Thickness (m)	S-Wave Velocity (m/s)	Inferred P-Wave Velocity (m/s)	Inferred Poisson's Ratio	Assumed Density (g/cm^3)
0	1	122	245	0.333	1.60
1	2	146	291	0.333	1.65
3	3	133	1483	0.496	1.65
6	5	157	1507	0.495	1.70
11	16	213	1563	0.491	1.80
27	24	249	1599	0.488	1.85
51	>24	296	1646	0.483	1.90

Notes: 1) Approximate depth of investigation = 60 m.
2) V_{S30} = 184 m/s.

Table 9 V_S Model (Imperial Units) - Array 4

Depth to Top of Layer (ft)	Layer Thickness (ft)	S-Wave Velocity (ft/s)	Inferred P-Wave Velocity (ft/s)	Inferred Poisson's Ratio	Assumed Density (lb/ft^3)
0.0	3.3	401	803	0.333	100
3.3	6.6	478	956	0.333	103
9.8	9.8	436	4865	0.496	103
19.7	16.4	515	4945	0.495	106
36.1	52.5	699	5128	0.491	112
88.6	78.7	818	5247	0.488	115
167.3	>78.7	970	5400	0.483	119

Notes: 1) Approximate depth of investigation = 197 ft.
2) V_{S100ft} = 605 ft/s.

Table 10 V_S Model (Metric Units) – Array 5

Depth to Top of Layer (m)	Layer Thickness (m)	S-Wave Velocity (m/s)	Inferred P-Wave Velocity (m/s)	Inferred Poisson's Ratio	Assumed Density (g/cm^3)
0	1	198	396	0.334	1.80
1	2	226	453	0.333	1.80
3	3	171	1521	0.494	1.75
6	5	152	1502	0.495	1.70
11	8	188	1538	0.492	1.80
19	12	213	1564	0.491	1.85
31	18	239	1589	0.488	1.90
49	27	305	1655	0.482	1.95
76	40	400	1749	0.472	2.00
116	>9	504	1854	0.460	2.05

Notes: 1) Approximate depth of investigation = 125 m.
2) V_{S30} = 189 m/s.

Table 11 V_S Model (Imperial Units) - Array 5

Depth to Top of Layer (ft)	Layer Thickness (ft)	S-Wave Velocity (ft/s)	Inferred P-Wave Velocity (ft/s)	Inferred Poisson's Ratio	Assumed Density (lb/ft^3)
0.0	3.3	649	1298	0.334	112
3.3	6.6	742	1485	0.333	112
9.8	9.8	562	4991	0.494	109
19.7	16.4	499	4928	0.495	106
36.1	26.2	616	5045	0.492	112
62.3	39.4	700	5130	0.491	115
101.7	59.1	783	5212	0.488	119
160.8	88.6	1002	5431	0.482	122
249.3	131.2	1311	5740	0.472	125
380.6	>29.5	1653	6081	0.460	128

Notes: 1) Approximate depth of investigation = 410 ft.
2) V_{S100ft} = 622 ft/s.

Table 12 V_S Model (Metric Units) – Array 6

Depth to Top of Layer (m)	Layer Thickness (m)	S-Wave Velocity (m/s)	Inferred P-Wave Velocity (m/s)	Inferred Poisson's Ratio	Assumed Density (g/cm^3)
0	1	246	492	0.333	1.80
1	2	244	488	0.334	1.80
3	3	204	1554	0.491	1.80
6	5	178	1528	0.493	1.75
11	8	181	1531	0.493	1.80
19	12	221	1571	0.49	1.80
31	18	246	1596	0.488	1.85
49	27	305	1656	0.482	1.90
76	40	407	1757	0.472	1.95
116	>9	487	1837	0.462	2.00

Notes: 1) Approximate depth of investigation = 125 m.
2) V_{S30} = 201 m/s.

Table 13 V_S Model (Imperial Units) - Array 6

Depth to Top of Layer (ft)	Layer Thickness (ft)	S-Wave Velocity (ft/s)	Inferred P-Wave Velocity (ft/s)	Inferred Poisson's Ratio	Assumed Density (lb/ft^3)
0.0	3.3	807	1614	0.333	112
3.3	6.6	800	1601	0.334	112
9.8	9.8	668	5097	0.491	112
19.7	16.4	583	5012	0.493	109
36.1	26.2	594	5024	0.493	112
62.3	39.4	726	5155	0.490	112
101.7	59.1	808	5237	0.488	115
160.8	88.6	1002	5431	0.482	119
249.3	131.2	1335	5765	0.472	122
380.6	>29.5	1598	6028	0.462	125

Notes: 1) Approximate depth of investigation = 410 ft.
2) V_{S100ft} = 662 ft/s.

FIGURES

1519670 1520326 1520982 1521639

7465824 7465168 7464512 7463856 7463200 7462544

Array 1
28
14
Array 2
15
24
6
18
9
1
7
Array 3
16
8
17
25
27
Array 6
Array 5
Array 4

Site Location Map

20 0 20 40 Meters

65 0 65 130 Feet

1519670 1520326 1520982 1521639

Legend

- Deep Passive Surface Wave Array
- MASW Array
- Shallow Passive Surface Wave Array

40 0 40 80 Meters

130 0 130 260 Feet

NOTES:
1. Coordinate System: Utah State Plane Central, NAD83 (4302), US Survey Feet
2. Base map source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

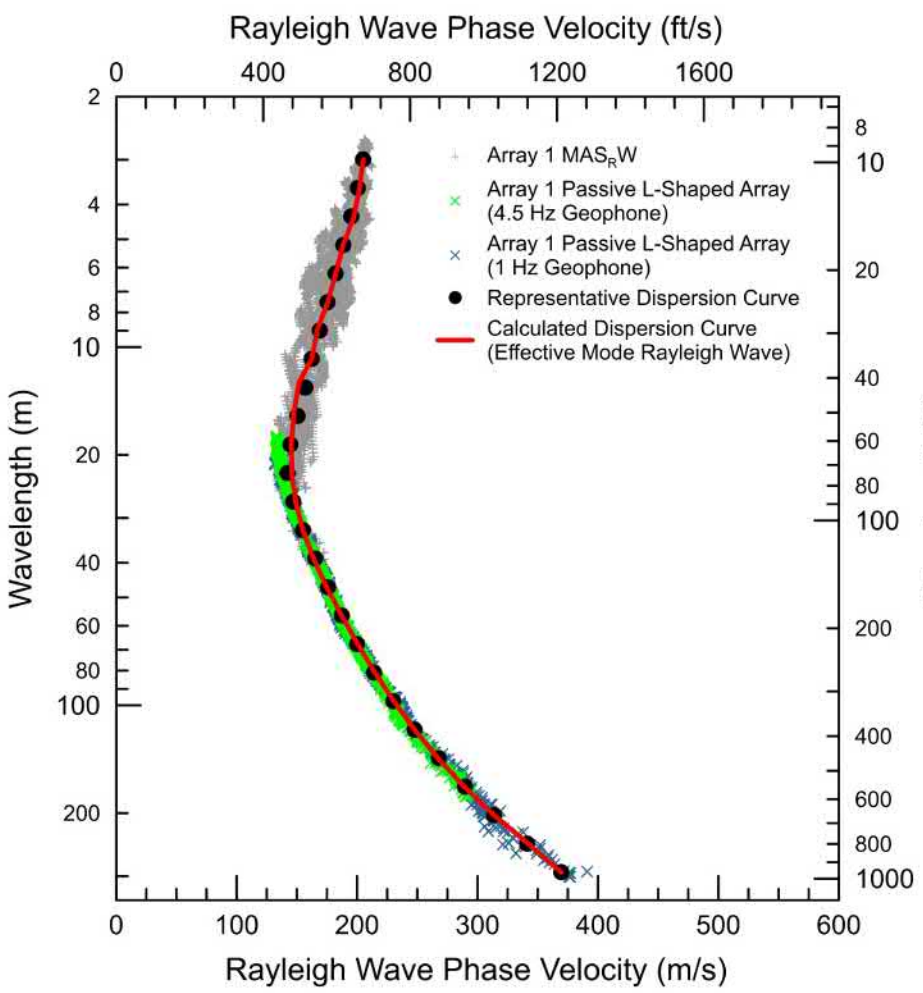
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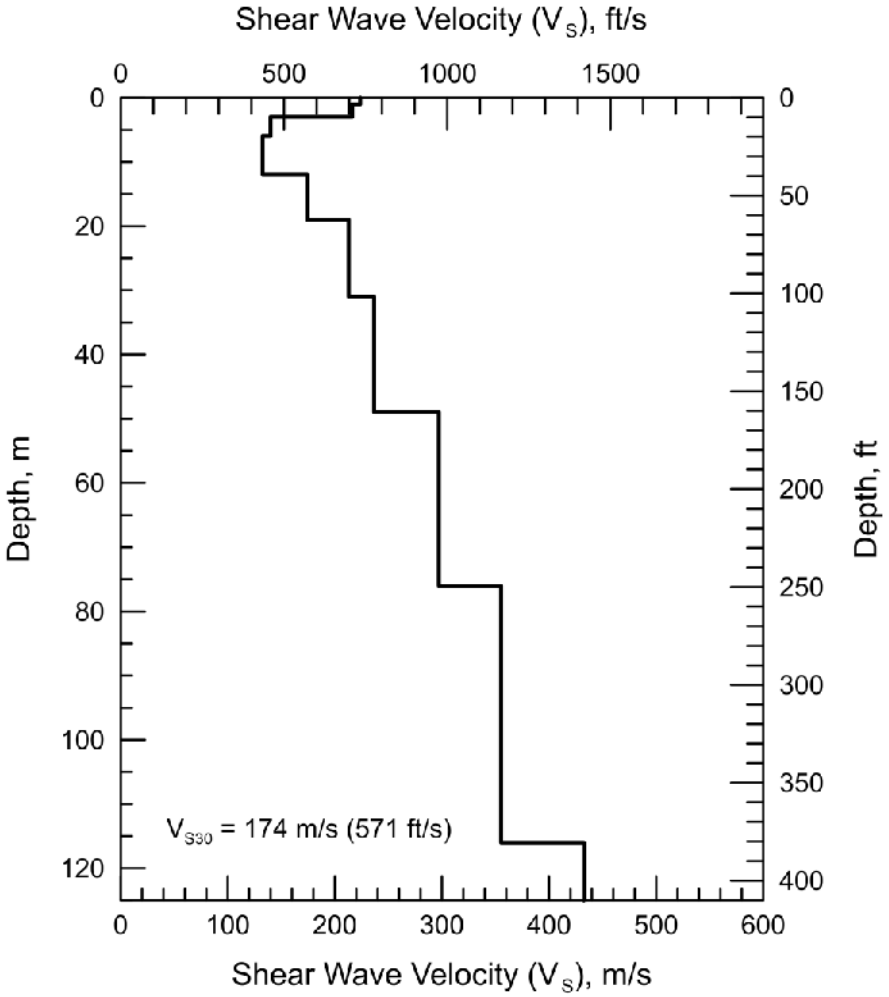
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GV Project:	18369
Developed by:	W Dalrymple
Drawn by:	T Rodriguez
Approved by:	A Martin
File Name:	18369-1.MXD

FIGURE 1
SITE MAP

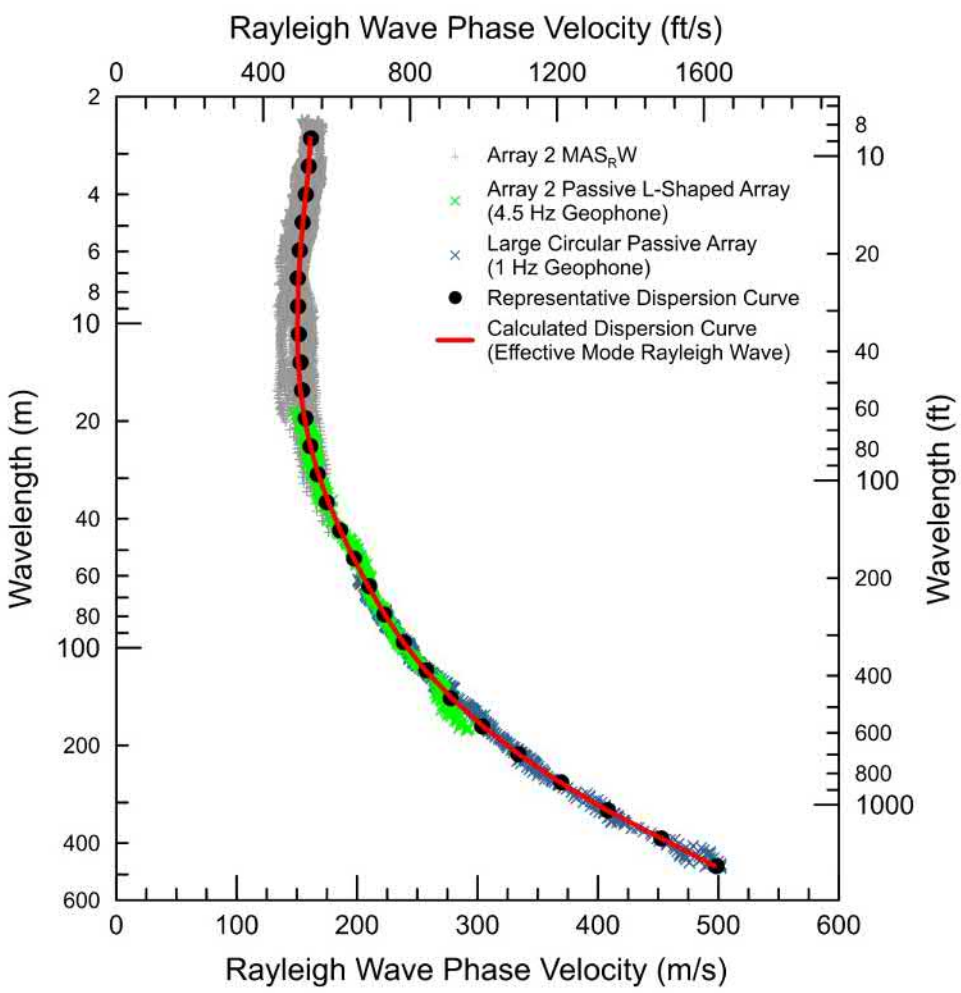
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1300 W 2300 N STREET
SALT LAKE CITY, UTAH

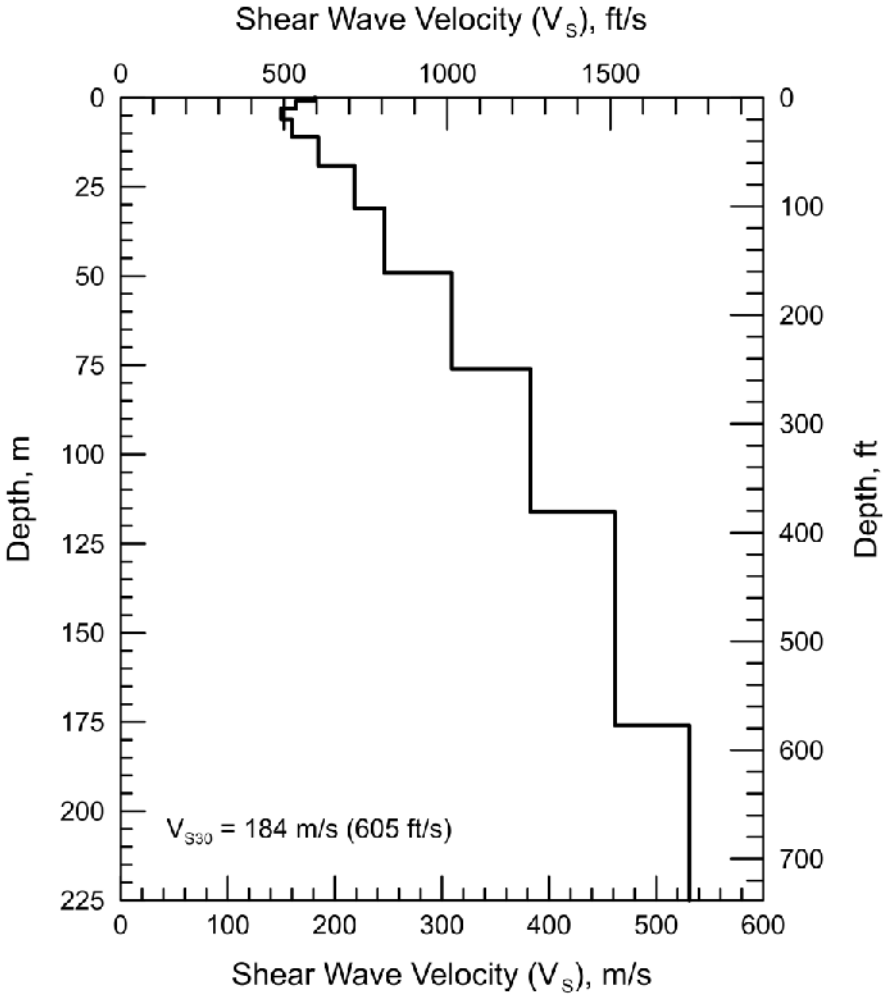
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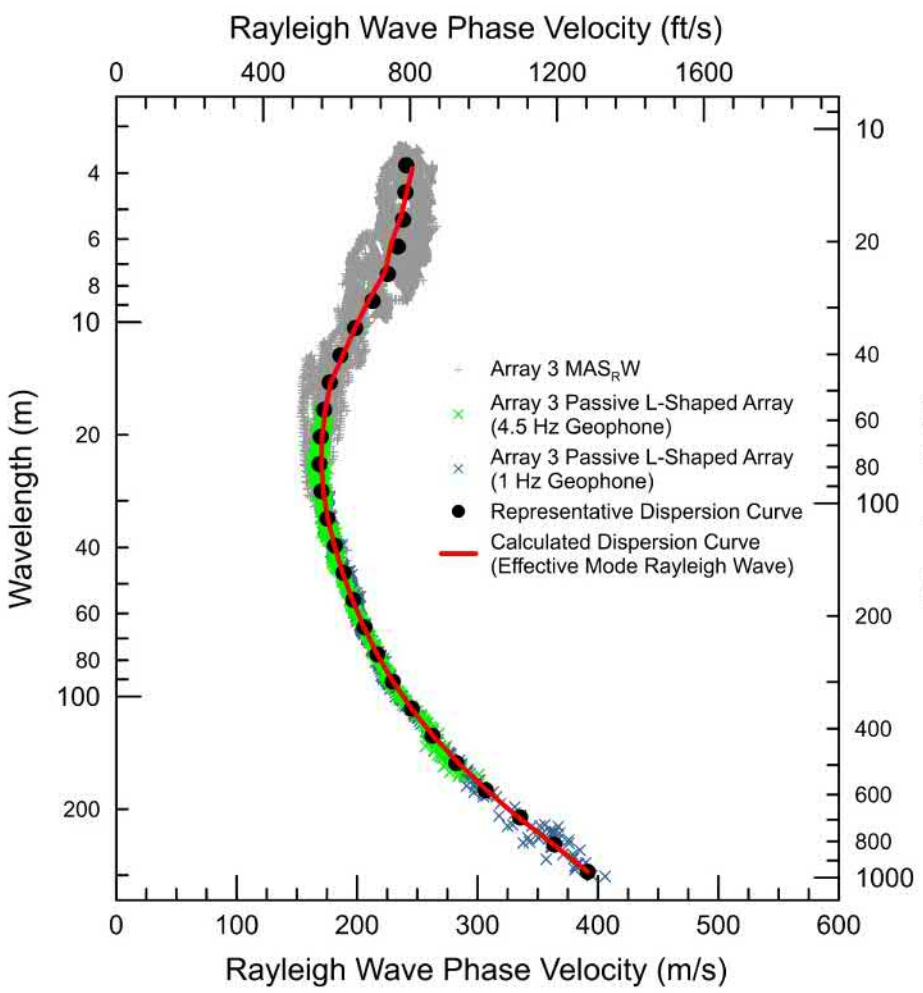


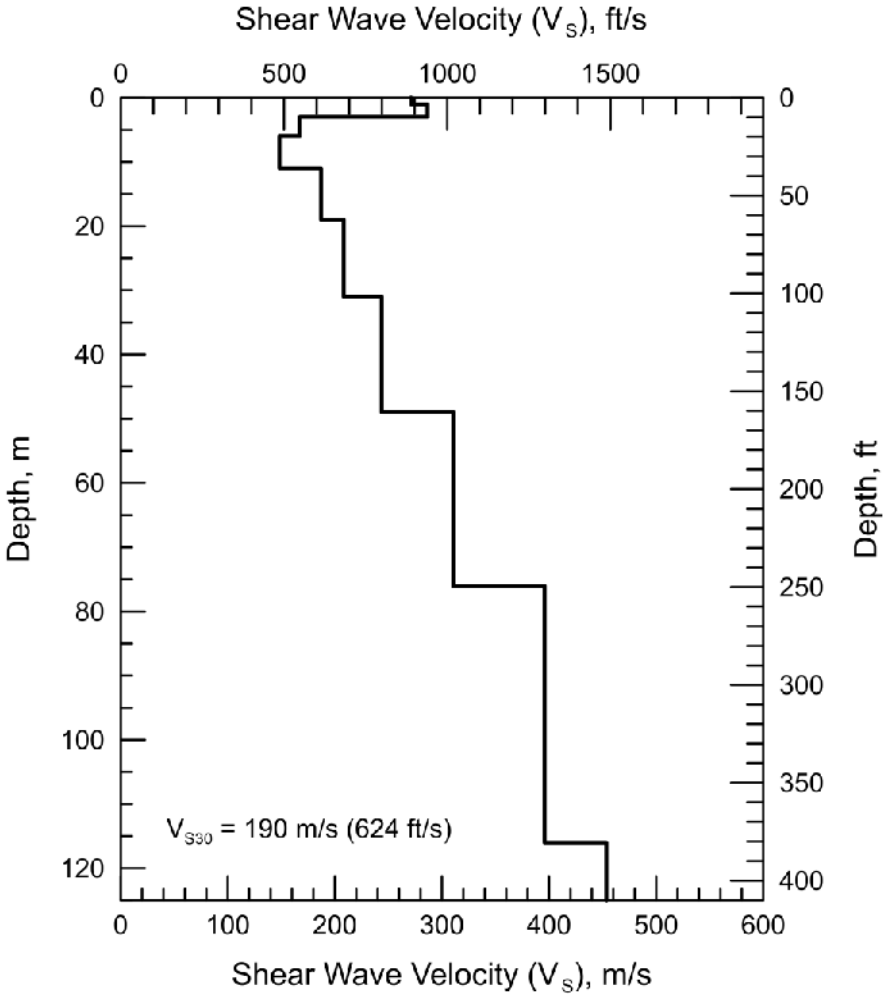
GEOVision geophysical services	FIGURE 2 SURFACE WAVE MODEL - ARRAY 1
Project No: 18369 Date: OCT 4, 2018 Drawn By: A MARTIN Approved By:	SALT LAKE CITY WATER RECLAMATION PLANT SALT LAKE CITY, UTAH
R:\GVProjects\2018\18369LCI\Report\Figure 2.cdr	PREPARED FOR LETTIS CONSULTANTS INTERNATIONAL



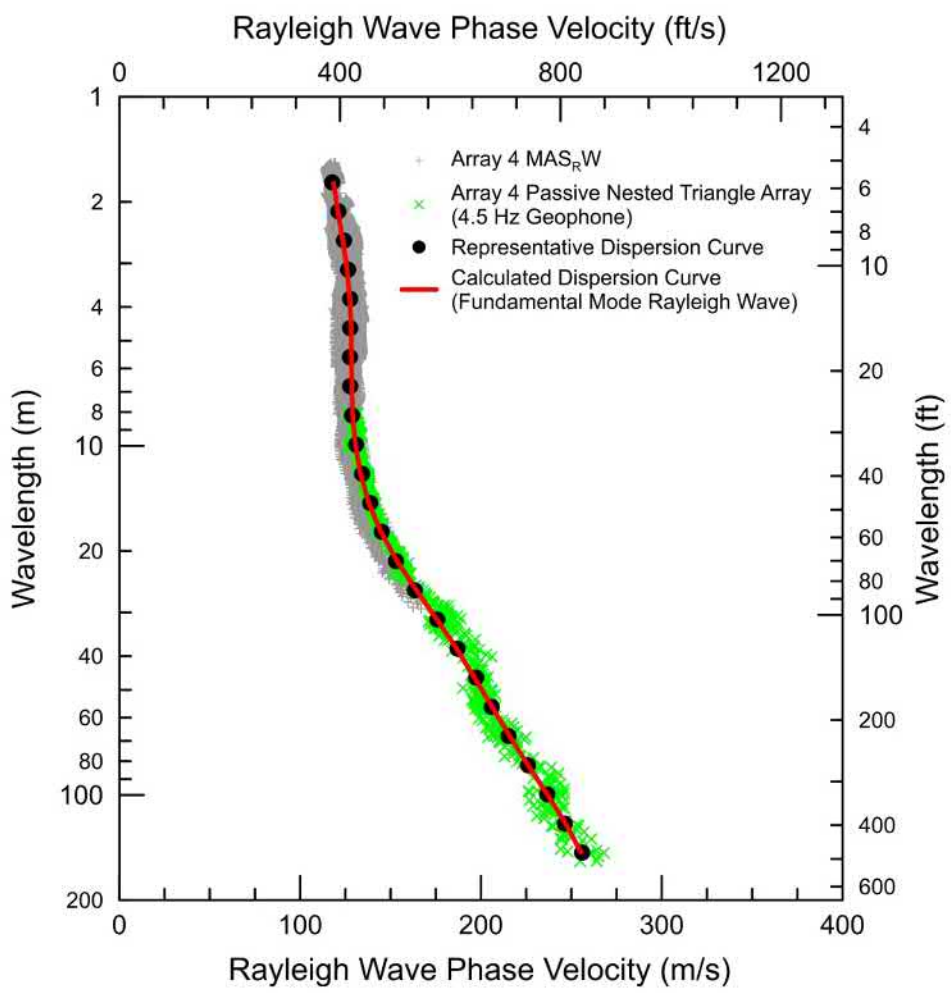


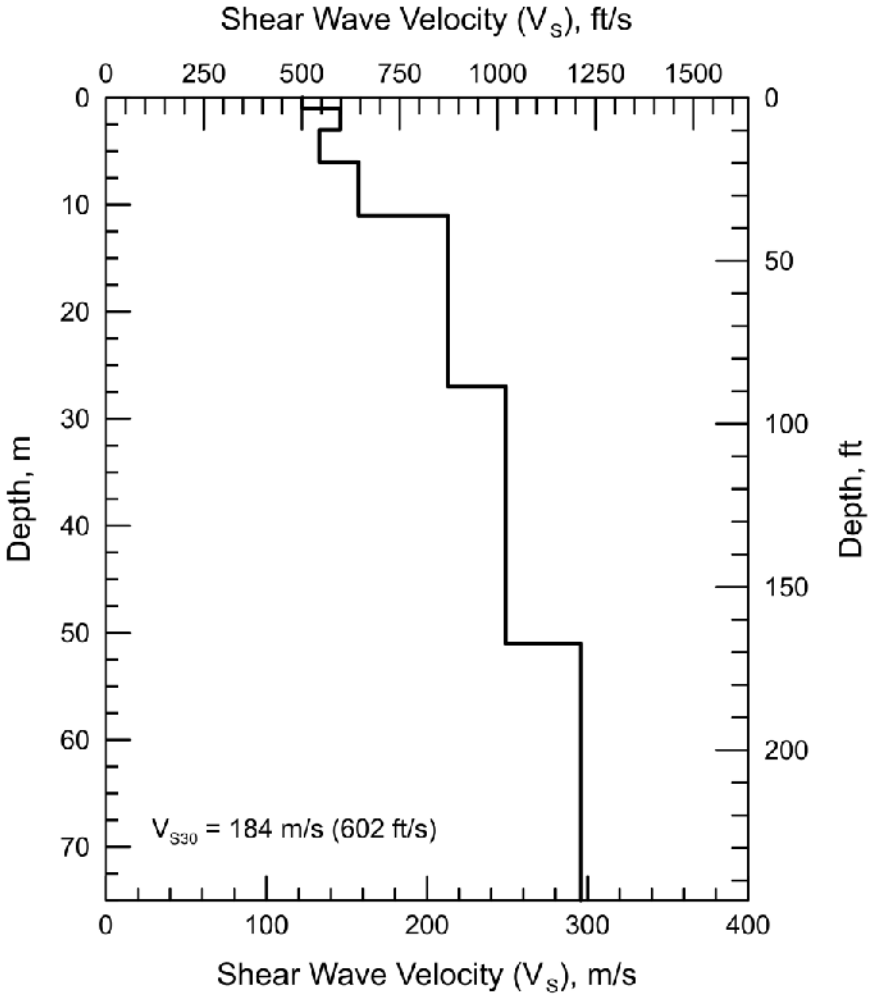
GEOVision geophysical services	FIGURE 3 SURFACE WAVE MODEL - ARRAY 2
Project No: 18369 Date: OCT 4, 2018 Drawn By: A MARTIN Approved By:	SALT LAKE CITY WATER RECLAMATION PLANT SALT LAKE CITY, UTAH
R:\GVProjects\2018\18369LC\Report\Figure 3.cdr	PREPARED FOR LETTIS CONSULTANTS INTERNATIONAL



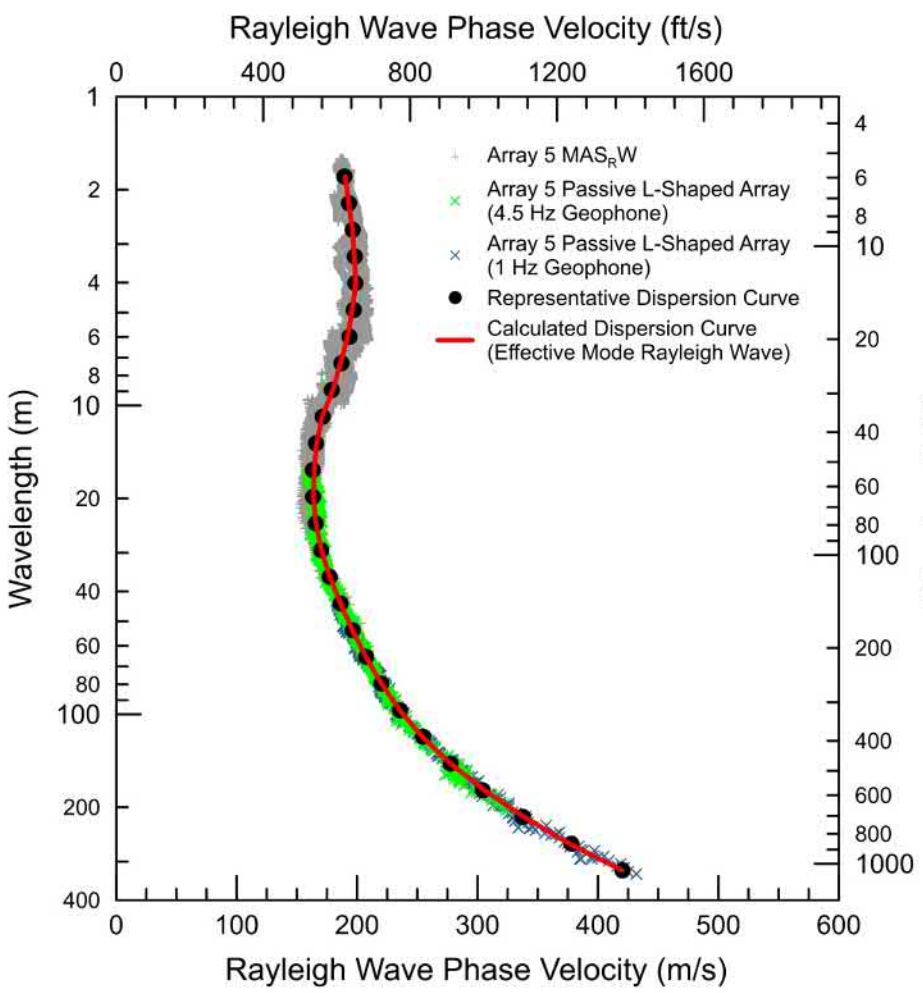


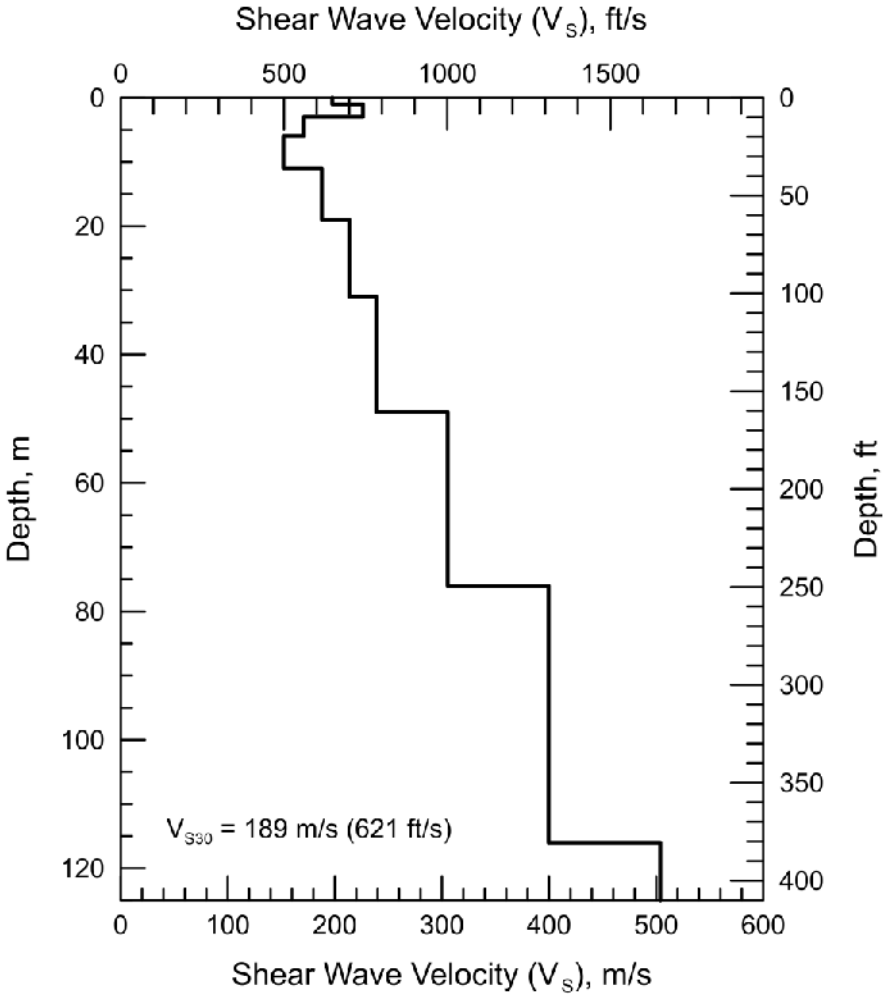
GEOVision geophysical services	FIGURE 4 SURFACE WAVE MODEL - ARRAY 3
Project No: 18369 Date: OCT 4, 2018 Drawn By: A MARTIN Approved By:	SALT LAKE CITY WATER RECLAMATION PLANT SALT LAKE CITY, UTAH
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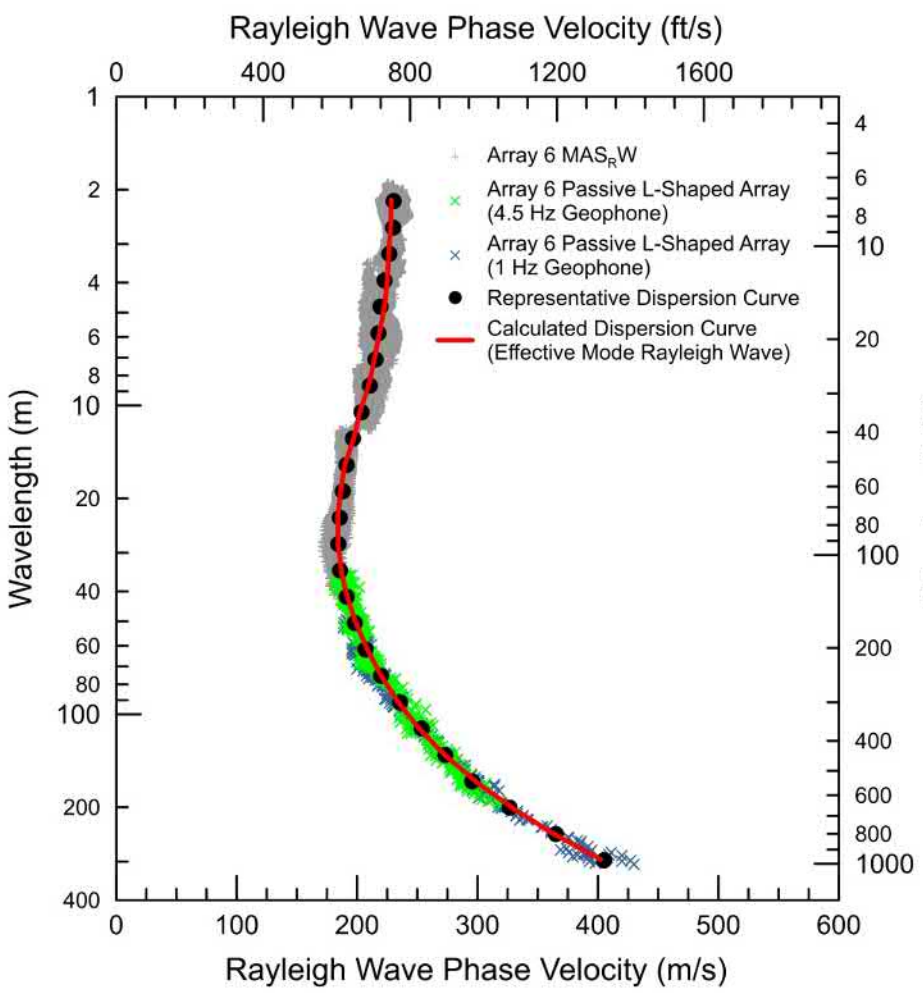


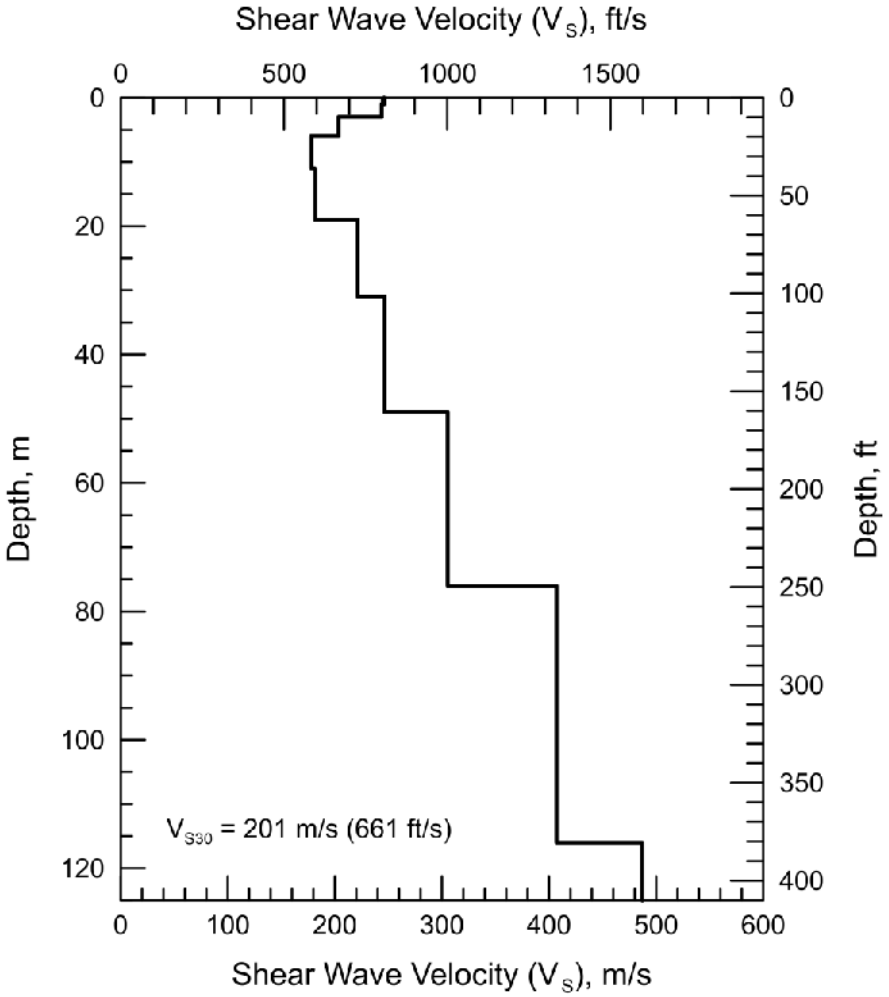
GEOVision geophysical services	FIGURE 5 SURFACE WAVE MODEL - ARRAY 4
Project No: 18369 Date: OCT 4, 2018 Drawn By: A MARTIN Approved By:	SALT LAKE CITY WATER RECLAMATION PLANT SALT LAKE CITY, UTAH
R:\GVProjects\2018\18369LCI\Report\Figure 5.cdr	PREPARED FOR LETTIS CONSULTANTS INTERNATIONAL



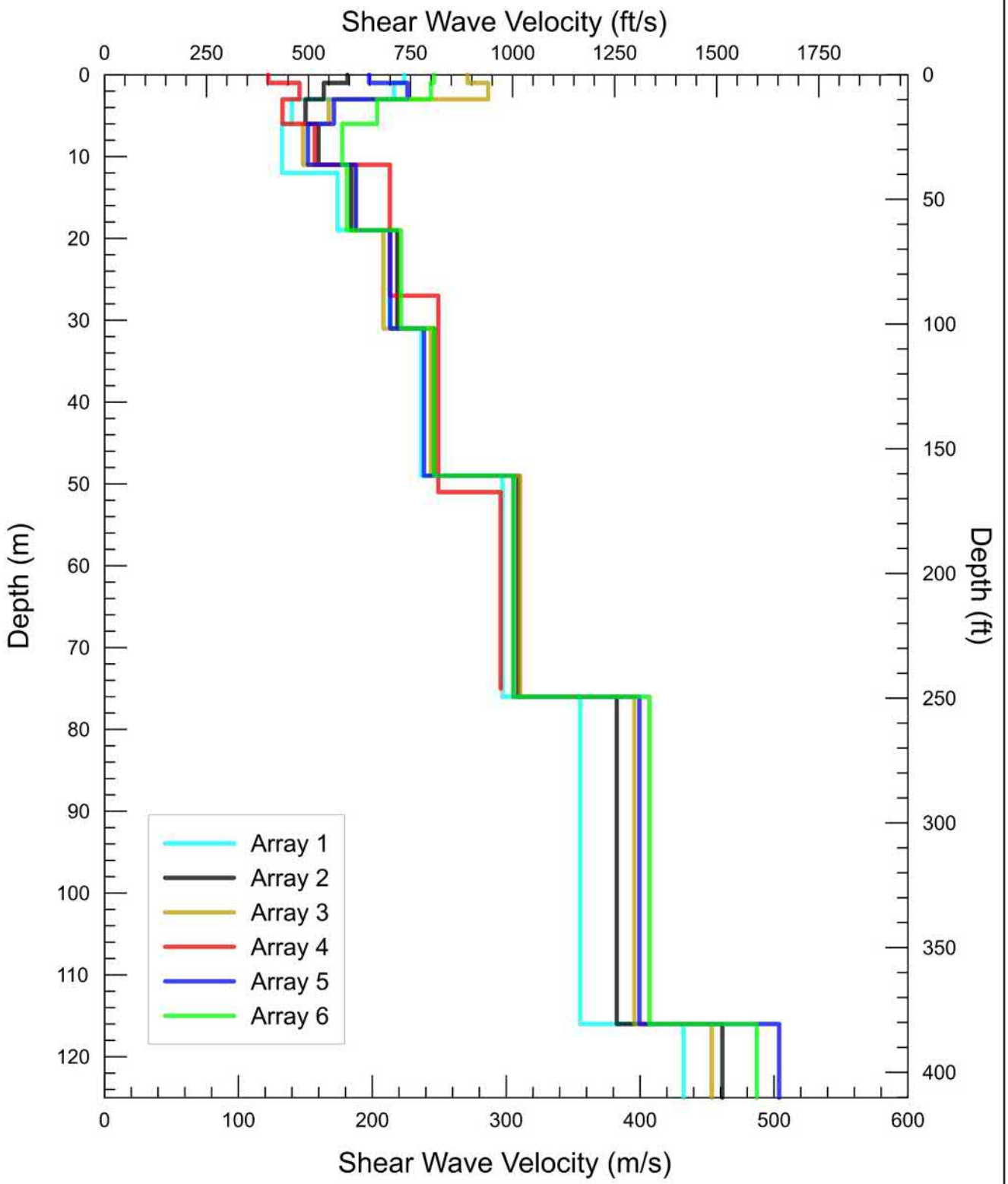


GEOVision geophysical services	FIGURE 6 SURFACE WAVE MODEL - ARRAY 5
Project No: 18369 Date: OCT 4, 2018 Drawn By: A MARTIN Approved By:	SALT LAKE CITY WATER RECLAMATION PLANT SALT LAKE CITY, UTAH
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GEOVision geophysical services	FIGURE 7 SURFACE WAVE MODEL - ARRAY 6
Project No: 18369 Date: OCT 4, 2018 Drawn By: A MARTIN Approved By:	SALT LAKE CITY WATER RECLAMATION PLANT SALT LAKE CITY, UTAH
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GEOVision geophysical services

Project No.: 18369	FIGURE 8 COMPARISON OF S-WAVE VELOCITY MODELS FOR SURFACE WAVE ARRAYS 1 TO 6
Date: OCT 8, 2018	SALT LAKE CITY WATER RECLAMATION PLANT SALT LAKE CITY, UTAH
Drawn By: A. MARTIN	
Approved By: A. MARTIN	PREPARED FOR LETTIS CONSULTANTS INTERNATIONAL
File P:\Project File\2018\18369LCI\Report\Figure 8.cdr	

Appendix E Laboratory Testing Results

Water Content and Unit Weight Test Results

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Waste Water Reclamation Facility
Date: 12/21/2018
By: EH/JP

Sample Info.	Boring No.	BH18-HP-1	BH18-HP-1	BH18-HP-1	BH18-HW-1	BH18-HW-1	BH18-HW-1	BH18-HW-1	BH18-PC-1
	Sample:	3	4	7	8	13	17	24	6
	Depth:	20'	25'	35'	49'	67'	85'	114'	39'
Unit Weight Info.	Sample height, H (in)		5.239	6.042	4.269	5.965	5.636	5.113	5.929
	Sample diameter, D (in)		2.837	2.738	2.774	2.769	2.843	2.775	2.813
	Sample volume, V (ft^3)		0.0192	0.0206	0.0149	0.0208	0.0207	0.0179	0.0213
	Mass rings + wet soil (g)		1736.57	931.94	1243.14	1114.25	1125.19	906.89	2264.13
	Mass rings/tare (g)		757.65	0.00	454.44	0.00	0.00	0.00	1182.58
	Moist soil, Ws (g)		978.92	931.94	788.70	1114.25	1125.19	906.89	1081.55
	Moist unit wt., γ_m (pcf)		112.61	99.80	116.46	118.17	119.81	111.72	111.82
Water Content	Wet soil + tare (g)	305.57	1107.02	303.58	473.61	1667.29	1432.81	1048.12	365.12
	Dry soil + tare (g)	275.25	841.67	235.31	382.59	1322.96	1144.90	776.48	319.21
	Tare (g)	152.70	139.85	122.53	126.95	407.89	312.08	140.51	225.11
Water Content, w (%)		**24.7**	**37.8**	**60.5**	**35.6**	**37.6**	**34.6**	**42.7**	**48.8**
Dry Unit Wt., γ_d (pcf)			**81.7**	**62.2**	**85.9**	**85.9**	**89.0**	**78.3**	**75.2**

Comments: Shelby tube labeled 115'

Entered by:_____

Reviewed:_____

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/5/2019
By: JDF

Sample Info.	Boring No.	BH19-ES-2	BH19-ES-2						
	Sample:	6	10						
	Depth:	20'	35'						
Unit Weight Info.	Sample height, H (in)	5.666	3.964						
	Sample diameter, D (in)	2.867	2.847						
	Sample volume, V (ft^3)	0.0212	0.0146						
	Mass rings + wet soil (g)	1863.02	685.03						
	Mass rings/tare (g)	757.39	0.00						
	Moist soil, Ws (g)	1105.63	685.03						
	Moist unit wt., γ_m (pcf)	115.15	103.42						
Water Content	Wet soil + tare (g)	1561.08	349.07						
	Dry soil + tare (g)	1265.16	304.42						
	Tare (g)	465.08	225.14						
Water Content, w (%)		**37.0**	**56.3**						
Dry Unit Wt., γ_d (pcf)		**84.1**	**66.2**						

Entered by:_____

Reviewed:_____

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

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Project: SLCWRF
No: 00100-015, 3G2 (XXIII)
Location: Salt Lake City, Utah
Date: 8/5/2021
By: RT/KB/JWB

Sample Info.	Boring No.	BH18-IT-5	BH18-IT-5	BH18-IT-5	BH18-IT-5	BH18-IT-5			
	Sample								
	Depth	10.0'	20.0'	30.0'	34.0'	40.0'			
	Split	No	No	No	No	No			
	Split sieve								
Total sample (g)									
Moist coarse fraction (g)									
Moist split fraction (g)									
Unit Weight Data	Sample height, H (in)	2.016	3.045	3.005	4.018				
	Sample diameter, D (in)	2.409	2.401	2.388	2.373				
	Mass rings + wet soil (g)	371.23	596.91	520.67	686.10				
	Mass rings/tare (g)	95.83	149.92	142.35	190.28				
	Moist unit wt., γ_m (pcf)	114.2	123.5	107.1	106.3				
	Wet soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Water Content Data	Wet soil + tare (g)	409.61	455.19	500.92	484.85	1208.55			
	Dry soil + tare (g)	347.95	400.39	382.05	390.57	1073.21			
	Tare (g)	124.42	120.72	124.51	151.64	408.75			
	Water content (%)	27.6	19.6	46.2	39.5	20.4			
Water Content, w (%)		**27.6**	**19.6**	**46.2**	**39.5**	**20.4**			
Dry Unit Wt., γ_d (pcf)		**89.5**	**103.3**	**73.3**	**76.2**				

Entered by:_____
Reviewed:_____

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/9/2019
By: JP

Sample Info.	Boring No.	BH19-ITW-4	BH19-ITW-4	BH19-ITW-4	BH19-ITW-4	BH19-ITW-4	BH19-ITW-4	BH19-ITW-2	BH19-ITW-2
	Sample:								
	Depth:	12.5'	15.0'	17.0'	20.0'	22.0'	25.0'	12.5'	15.0'
Unit Weight Info.	Sample height, H (in)								
	Sample diameter, D (in)								
	Sample volume, V (ft^3)								
	Mass rings + wet soil (g)								
	Mass rings/tare (g)								
	Moist soil, Ws (g)								
	Moist unit wt., γ_m (pcf)								
Water Content	Wet soil + tare (g)	313.74	436.63	320.46	970.18	305.00	440.82	421.96	218.31
	Dry soil + tare (g)	245.05	381.66	279.64	824.76	242.47	324.00	336.38	184.58
	Tare (g)	120.17	221.94	180.29	333.16	122.10	140.31	126.82	121.49
Water Content, w (%)		**55.0**	**34.4**	**41.1**	**29.6**	**51.9**	**63.6**	**40.8**	**53.5**
Dry Unit Wt., γ_d (pcf)									

Entered by:_____
Reviewed:_____

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/9/2019
By: JP

Sample Info.	Boring No.	BH19-ITW-2	BH19-ITW-2	BH19-ITW-2	BH19-IT-6	BH19-IT-6			
	Sample:								
	Depth:	17.0'	22.0'	25.0'	15.0'	20.0'			
Unit Weight Info.	Sample height, H (in)								
	Sample diameter, D (in)								
	Sample volume, V (ft^3)								
	Mass rings + wet soil (g)								
	Mass rings/tare (g)								
	Moist soil, Ws (g)								
	Moist unit wt., γ_m (pcf)								
Water Content	Wet soil + tare (g)	328.24	346.81	388.99	311.31	454.38			
	Dry soil + tare (g)	263.10	296.20	316.09	254.59	354.55			
	Tare (g)	126.91	177.30	215.02	123.69	151.74			
Water Content, w (%)		**47.8**	**42.6**	**72.1**	**43.3**	**49.2**			
Dry Unit Wt., γ_d (pcf)									

Comments: Bag containing test specimen was not completely closed upon receipt

Entered by:_____

Reviewed:_____

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/9/2021
By: EH/BSS

Sample Info.	Boring No.	B21-OIPS-01	B21-OIPS-02	B21-OIPS-05	B21-OIPS-06	B21-OIPS-07	B21-OIPS-07	B21-OIPS-08	B21-OIPS-09
	Sample	6	9	13	7	2	19	13	18
	Depth	28'	44'	65'	28'	10'	96'	64'	95'
	Split	No	No	No	No	No	No	No	No
	Split sieve								
	Total sample (g)								
	Moist coarse fraction (g)								
	Moist split fraction (g)								
Unit Weight Data	Sample height, H (in)	6.003	5.716	6.009	6.008	6.001	5.992	5.966	5.718
	Sample diameter, D (in)	2.860	2.855	2.388	2.858	2.851	2.869	2.869	2.855
	Mass rings + wet soil (g)	1101.49	1388.24	1003.97	1086.77	1400.36	1118.37	1120.93	1407.61
	Mass rings/tare (g)	0.00	281.11	214.41	0.00	281.11	0.00	0.00	281.11
	Moist unit wt., γ_m (pcf)	108.8	115.3	111.8	107.4	111.3	110.0	110.7	117.2
	Wet soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Water Content Data	Wet soil + tare (g)	690.86	386.84	567.25	345.37	347.04	329.05	337.78	341.60
	Dry soil + tare (g)	500.15	317.38	451.43	267.86	277.76	267.91	271.59	286.63
	Tare (g)	126.87	128.42	226.59	122.35	122.67	124.68	122.43	128.47
	Water content (%)	51.1	36.8	51.5	53.3	44.7	42.7	44.4	34.8
Water Content, w (%)		**51.1**	**36.8**	**51.5**	**53.3**	**44.7**	**42.7**	**44.4**	**34.8**
Dry Unit Wt., γ_d (pcf)		**72.0**	**84.3**	**73.8**	**70.1**	**76.9**	**77.1**	**76.7**	**87.0**

Entered by:_____
Reviewed:_____

Atterberg Limits Test Results

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 12/17/2018
By: BRR

Boring No.: BH18-PC-1
Sample: 6
Depth: 39'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.10
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 48.8

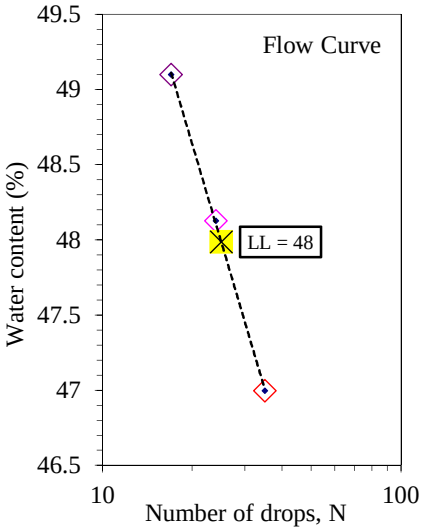
Plastic Limit

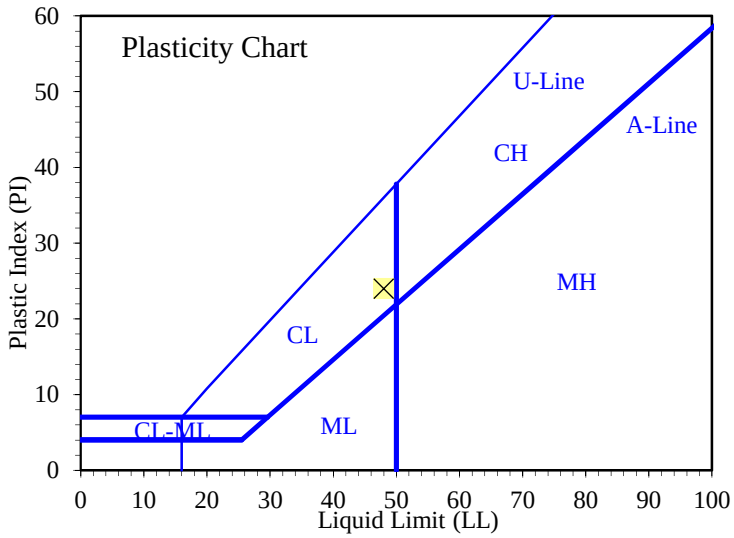
Determination No	1	2				
Wet Soil + Tare (g)	14.94	14.81				
Dry Soil + Tare (g)	13.43	13.32				
Water Loss (g)	1.51	1.49				
Tare (g)	7.04	7.10				
Dry Soil (g)	6.39	6.22				
Water Content, w (%)	23.63	23.95				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	24	17			
Wet Soil + Tare (g)	15.10	14.15	14.87			
Dry Soil + Tare (g)	12.52	11.84	12.42			
Water Loss (g)	2.58	2.31	2.45			
Tare (g)	7.03	7.04	7.43			
Dry Soil (g)	5.49	4.80	4.99			
Water Content, w (%)	46.99	48.13	49.10			
One-Point LL (%)		48				

Liquid Limit, LL (%)	**48**
Plastic Limit, PL (%)	**24**
Plasticity Index, PI (%)	**24**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 12/6/2018
By: BRR

Boring No.: BH18-PC-1
Sample: 10A
Depth: 55'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.20
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

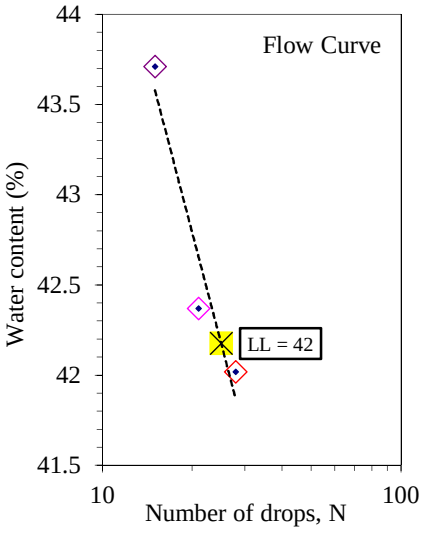
Plastic Limit

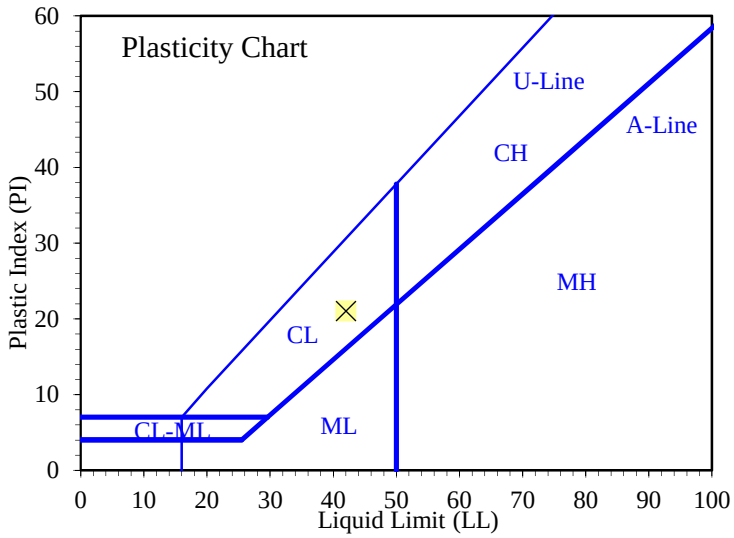
Determination No	1	2				
Wet Soil + Tare (g)	13.03	13.98				
Dry Soil + Tare (g)	11.87	12.77				
Water Loss (g)	1.16	1.21				
Tare (g)	6.43	7.07				
Dry Soil (g)	5.44	5.70				
Water Content, w (%)	21.32	21.23				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	21	15			
Wet Soil + Tare (g)	13.91	16.16	15.96			
Dry Soil + Tare (g)	11.91	13.44	13.25			
Water Loss (g)	2.00	2.72	2.71			
Tare (g)	7.15	7.02	7.05			
Dry Soil (g)	4.76	6.42	6.20			
Water Content, w (%)	42.02	42.37	43.71			
One-Point LL (%)	43	41				

Liquid Limit, LL (%)	**42**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**21**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 12/7/2018
By: BRR

Boring No.: BH18-PC-1
Sample: 16B
Depth: 85'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.10
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): Not requested

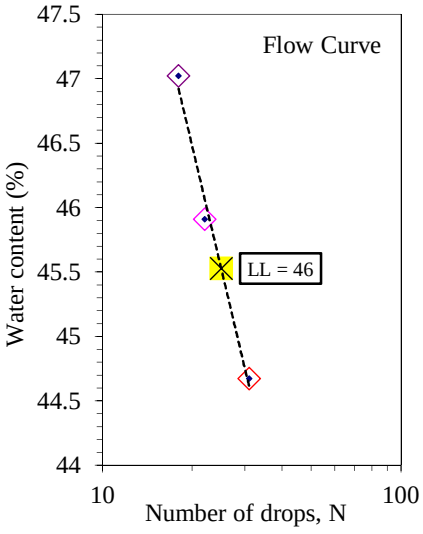
Plastic Limit

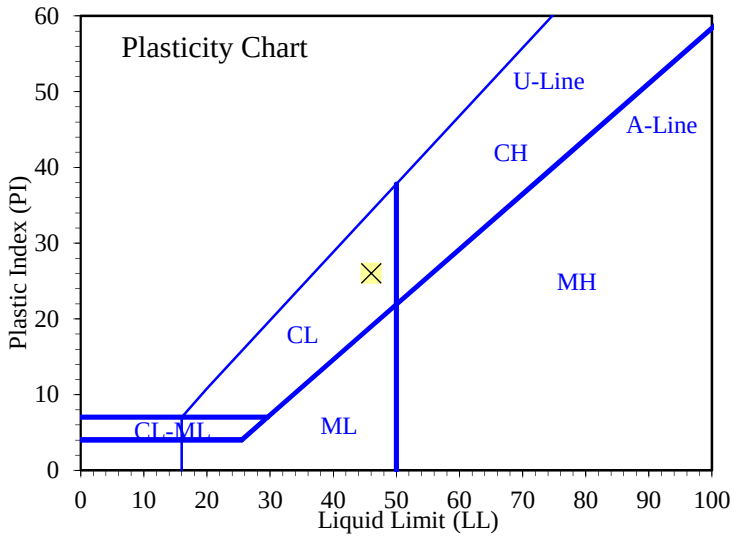
Determination No	1	2				
Wet Soil + Tare (g)	14.06	13.64				
Dry Soil + Tare (g)	12.87	12.53				
Water Loss (g)	1.19	1.11				
Tare (g)	7.07	7.04				
Dry Soil (g)	5.80	5.49				
Water Content, w (%)	20.52	20.22				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	31	22	18			
Wet Soil + Tare (g)	14.80	14.61	14.23			
Dry Soil + Tare (g)	12.41	12.31	11.94			
Water Loss (g)	2.39	2.30	2.29			
Tare (g)	7.06	7.30	7.07			
Dry Soil (g)	5.35	5.01	4.87			
Water Content, w (%)	44.67	45.91	47.02			
One-Point LL (%)		45				

Liquid Limit, LL (%)	**46**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**26**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 12/11/2018
By: BRR

Boring No.: BH18-PC-1
Sample: 21
Depth: 110'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.40
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

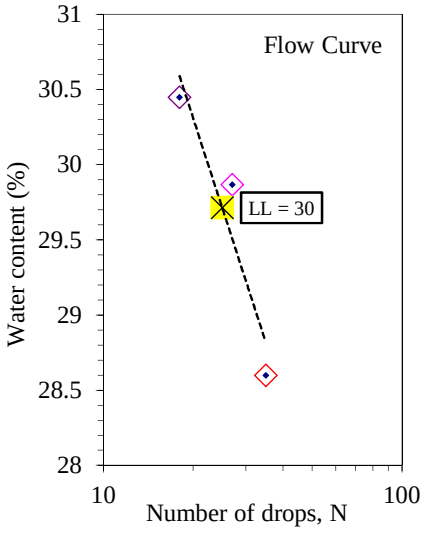
Plastic Limit

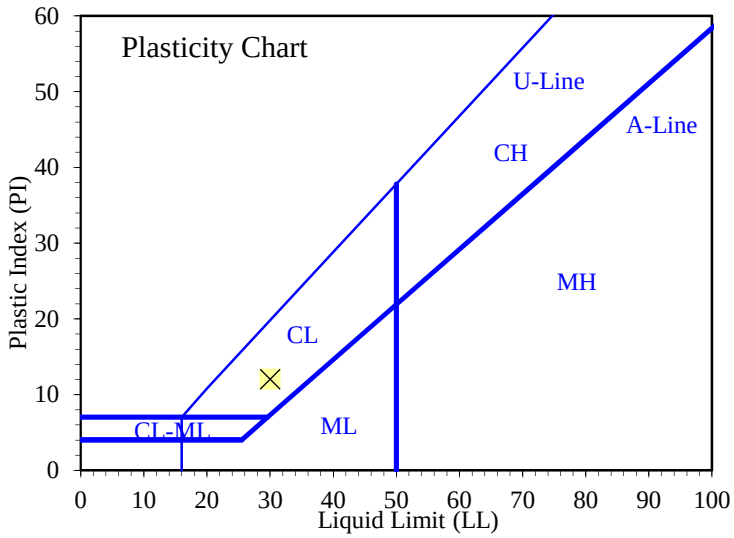
Determination No	1	2				
Wet Soil + Tare (g)	13.96	15.08				
Dry Soil + Tare (g)	12.91	13.84				
Water Loss (g)	1.05	1.24				
Tare (g)	7.07	7.06				
Dry Soil (g)	5.84	6.78				
Water Content, w (%)	17.98	18.29				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	27	18			
Wet Soil + Tare (g)	14.25	14.06	15.84			
Dry Soil + Tare (g)	12.70	12.51	13.80			
Water Loss (g)	1.55	1.55	2.04			
Tare (g)	7.28	7.32	7.10			
Dry Soil (g)	5.42	5.19	6.70			
Water Content, w (%)	28.60	29.87	30.45			
One-Point LL (%)		30				

Liquid Limit, LL (%)	**30**
Plastic Limit, PL (%)	**18**
Plasticity Index, PI (%)	**12**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 12/11/2018
By: BRR

Boring No.: BH18-PC-1
Sample: 23
Depth: 120'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.40
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

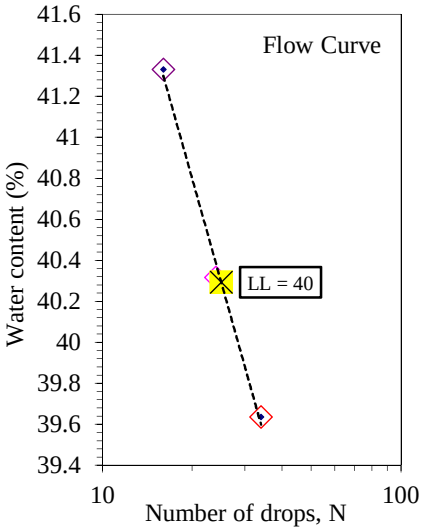
Plastic Limit

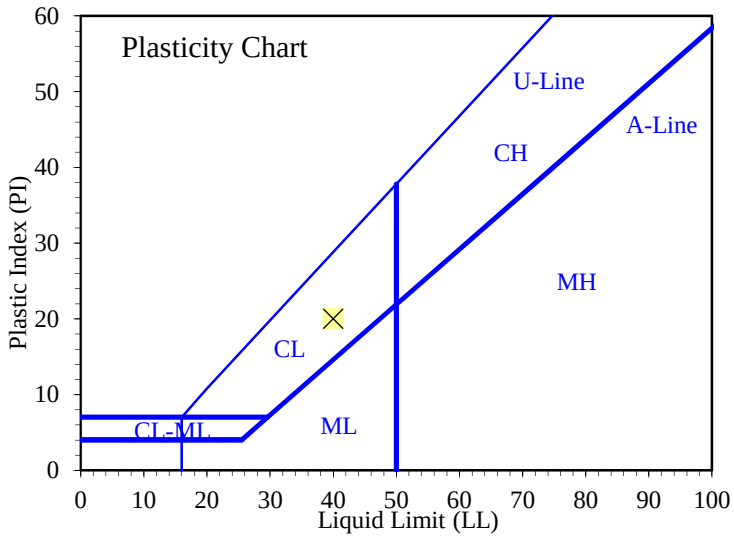
Determination No	1	2				
Wet Soil + Tare (g)	14.99	14.82				
Dry Soil + Tare (g)	13.64	13.51				
Water Loss (g)	1.35	1.31				
Tare (g)	7.05	7.10				
Dry Soil (g)	6.59	6.41				
Water Content, w (%)	20.49	20.44				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	24	16			
Wet Soil + Tare (g)	15.75	14.20	15.16			
Dry Soil + Tare (g)	13.36	12.16	12.80			
Water Loss (g)	2.39	2.04	2.36			
Tare (g)	7.33	7.10	7.09			
Dry Soil (g)	6.03	5.06	5.71			
Water Content, w (%)	39.64	40.32	41.33			
One-Point LL (%)		40				

Liquid Limit, LL (%)	**40**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**20**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/1/2019
By: BRR

Boring No.: BH19-ES-1
Sample: 3
Depth: 13'
Description: Brown elastic silt

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: By hand
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

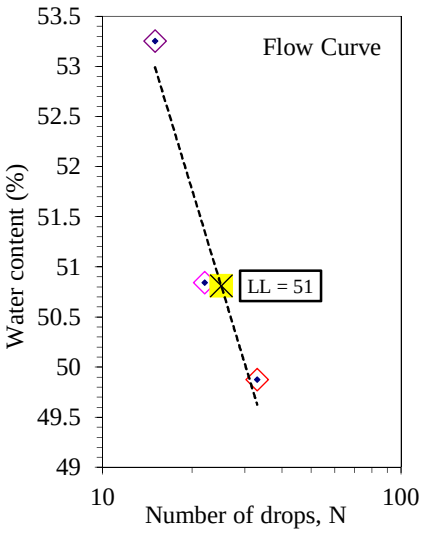
Plastic Limit

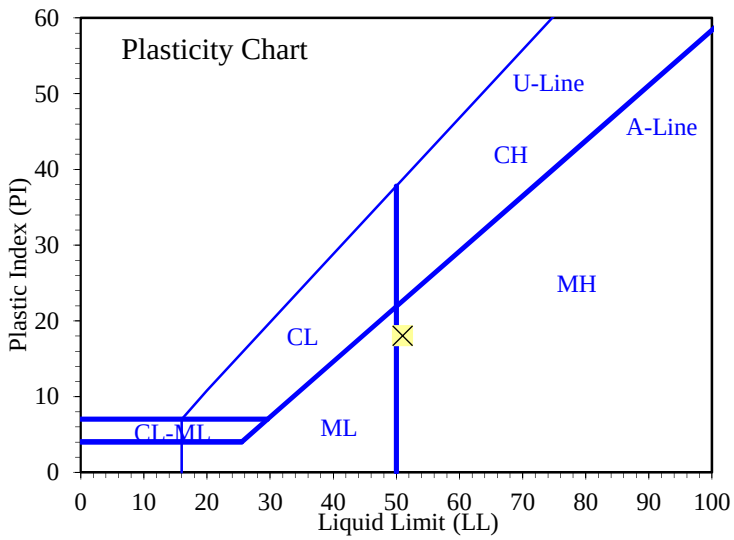
Determination No	1	2				
Wet Soil + Tare (g)	13.99	13.20				
Dry Soil + Tare (g)	12.39	11.68				
Water Loss (g)	1.60	1.52				
Tare (g)	7.54	7.07				
Dry Soil (g)	4.85	4.61				
Water Content, w (%)	32.99	32.97				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	22	15			
Wet Soil + Tare (g)	12.93	15.99	13.82			
Dry Soil + Tare (g)	10.97	12.97	11.61			
Water Loss (g)	1.96	3.02	2.21			
Tare (g)	7.04	7.03	7.46			
Dry Soil (g)	3.93	5.94	4.15			
Water Content, w (%)	49.87	50.84	53.25			
One-Point LL (%)		50				

Liquid Limit, LL (%)	**51**
Plastic Limit, PL (%)	**33**
Plasticity Index, PI (%)	**18**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/1/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ES-1
Sample: 5
Depth: 17'
Description: Brown silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: 3/8"
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

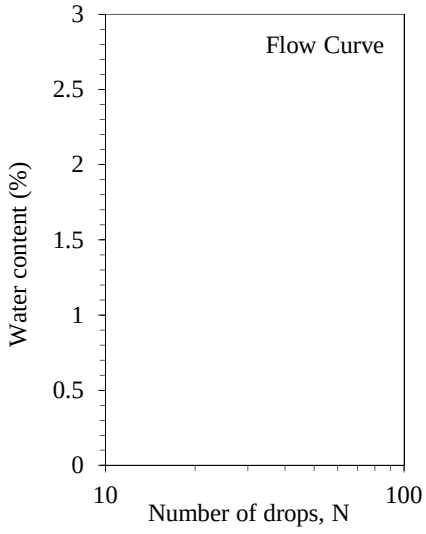
Plastic Limit

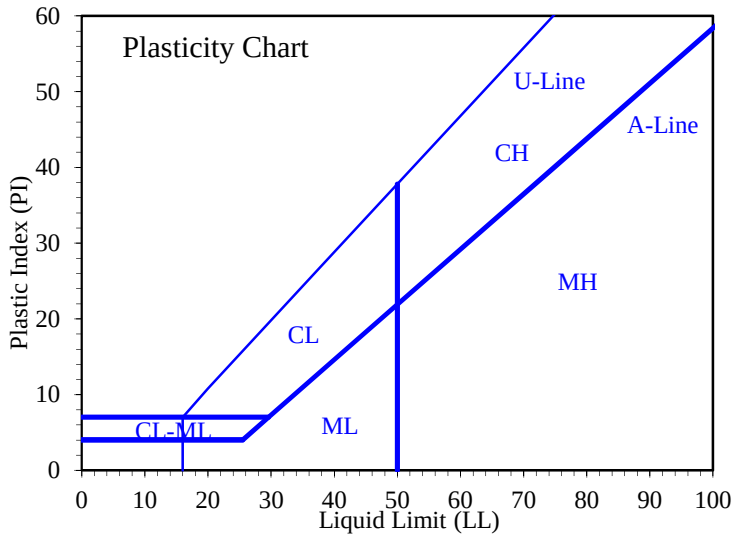
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 7/31/2019
By: BRR

Boring No.: BH19-ES-1
Sample: 7
Depth: 20'
Description: Brown lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.40
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

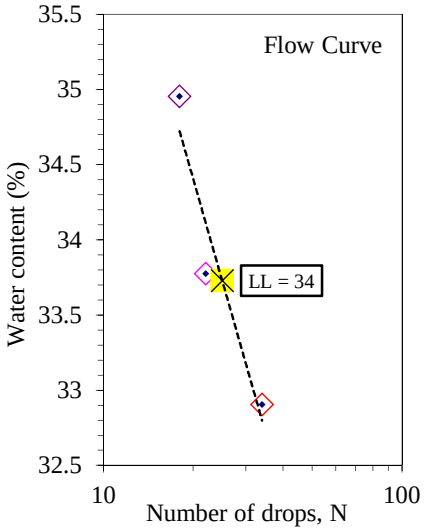
Plastic Limit

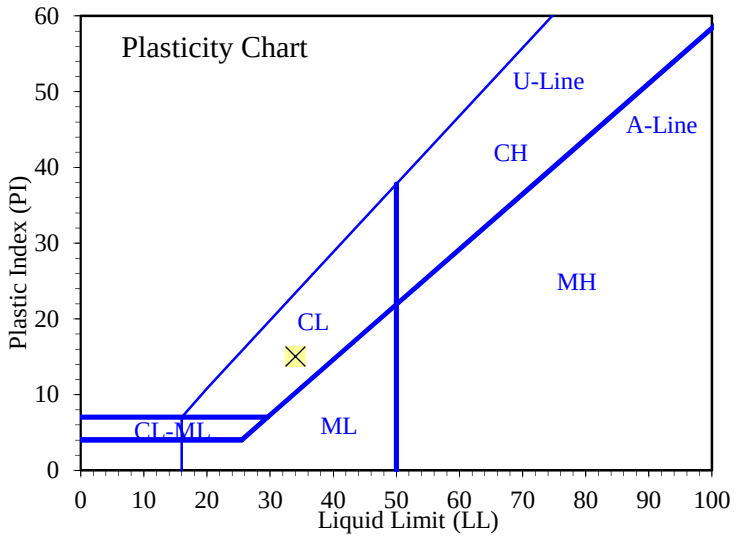
Determination No	1	2				
Wet Soil + Tare (g)	13.32	14.91				
Dry Soil + Tare (g)	12.33	13.72				
Water Loss (g)	0.99	1.19				
Tare (g)	7.08	7.46				
Dry Soil (g)	5.25	6.26				
Water Content, w (%)	18.86	19.01				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	22	18			
Wet Soil + Tare (g)	14.55	15.20	15.97			
Dry Soil + Tare (g)	12.76	13.16	13.74			
Water Loss (g)	1.79	2.04	2.23			
Tare (g)	7.32	7.12	7.36			
Dry Soil (g)	5.44	6.04	6.38			
Water Content, w (%)	32.90	33.77	34.95			
One-Point LL (%)		33				

Liquid Limit, LL (%)	**34**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**15**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ES-1
Sample: 8B
Depth: 24'
Description: Grey silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.20
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

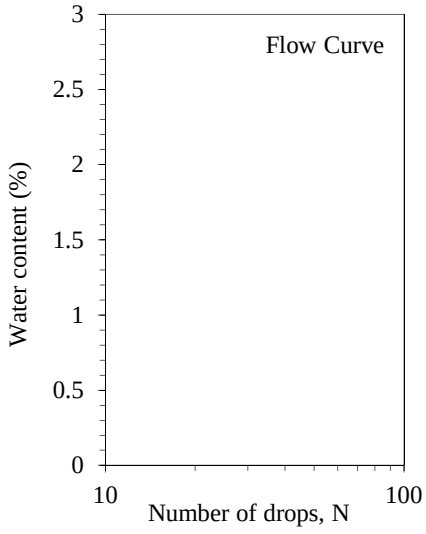
Plastic Limit

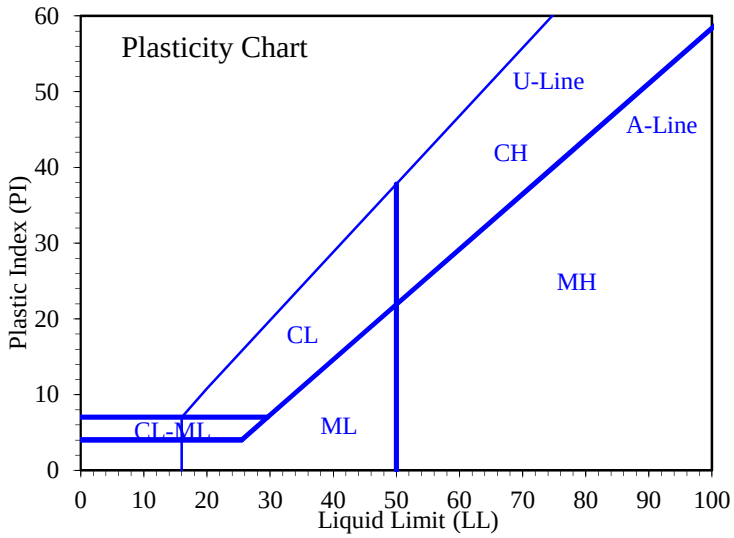
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/1/2019
By: BRR

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'
Description: Grey fat clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.40
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

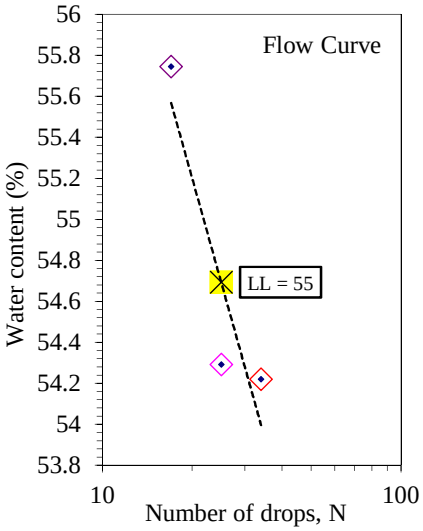
Plastic Limit

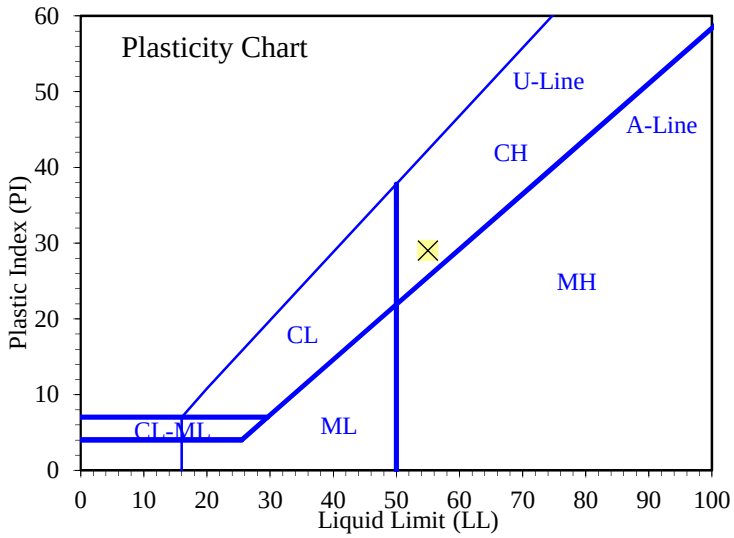
Determination No	1	2				
Wet Soil + Tare (g)	14.12	14.62				
Dry Soil + Tare (g)	12.69	13.16				
Water Loss (g)	1.43	1.46				
Tare (g)	7.10	7.42				
Dry Soil (g)	5.59	5.74				
Water Content, w (%)	25.58	25.44				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	25	17			
Wet Soil + Tare (g)	16.17	15.36	14.37			
Dry Soil + Tare (g)	13.15	12.45	11.75			
Water Loss (g)	3.02	2.91	2.62			
Tare (g)	7.58	7.09	7.05			
Dry Soil (g)	5.57	5.36	4.70			
Water Content, w (%)	54.22	54.29	55.74			
One-Point LL (%)		54				

Liquid Limit, LL (%)	**55**
Plastic Limit, PL (%)	**26**
Plasticity Index, PI (%)	**29**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/1/2019
By: BRR

Boring No.: BH19-ES-1
Sample: 15
Depth: 55'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: By hand
Approximate maximum grain size: No.4
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

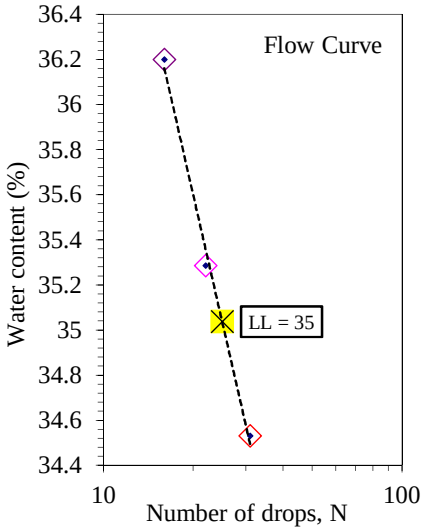
Plastic Limit

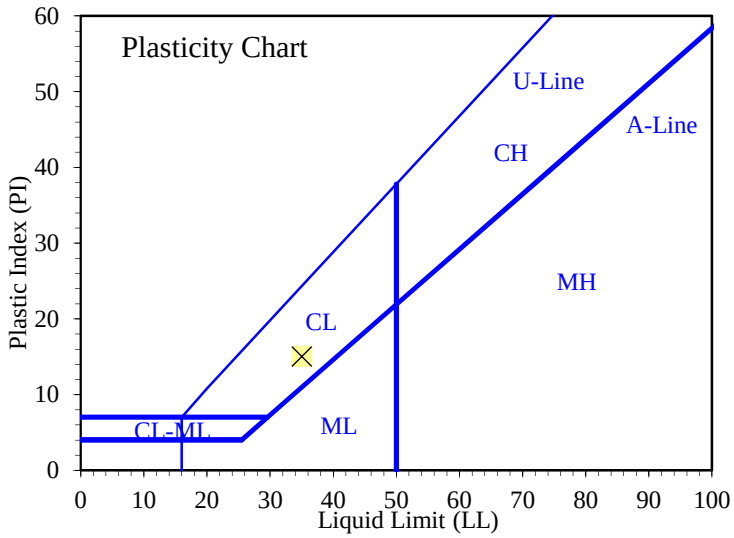
Determination No	1	2				
Wet Soil + Tare (g)	14.17	14.52				
Dry Soil + Tare (g)	12.98	13.27				
Water Loss (g)	1.19	1.25				
Tare (g)	7.07	7.06				
Dry Soil (g)	5.91	6.21				
Water Content, w (%)	20.14	20.13				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	31	22	16			
Wet Soil + Tare (g)	15.33	15.14	15.28			
Dry Soil + Tare (g)	13.31	13.03	13.09			
Water Loss (g)	2.02	2.11	2.19			
Tare (g)	7.46	7.05	7.04			
Dry Soil (g)	5.85	5.98	6.05			
Water Content, w (%)	34.53	35.28	36.20			
One-Point LL (%)		35				

Liquid Limit, LL (%)	**35**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**15**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: BRR

Boring No.: BH19-ES-1
Sample: 18
Depth: 70'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Mixed on glass plate
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

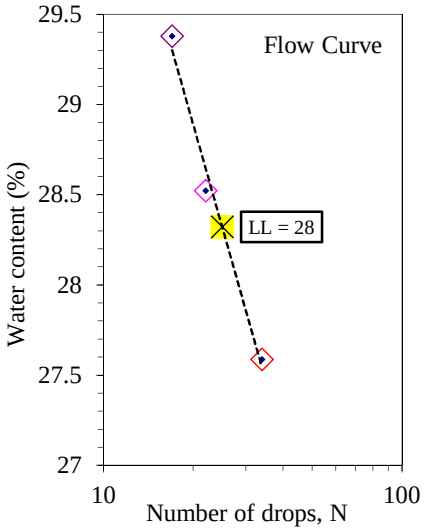
Plastic Limit

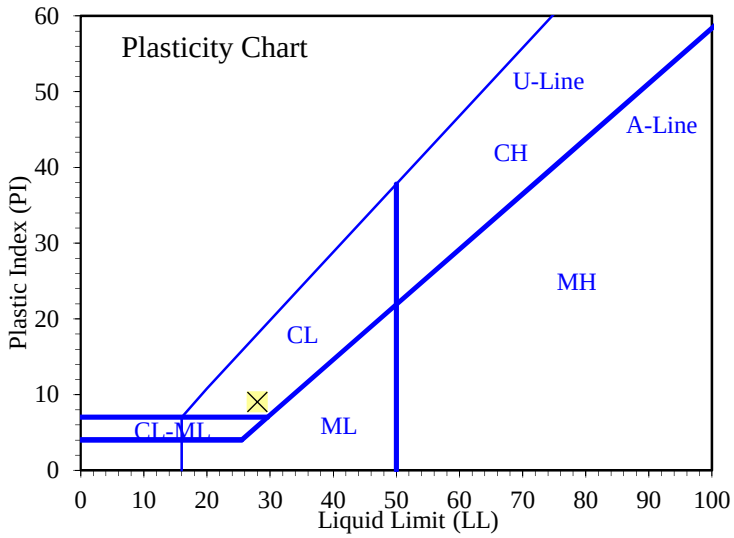
Determination No	1	2				
Wet Soil + Tare (g)	14.88	13.46				
Dry Soil + Tare (g)	13.63	12.42				
Water Loss (g)	1.25	1.04				
Tare (g)	7.13	7.04				
Dry Soil (g)	6.50	5.38				
Water Content, w (%)	19.23	19.33				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	22	17			
Wet Soil + Tare (g)	13.38	15.02	14.50			
Dry Soil + Tare (g)	12.10	13.42	12.94			
Water Loss (g)	1.28	1.60	1.56			
Tare (g)	7.46	7.81	7.63			
Dry Soil (g)	4.64	5.61	5.31			
Water Content, w (%)	27.59	28.52	29.38			
One-Point LL (%)		28				

Liquid Limit, LL (%)	**28**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**9**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/1/2019
By: BRR

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: By hand
Approximate maximum grain size: No.20
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

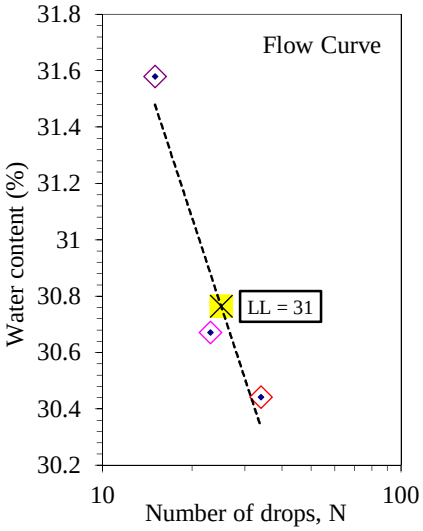
Plastic Limit

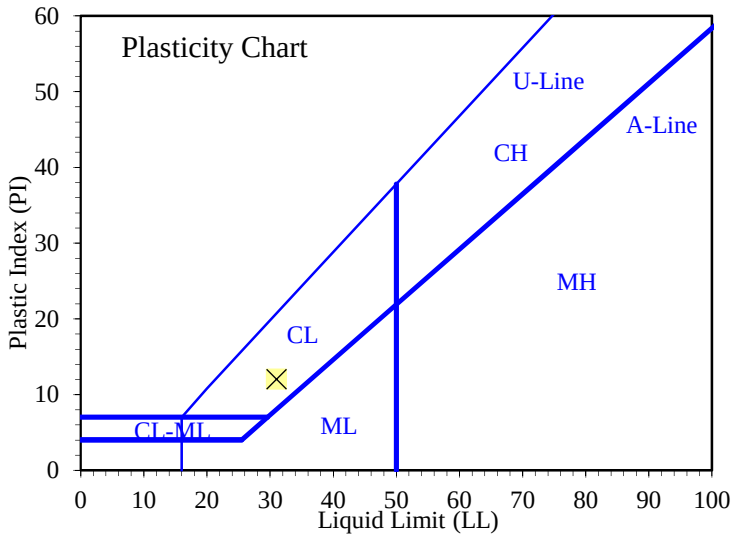
Determination No	1	2				
Wet Soil + Tare (g)	13.46	14.99				
Dry Soil + Tare (g)	12.47	13.81				
Water Loss (g)	0.99	1.18				
Tare (g)	7.06	7.51				
Dry Soil (g)	5.41	6.30				
Water Content, w (%)	18.30	18.73				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	23	15			
Wet Soil + Tare (g)	15.34	15.22	15.29			
Dry Soil + Tare (g)	13.41	13.30	13.37			
Water Loss (g)	1.93	1.92	1.92			
Tare (g)	7.07	7.04	7.29			
Dry Soil (g)	6.34	6.26	6.08			
Water Content, w (%)	30.44	30.67	31.58			
One-Point LL (%)		30				

Liquid Limit, LL (%)	**31**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**12**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 7/31/2019
By: BRR

Boring No.: BH19-ES-1
Sample: 24
Depth: 100'
Description: Grey fat clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.40
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

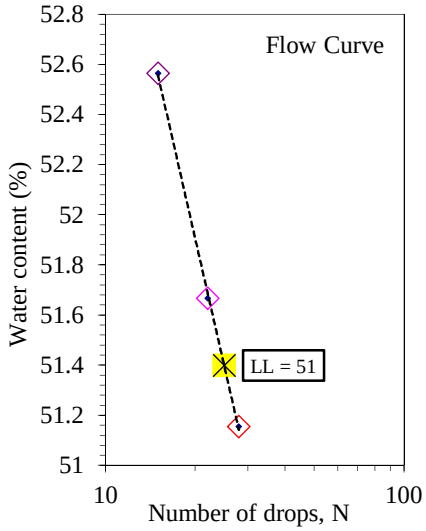
Plastic Limit

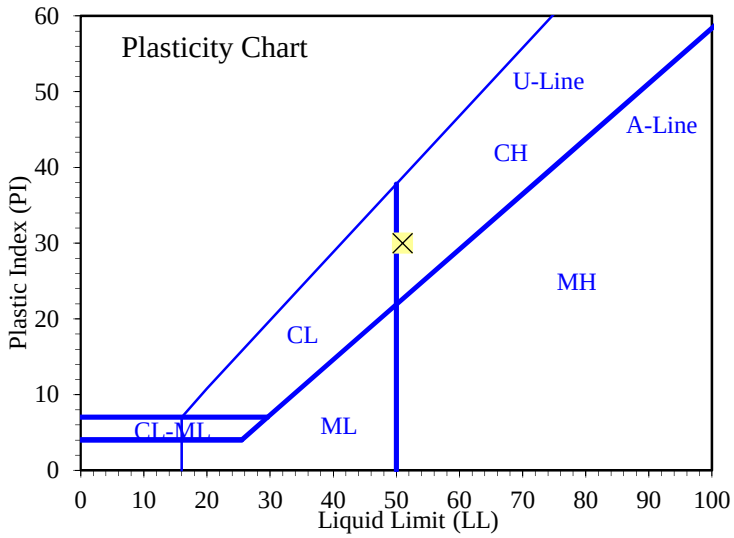
Determination No	1	2				
Wet Soil + Tare (g)	15.13	14.00				
Dry Soil + Tare (g)	13.81	12.81				
Water Loss (g)	1.32	1.19				
Tare (g)	7.49	7.13				
Dry Soil (g)	6.32	5.68				
Water Content, w (%)	20.89	20.95				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	22	15			
Wet Soil + Tare (g)	14.92	14.42	14.95			
Dry Soil + Tare (g)	12.26	11.94	12.49			
Water Loss (g)	2.66	2.48	2.46			
Tare (g)	7.06	7.14	7.81			
Dry Soil (g)	5.20	4.80	4.68			
Water Content, w (%)	51.15	51.67	52.56			
One-Point LL (%)	52	51				

Liquid Limit, LL (%)	**51**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**30**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: BRR

Boring No.: BH19-ES-2
Sample: 2B
Depth: 11'
Description: Brown/grey elastic silt

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.40
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

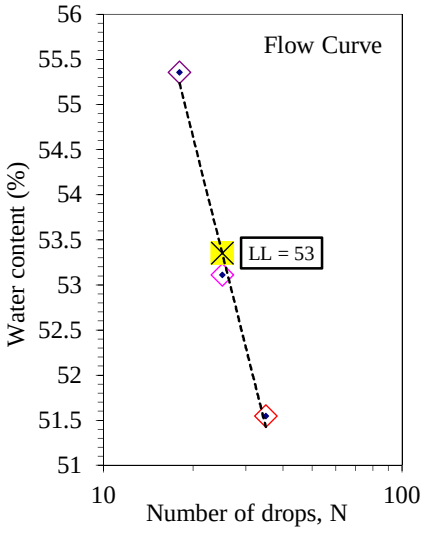
Plastic Limit

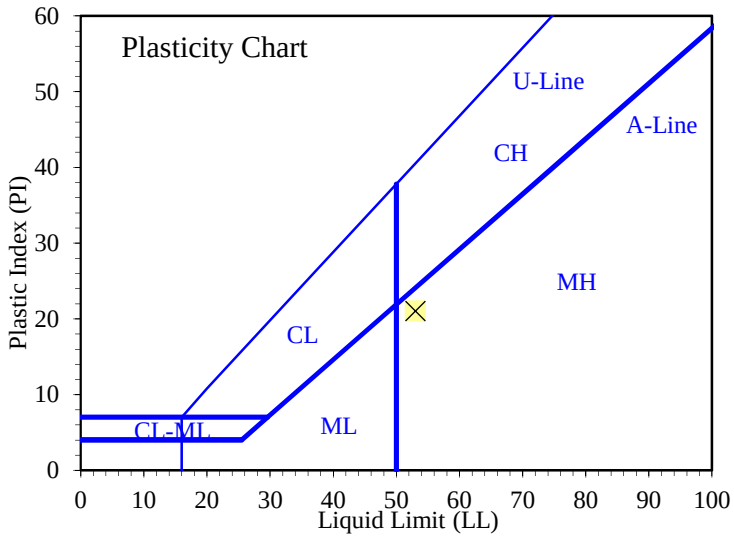
Determination No	1	2				
Wet Soil + Tare (g)	14.30	13.98				
Dry Soil + Tare (g)	12.62	12.38				
Water Loss (g)	1.68	1.60				
Tare (g)	7.38	7.38				
Dry Soil (g)	5.24	5.00				
Water Content, w (%)	32.06	32.00				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	25	18			
Wet Soil + Tare (g)	13.50	13.92	15.44			
Dry Soil + Tare (g)	11.33	11.70	12.65			
Water Loss (g)	2.17	2.22	2.79			
Tare (g)	7.12	7.52	7.61			
Dry Soil (g)	4.21	4.18	5.04			
Water Content, w (%)	51.54	53.11	55.36			
One-Point LL (%)		53				

Liquid Limit, LL (%)	**53**
Plastic Limit, PL (%)	**32**
Plasticity Index, PI (%)	**21**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/1/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ES-2
Sample: 3B
Depth: 13'
Description: Brown silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

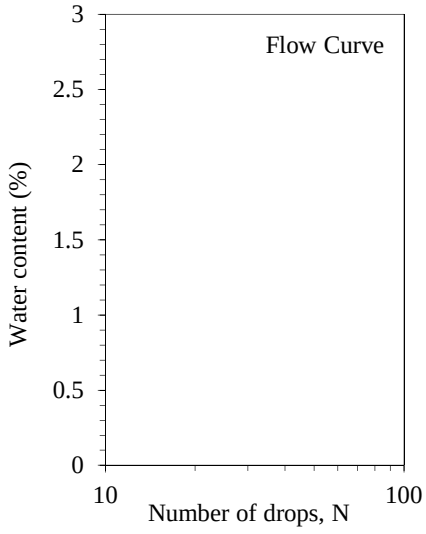
Plastic Limit

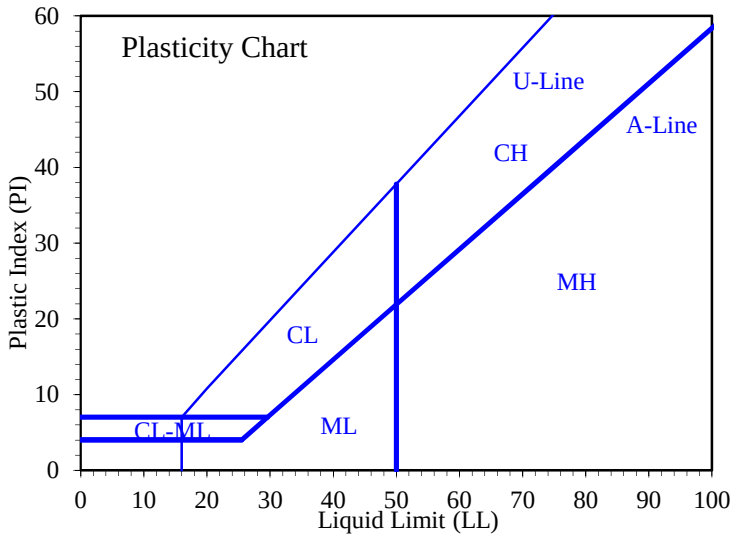
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: BRR

Boring No.: BH19-ES-2
Sample: 6b
Depth: 20'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

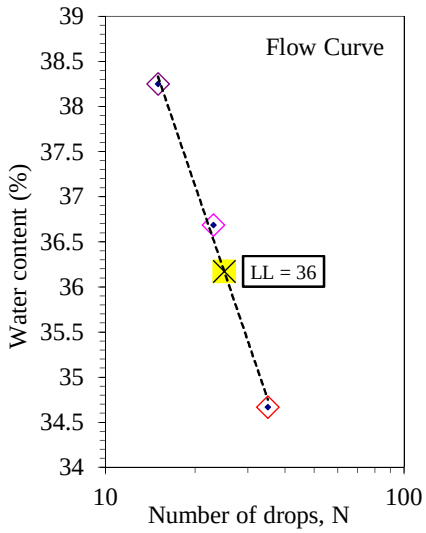
Plastic Limit

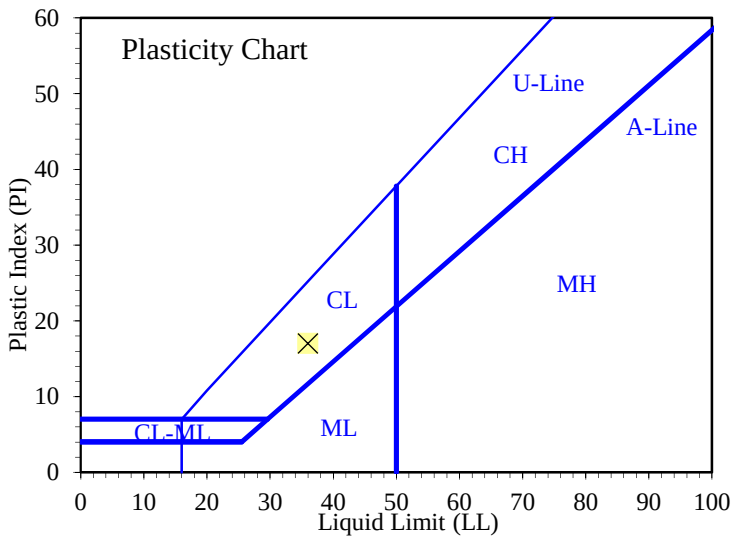
Determination No	1	2				
Wet Soil + Tare (g)	15.33	13.66				
Dry Soil + Tare (g)	14.11	12.61				
Water Loss (g)	1.22	1.05				
Tare (g)	7.63	7.05				
Dry Soil (g)	6.48	5.56				
Water Content, w (%)	18.83	18.88				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	23	15			
Wet Soil + Tare (g)	15.43	15.48	15.47			
Dry Soil + Tare (g)	13.35	13.40	13.24			
Water Loss (g)	2.08	2.08	2.23			
Tare (g)	7.35	7.73	7.41			
Dry Soil (g)	6.00	5.67	5.83			
Water Content, w (%)	34.67	36.68	38.25			
One-Point LL (%)		36				

Liquid Limit, LL (%)	**36**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**17**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: BRR

Boring No.: BH19-ES-2
Sample: 7C
Depth: 23'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

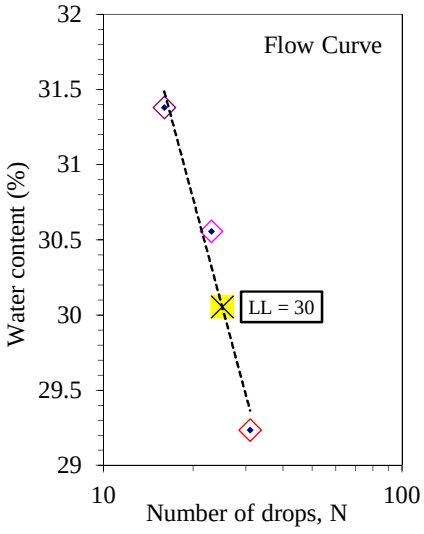
Plastic Limit

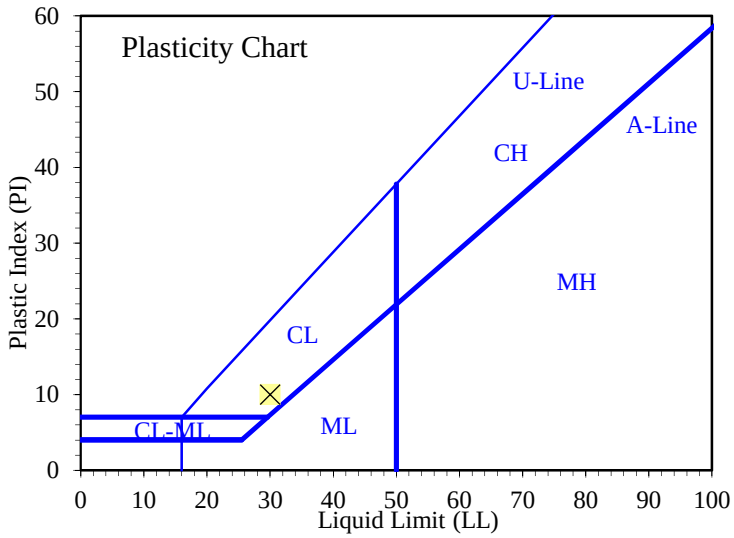
Determination No	1	2				
Wet Soil + Tare (g)	13.80	13.92				
Dry Soil + Tare (g)	12.66	12.76				
Water Loss (g)	1.14	1.16				
Tare (g)	7.07	7.08				
Dry Soil (g)	5.59	5.68				
Water Content, w (%)	20.39	20.42				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	31	23	16			
Wet Soil + Tare (g)	13.47	15.28	15.02			
Dry Soil + Tare (g)	12.02	13.52	13.20			
Water Loss (g)	1.45	1.76	1.82			
Tare (g)	7.06	7.76	7.40			
Dry Soil (g)	4.96	5.76	5.80			
Water Content, w (%)	29.23	30.56	31.38			
One-Point LL (%)		30				

Liquid Limit, LL (%)	**30**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**10**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: BRR

Boring No.: BH19-ES-2
Sample: 10
Depth: 35'
Description: Grey fat clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.40
Estimated percent retained on No.40: Not requested
As-received water content (%): 56.3

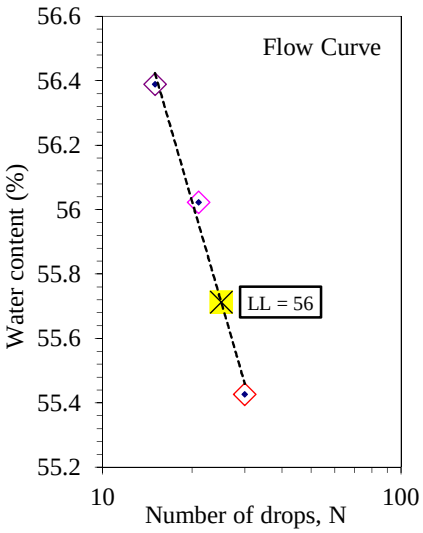
Plastic Limit

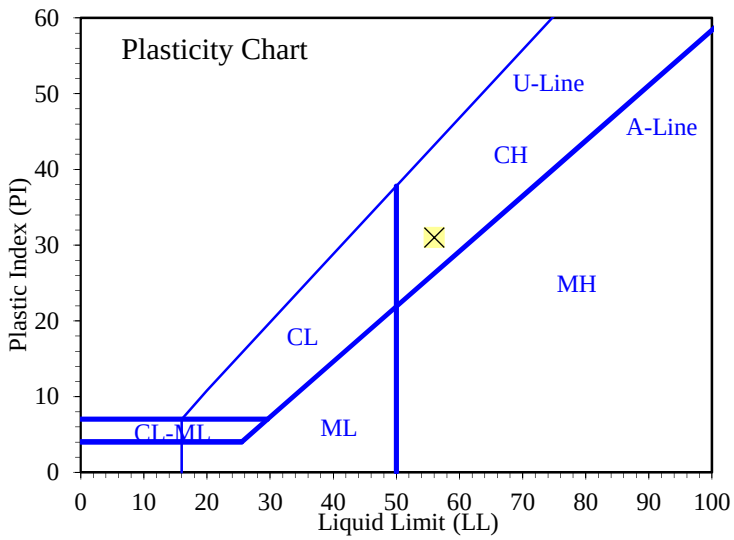
Determination No	1	2				
Wet Soil + Tare (g)	13.66	13.72				
Dry Soil + Tare (g)	12.33	12.38				
Water Loss (g)	1.33	1.34				
Tare (g)	7.06	7.09				
Dry Soil (g)	5.27	5.29				
Water Content, w (%)	25.24	25.33				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	30	21	15			
Wet Soil + Tare (g)	15.07	16.39	13.10			
Dry Soil + Tare (g)	12.21	13.32	11.07			
Water Loss (g)	2.86	3.07	2.03			
Tare (g)	7.05	7.84	7.47			
Dry Soil (g)	5.16	5.48	3.60			
Water Content, w (%)	55.43	56.02	56.39			
One-Point LL (%)	57	55				

Liquid Limit, LL (%)	**56**
Plastic Limit, PL (%)	**25**
Plasticity Index, PI (%)	**31**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: BRR

Boring No.: BH19-ES-2
Sample: 14
Depth: 55'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.40
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

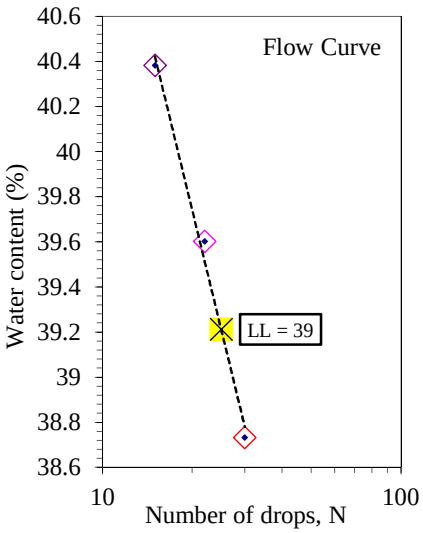
Plastic Limit

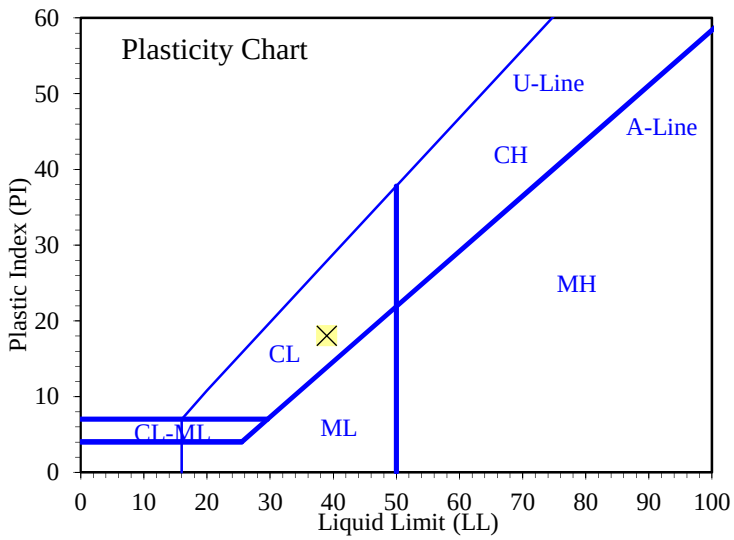
Determination No	1	2				
Wet Soil + Tare (g)	14.49	13.95				
Dry Soil + Tare (g)	13.20	12.76				
Water Loss (g)	1.29	1.19				
Tare (g)	7.04	7.07				
Dry Soil (g)	6.16	5.69				
Water Content, w (%)	20.94	20.91				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	30	22	15			
Wet Soil + Tare (g)	15.32	15.81	16.96			
Dry Soil + Tare (g)	13.00	13.43	14.21			
Water Loss (g)	2.32	2.38	2.75			
Tare (g)	7.01	7.42	7.40			
Dry Soil (g)	5.99	6.01	6.81			
Water Content, w (%)	38.73	39.60	40.38			
One-Point LL (%)	40	39				

Liquid Limit, LL (%)	**39**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**18**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 7/31/2019
By: BRR

Boring No.: BH19-ES-2
Sample: 23
Depth: 100'
Description: Grey fat clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.40
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

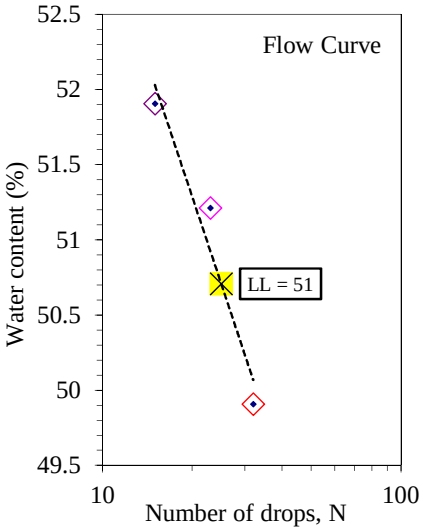
Plastic Limit

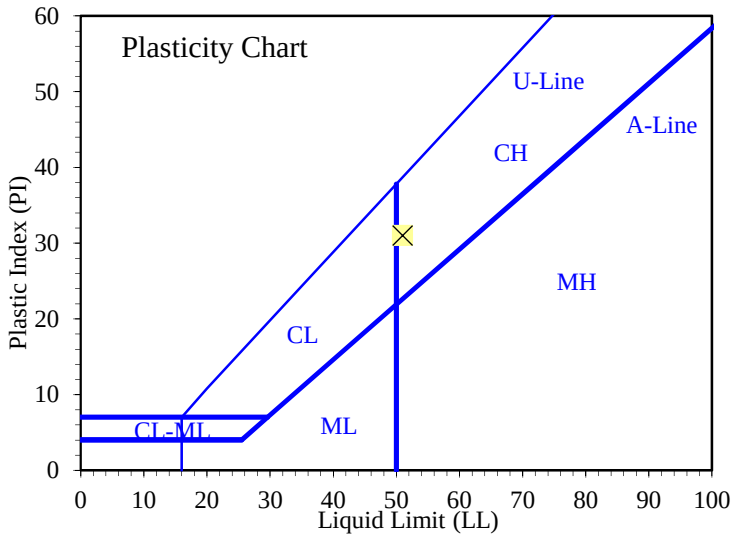
Determination No	1	2				
Wet Soil + Tare (g)	14.71	13.86				
Dry Soil + Tare (g)	13.41	12.77				
Water Loss (g)	1.30	1.09				
Tare (g)	7.08	7.43				
Dry Soil (g)	6.33	5.34				
Water Content, w (%)	20.54	20.41				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	23	15			
Wet Soil + Tare (g)	15.08	14.54	15.40			
Dry Soil + Tare (g)	12.44	12.00	12.81			
Water Loss (g)	2.64	2.54	2.59			
Tare (g)	7.15	7.04	7.82			
Dry Soil (g)	5.29	4.96	4.99			
Water Content, w (%)	49.91	51.21	51.90			
One-Point LL (%)		51				

Liquid Limit, LL (%)	**51**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**31**





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Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/1/2019
By: BRR

Boring No.: BH19-ES-2
Sample: 25A
Depth: 110'
Description: Grey lean clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.40
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

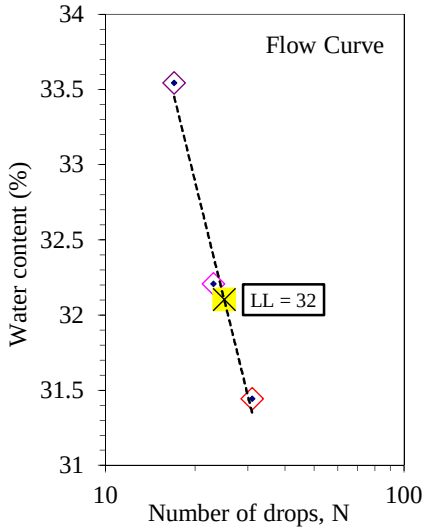
Plastic Limit

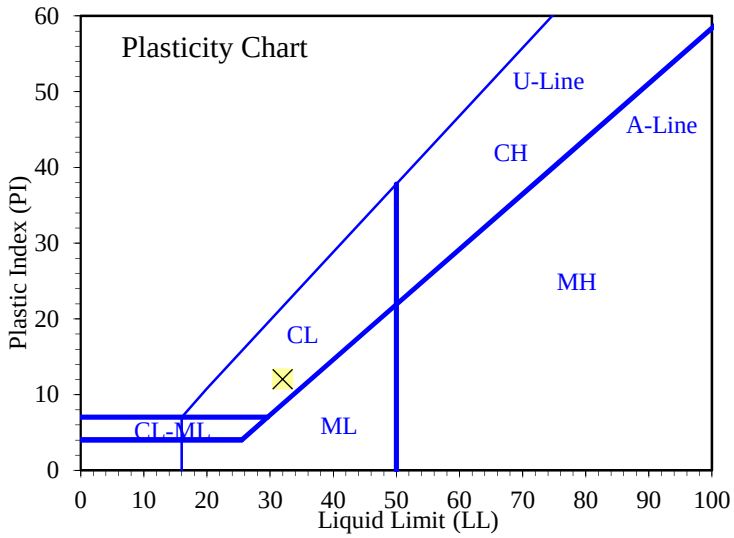
Determination No	1	2				
Wet Soil + Tare (g)	13.47	13.37				
Dry Soil + Tare (g)	12.48	12.33				
Water Loss (g)	0.99	1.04				
Tare (g)	7.36	7.11				
Dry Soil (g)	5.12	5.22				
Water Content, w (%)	19.34	19.92				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	31	23	17			
Wet Soil + Tare (g)	15.65	15.94	18.02			
Dry Soil + Tare (g)	13.71	13.94	15.35			
Water Loss (g)	1.94	2.00	2.67			
Tare (g)	7.54	7.73	7.39			
Dry Soil (g)	6.17	6.21	7.96			
Water Content, w (%)	31.44	32.21	33.54			
One-Point LL (%)		32				

Liquid Limit, LL (%)	**32**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**12**





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Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: BRR

Boring No.: BH19-ES-2
Sample: 27
Depth: 120'
Description: Grey fat clay

Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

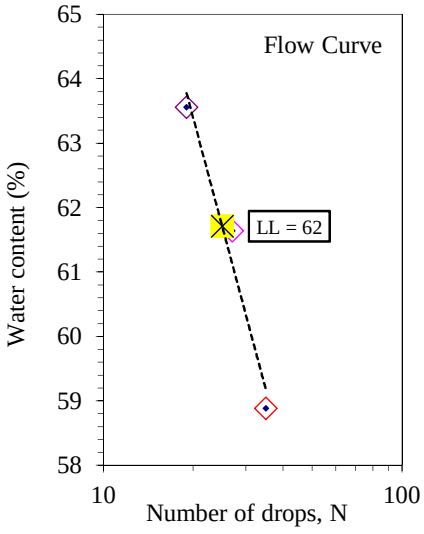
Plastic Limit

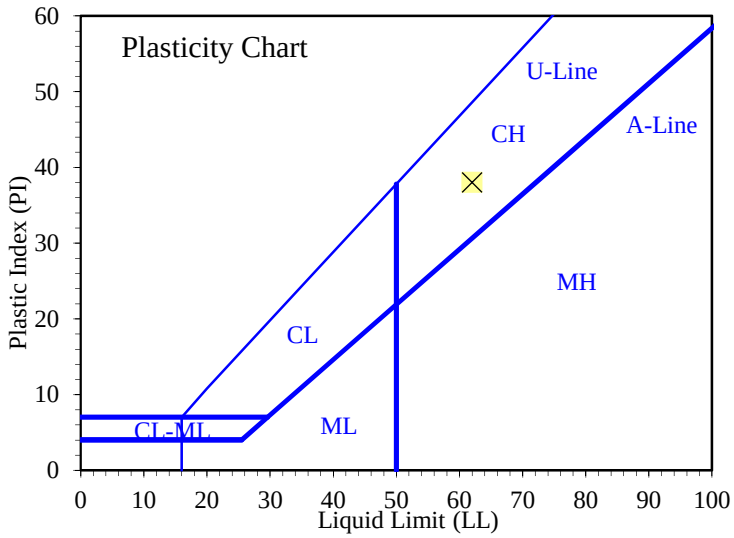
Determination No	1	2				
Wet Soil + Tare (g)	13.20	14.21				
Dry Soil + Tare (g)	12.02	12.86				
Water Loss (g)	1.18	1.35				
Tare (g)	7.08	7.09				
Dry Soil (g)	4.94	5.77				
Water Content, w (%)	23.89	23.40				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	27	19			
Wet Soil + Tare (g)	15.03	14.64	14.76			
Dry Soil + Tare (g)	12.18	11.78	11.90			
Water Loss (g)	2.85	2.86	2.86			
Tare (g)	7.34	7.14	7.40			
Dry Soil (g)	4.84	4.64	4.50			
Water Content, w (%)	58.88	61.64	63.56			
One-Point LL (%)		62				

Liquid Limit, LL (%)	**62**
Plastic Limit, PL (%)	**24**
Plasticity Index, PI (%)	**38**





Entered by:_____
Reviewed:_____

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XXIII)
Location: Salt Lake City, Utah
Date: 8/4/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH18-IT-5
Sample:
Depth: 20.0'
Description: Grey silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.4
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 19.6

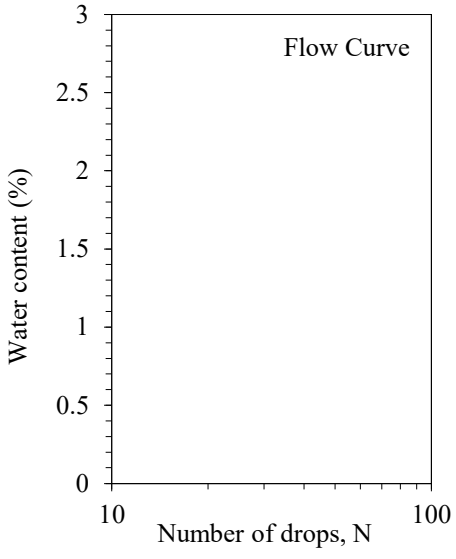
Plastic Limit

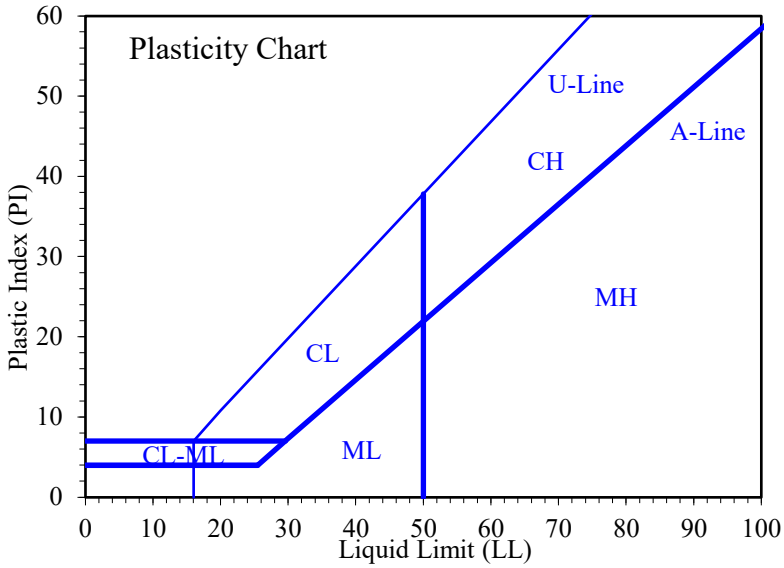
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XXIII)
Location: Salt Lake City, Utah
Date: 8/4/2021
By: EH/BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH18-IT-5
Sample:
Depth: 56.0'
Description: Brown silt

Preparation method: Air Dry
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Dry sieved
Approximate maximum grain size: No.4
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): Not requested

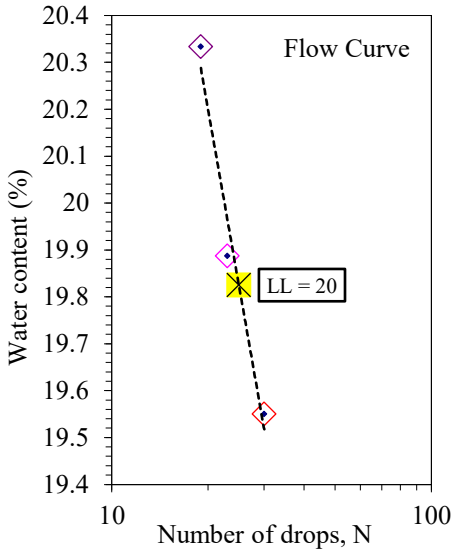
Plastic Limit

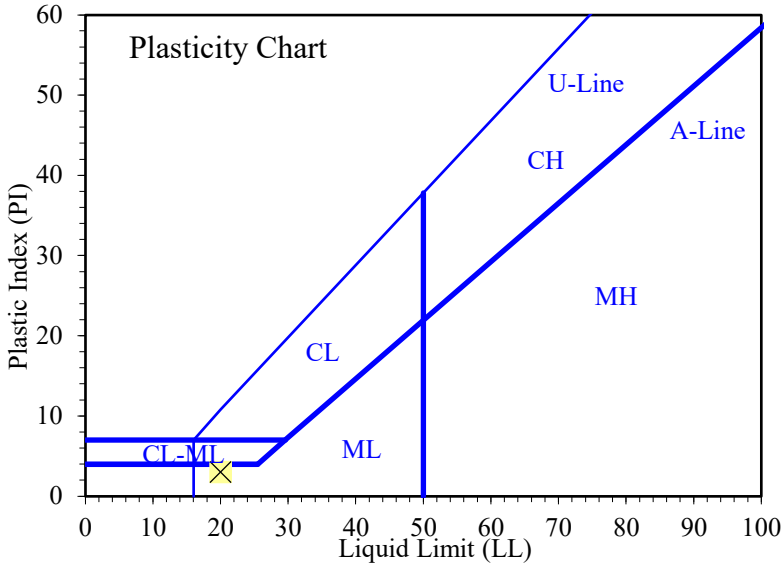
Determination No	1	2				
Wet Soil + Tare (g)	15.53	16.14				
Dry Soil + Tare (g)	14.30	14.85				
Water Loss (g)	1.23	1.29				
Tare (g)	7.10	7.09				
Dry Soil (g)	7.20	7.76				
Water Content, w (%)	17.08	16.62				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	30	23	19			
Wet Soil + Tare (g)	17.69	17.72	18.92			
Dry Soil + Tare (g)	15.95	15.95	16.97			
Water Loss (g)	1.74	1.77	1.95			
Tare (g)	7.05	7.05	7.38			
Dry Soil (g)	8.90	8.90	9.59			
Water Content, w (%)	19.55	19.89	20.33			
One-Point LL (%)	20	20				

Liquid Limit, LL (%)	**20**
Plastic Limit, PL (%)	**17**
Plasticity Index, PI (%)	**3**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/8/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-IT-6
Sample:
Depth: 15.0'
Description: Grey silt

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.10
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 43.3

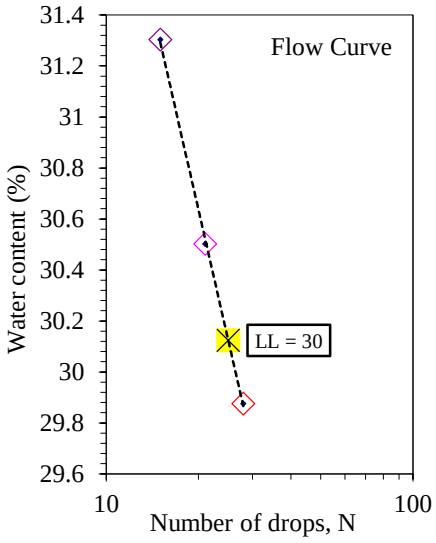
Plastic Limit

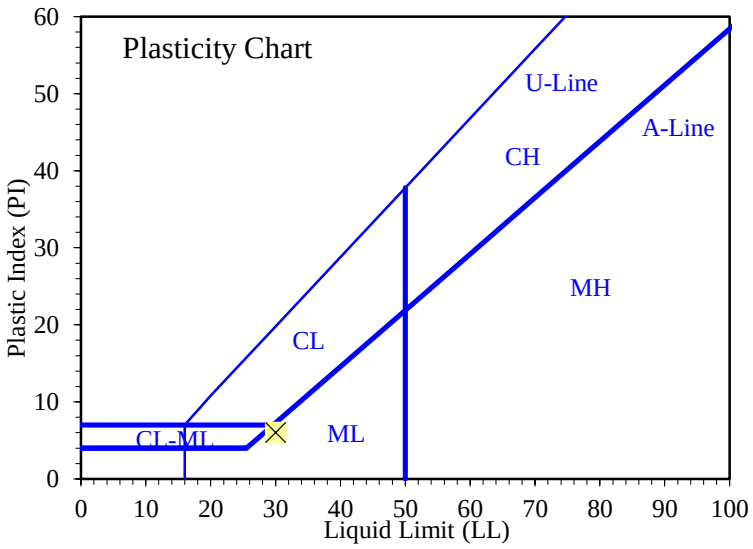
Determination No	1	2				
Wet Soil + Tare (g)	14.76	16.28				
Dry Soil + Tare (g)	13.29	14.64				
Water Loss (g)	1.47	1.64				
Tare (g)	7.05	7.70				
Dry Soil (g)	6.24	6.94				
Water Content, w (%)	23.56	23.63				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	21	15			
Wet Soil + Tare (g)	13.36	14.37	14.07			
Dry Soil + Tare (g)	11.92	12.79	12.58			
Water Loss (g)	1.44	1.58	1.49			
Tare (g)	7.10	7.61	7.82			
Dry Soil (g)	4.82	5.18	4.76			
Water Content, w (%)	29.88	30.50	31.30			
One-Point LL (%)	30	30				

Liquid Limit, LL (%)	**30**
Plastic Limit, PL (%)	**24**
Plasticity Index, PI (%)	**6**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/10/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-IT-6
Sample:
Depth: 20.0'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 49.2

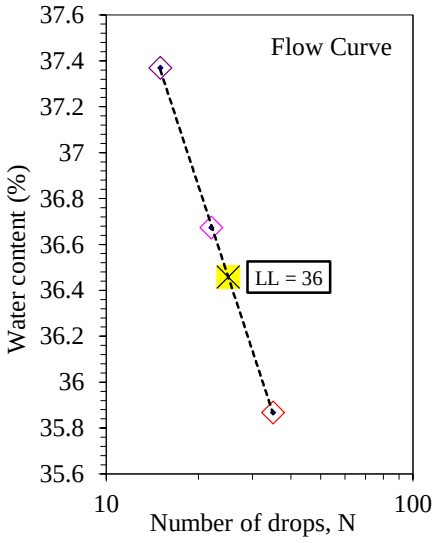
Plastic Limit

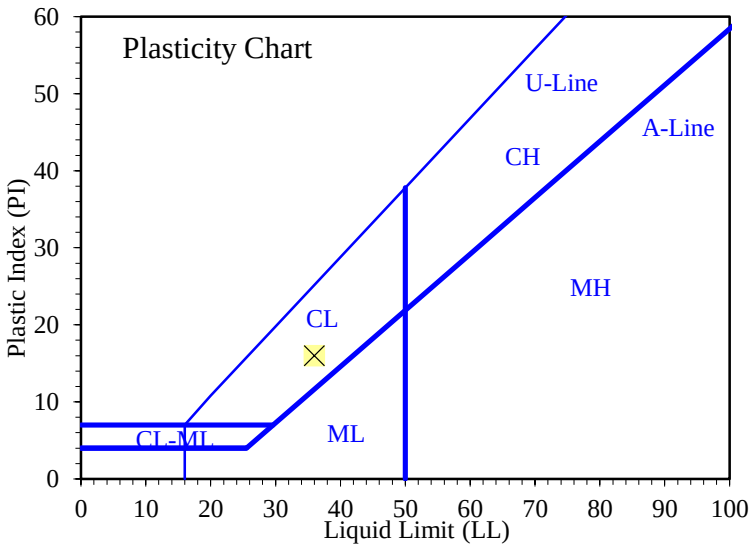
Determination No	1	2				
Wet Soil + Tare (g)	13.61	14.52				
Dry Soil + Tare (g)	12.50	13.26				
Water Loss (g)	1.11	1.26				
Tare (g)	7.04	7.11				
Dry Soil (g)	5.46	6.15				
Water Content, w (%)	20.33	20.49				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	22	15			
Wet Soil + Tare (g)	14.03	14.53	15.35			
Dry Soil + Tare (g)	12.19	12.59	13.22			
Water Loss (g)	1.84	1.94	2.13			
Tare (g)	7.06	7.30	7.52			
Dry Soil (g)	5.13	5.29	5.70			
Water Content, w (%)	35.87	36.67	37.37			
One-Point LL (%)		36				

Liquid Limit, LL (%)	**36**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**16**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/8/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-2
Sample:
Depth: 12.5'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.4
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 40.8

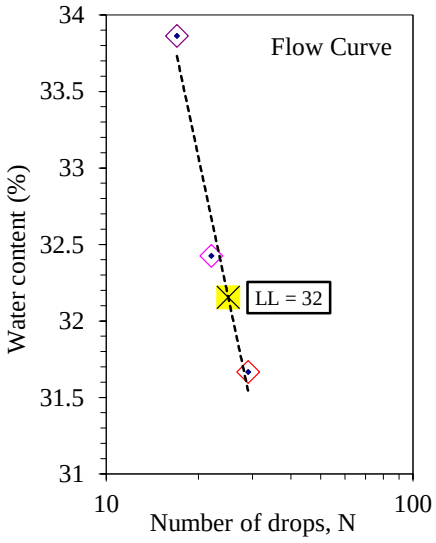
Plastic Limit

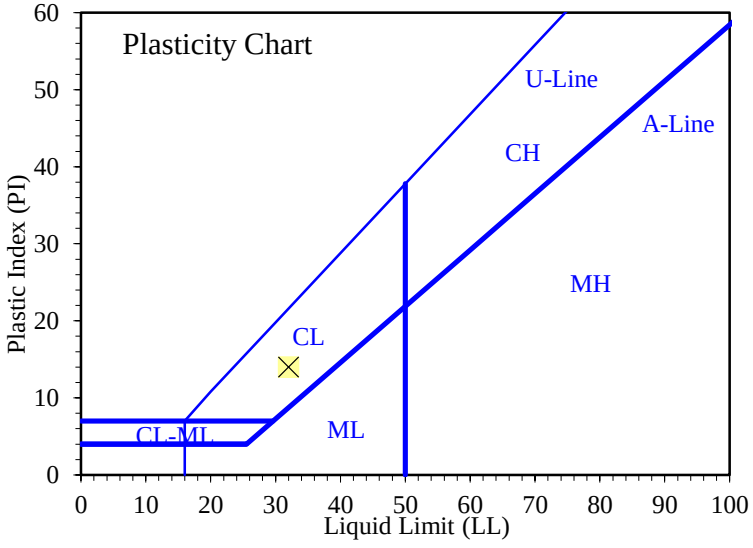
Determination No	1	2				
Wet Soil + Tare (g)	14.29	15.21				
Dry Soil + Tare (g)	13.18	13.98				
Water Loss (g)	1.11	1.23				
Tare (g)	7.11	7.28				
Dry Soil (g)	6.07	6.70				
Water Content, w (%)	18.29	18.36				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	29	22	17			
Wet Soil + Tare (g)	14.25	16.52	16.76			
Dry Soil + Tare (g)	12.54	14.38	14.41			
Water Loss (g)	1.71	2.14	2.35			
Tare (g)	7.14	7.78	7.47			
Dry Soil (g)	5.40	6.60	6.94			
Water Content, w (%)	31.67	32.42	33.86			
One-Point LL (%)	32	32				

Liquid Limit, LL (%)	**32**
Plastic Limit, PL (%)	**18**
Plasticity Index, PI (%)	**14**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/13/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-2
Sample:
Depth: 15.0'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 53.5

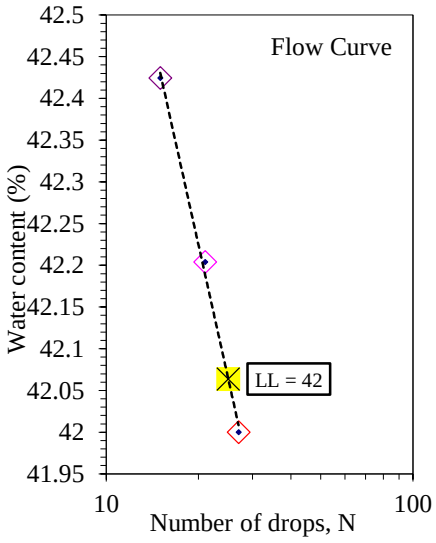
Plastic Limit

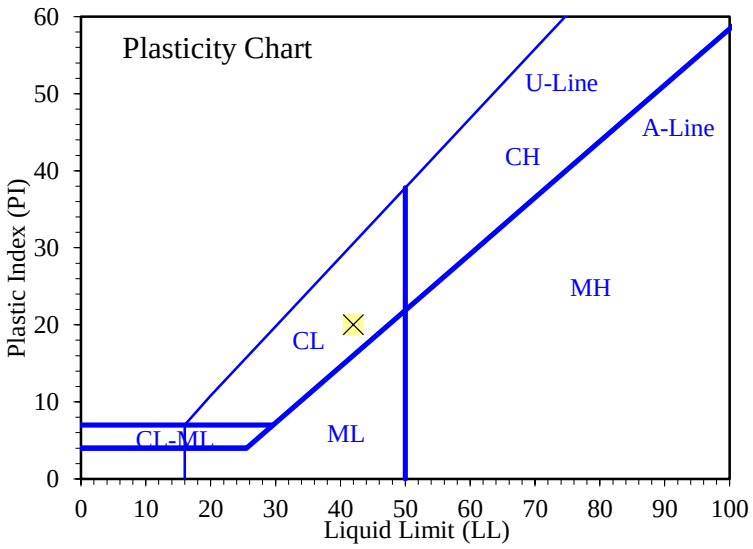
Determination No	1	2				
Wet Soil + Tare (g)	13.74	13.99				
Dry Soil + Tare (g)	12.54	12.73				
Water Loss (g)	1.20	1.26				
Tare (g)	7.13	7.05				
Dry Soil (g)	5.41	5.68				
Water Content, w (%)	22.18	22.18				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	27	21	15			
Wet Soil + Tare (g)	14.58	14.25	14.50			
Dry Soil + Tare (g)	12.48	12.22	12.40			
Water Loss (g)	2.10	2.03	2.10			
Tare (g)	7.48	7.41	7.45			
Dry Soil (g)	5.00	4.81	4.95			
Water Content, w (%)	42.00	42.20	42.42			
One-Point LL (%)	42	41				

Liquid Limit, LL (%)	**42**
Plastic Limit, PL (%)	**22**
Plasticity Index, PI (%)	**20**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

© IGES 2004, 2019

Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/8/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-2
Sample:
Depth: 17.0'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.10
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 47.8

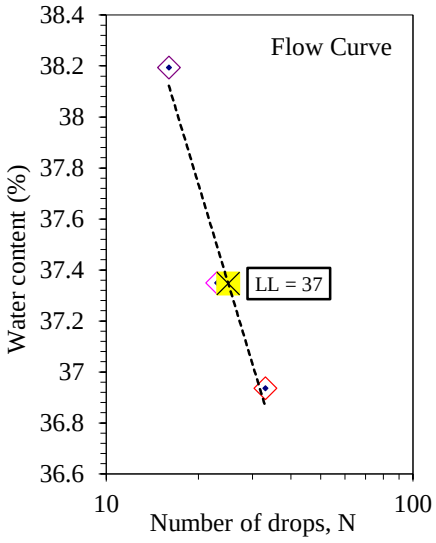
Plastic Limit

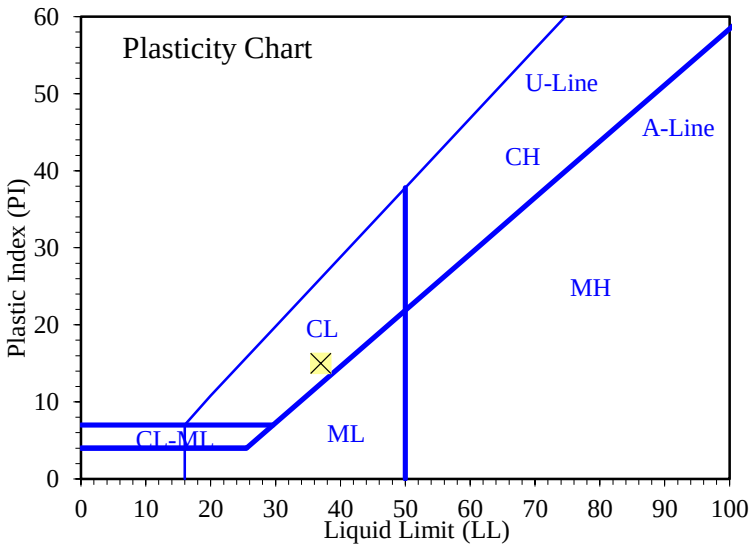
Determination No	1	2				
Wet Soil + Tare (g)	14.57	14.20				
Dry Soil + Tare (g)	13.23	12.94				
Water Loss (g)	1.34	1.26				
Tare (g)	7.03	7.07				
Dry Soil (g)	6.20	5.87				
Water Content, w (%)	21.61	21.47				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	23	16			
Wet Soil + Tare (g)	14.02	15.27	16.08			
Dry Soil + Tare (g)	12.14	13.10	13.67			
Water Loss (g)	1.88	2.17	2.41			
Tare (g)	7.05	7.29	7.36			
Dry Soil (g)	5.09	5.81	6.31			
Water Content, w (%)	36.94	37.35	38.19			
One-Point LL (%)		37				

Liquid Limit, LL (%)	**37**
Plastic Limit, PL (%)	**22**
Plasticity Index, PI (%)	**15**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/8/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-2
Sample:
Depth: 22.0'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 42.6

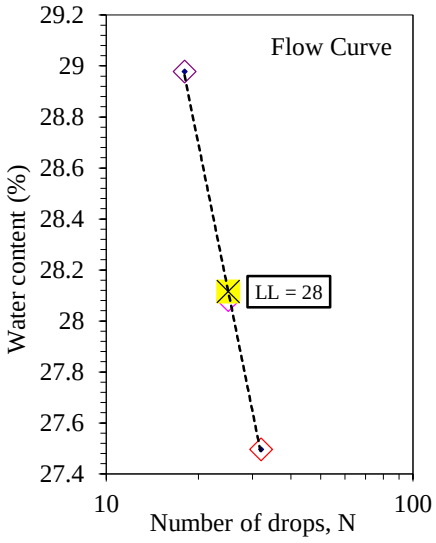
Plastic Limit

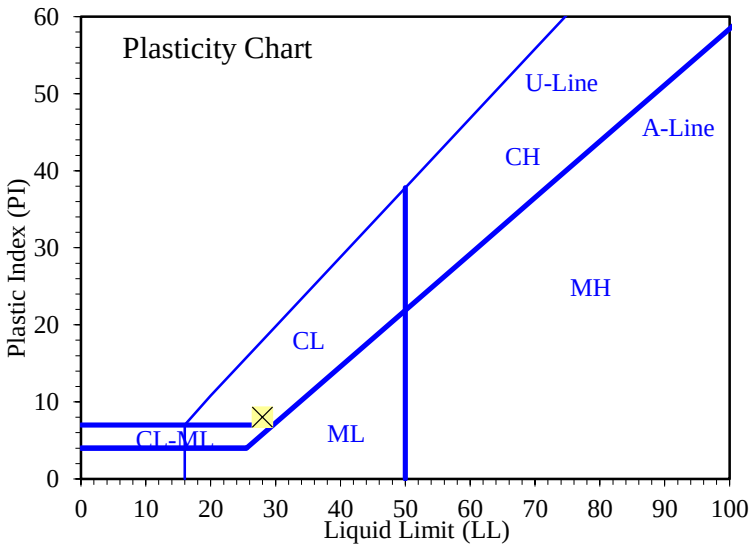
Determination No	1	2				
Wet Soil + Tare (g)	15.09	15.81				
Dry Soil + Tare (g)	13.75	14.34				
Water Loss (g)	1.34	1.47				
Tare (g)	7.06	7.07				
Dry Soil (g)	6.69	7.27				
Water Content, w (%)	20.03	20.22				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	25	18			
Wet Soil + Tare (g)	14.84	15.36	15.35			
Dry Soil + Tare (g)	13.16	13.56	13.62			
Water Loss (g)	1.68	1.80	1.73			
Tare (g)	7.05	7.15	7.65			
Dry Soil (g)	6.11	6.41	5.97			
Water Content, w (%)	27.50	28.08	28.98			
One-Point LL (%)		28				

Liquid Limit, LL (%)	**28**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**8**





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Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/10/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-2
Sample:
Depth: 25.0'
Description: Grey fat clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.10
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 72.1

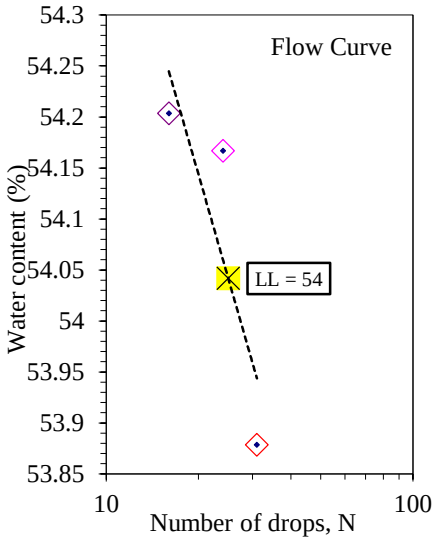
Plastic Limit

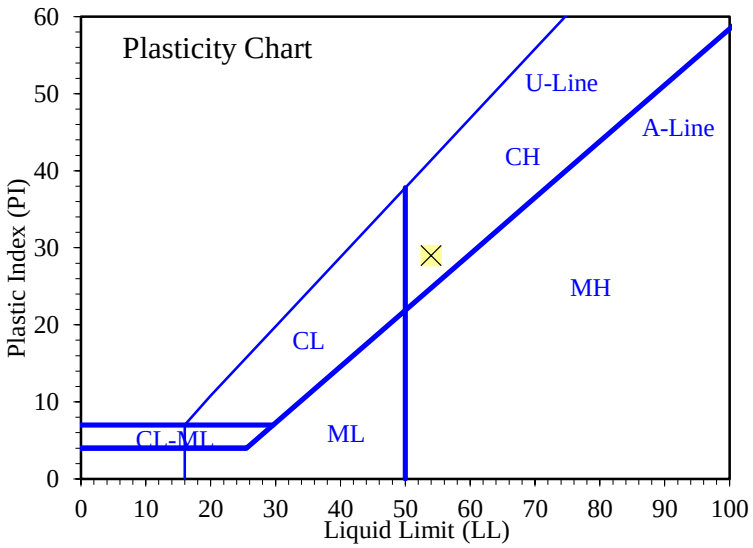
Determination No	1	2				
Wet Soil + Tare (g)	13.39	14.47				
Dry Soil + Tare (g)	12.10	13.07				
Water Loss (g)	1.29	1.40				
Tare (g)	7.04	7.54				
Dry Soil (g)	5.06	5.53				
Water Content, w (%)	25.49	25.32				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	31	24	16			
Wet Soil + Tare (g)	14.45	15.13	14.41			
Dry Soil + Tare (g)	11.88	12.53	11.96			
Water Loss (g)	2.57	2.60	2.45			
Tare (g)	7.11	7.73	7.44			
Dry Soil (g)	4.77	4.80	4.52			
Water Content, w (%)	53.88	54.17	54.20			
One-Point LL (%)		54				

Liquid Limit, LL (%)	**54**
Plastic Limit, PL (%)	**25**
Plasticity Index, PI (%)	**29**





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Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/8/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-4
Sample:
Depth: 12.5'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.4
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 55.0

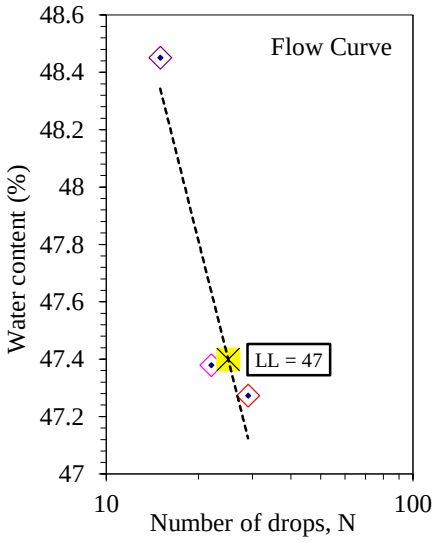
Plastic Limit

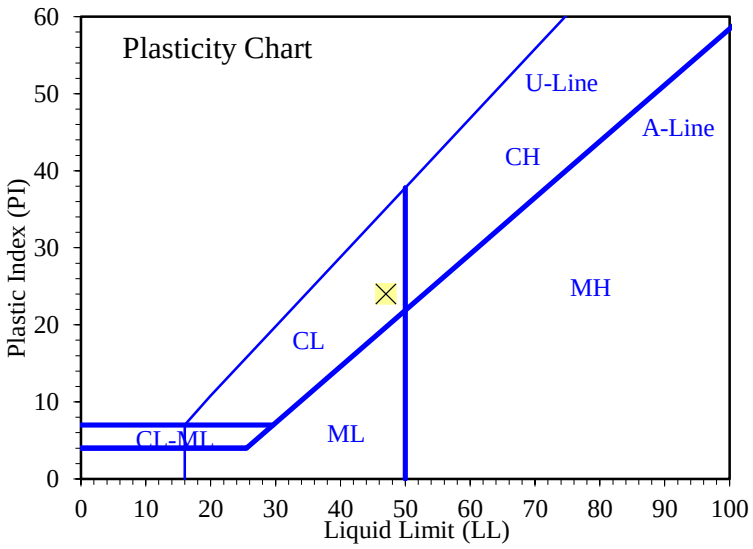
Determination No	1	2				
Wet Soil + Tare (g)	13.17	14.37				
Dry Soil + Tare (g)	12.04	13.05				
Water Loss (g)	1.13	1.32				
Tare (g)	7.13	7.32				
Dry Soil (g)	4.91	5.73				
Water Content, w (%)	23.01	23.04				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	29	22	15			
Wet Soil + Tare (g)	13.60	14.38	16.48			
Dry Soil + Tare (g)	11.52	12.03	13.51			
Water Loss (g)	2.08	2.35	2.97			
Tare (g)	7.12	7.07	7.38			
Dry Soil (g)	4.40	4.96	6.13			
Water Content, w (%)	47.27	47.38	48.45			
One-Point LL (%)	48	47				

Liquid Limit, LL (%)	**47**
Plastic Limit, PL (%)	**23**
Plasticity Index, PI (%)	**24**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/13/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-4
Sample:
Depth: 15.0'
Description: Grey silty clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 34.4

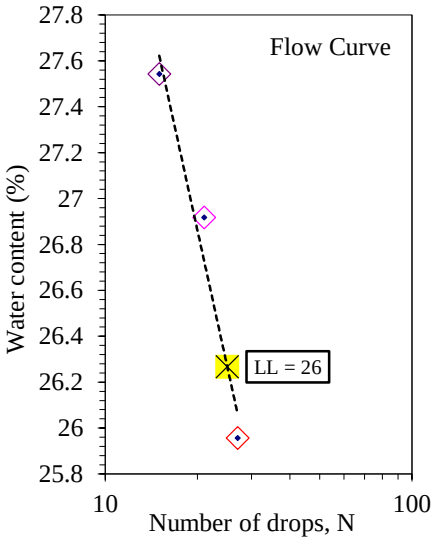
Plastic Limit

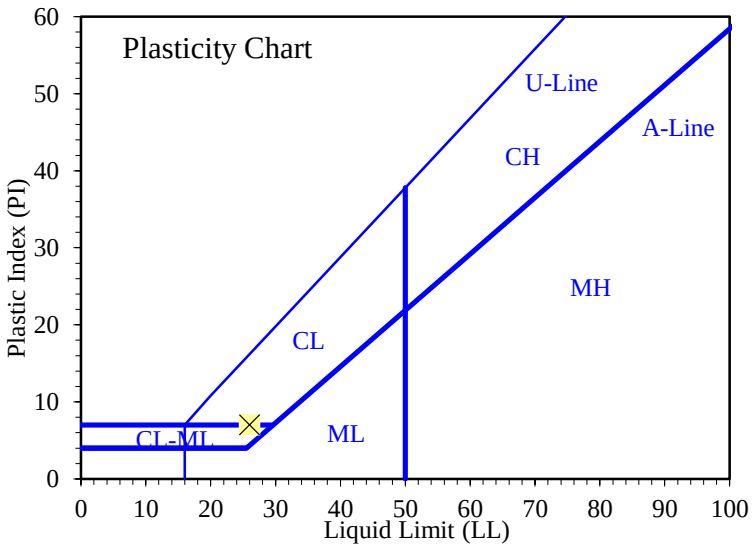
Determination No	1	2				
Wet Soil + Tare (g)	13.93	14.14				
Dry Soil + Tare (g)	12.89	12.99				
Water Loss (g)	1.04	1.15				
Tare (g)	7.59	7.04				
Dry Soil (g)	5.30	5.95				
Water Content, w (%)	19.62	19.33				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	27	21	15			
Wet Soil + Tare (g)	15.67	14.88	16.43			
Dry Soil + Tare (g)	14.04	13.30	14.48			
Water Loss (g)	1.63	1.58	1.95			
Tare (g)	7.76	7.43	7.40			
Dry Soil (g)	6.28	5.87	7.08			
Water Content, w (%)	25.96	26.92	27.54			
One-Point LL (%)	26	26				

Liquid Limit, LL (%)	**26**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**7**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/8/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-4
Sample:
Depth: 17.0'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.10
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 41.1

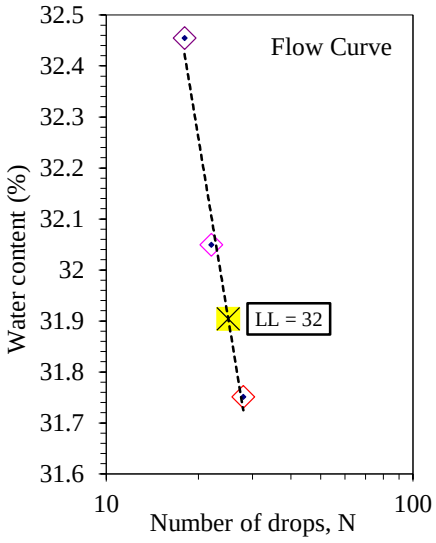
Plastic Limit

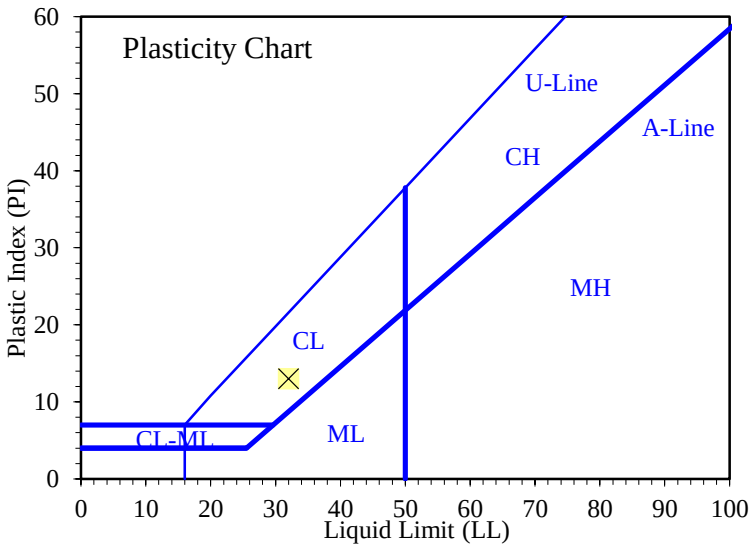
Determination No	1	2				
Wet Soil + Tare (g)	14.92	15.36				
Dry Soil + Tare (g)	13.66	14.04				
Water Loss (g)	1.26	1.32				
Tare (g)	7.10	7.11				
Dry Soil (g)	6.56	6.93				
Water Content, w (%)	19.21	19.05				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	22	18			
Wet Soil + Tare (g)	16.41	14.58	15.16			
Dry Soil + Tare (g)	14.27	12.75	13.19			
Water Loss (g)	2.14	1.83	1.97			
Tare (g)	7.53	7.04	7.12			
Dry Soil (g)	6.74	5.71	6.07			
Water Content, w (%)	31.75	32.05	32.45			
One-Point LL (%)	32	32				

Liquid Limit, LL (%)	**32**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**13**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/8/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-4
Sample:
Depth: 20.0'
Description: Grey silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 29.6

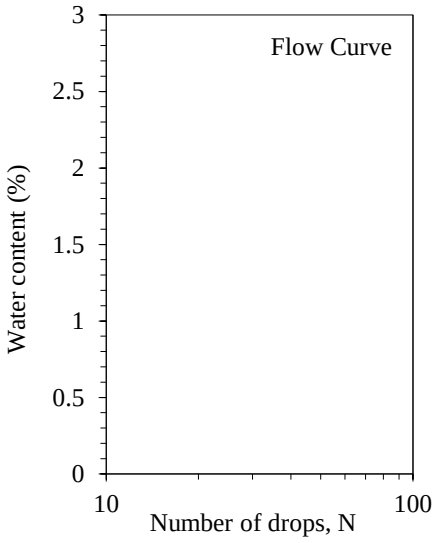
Plastic Limit

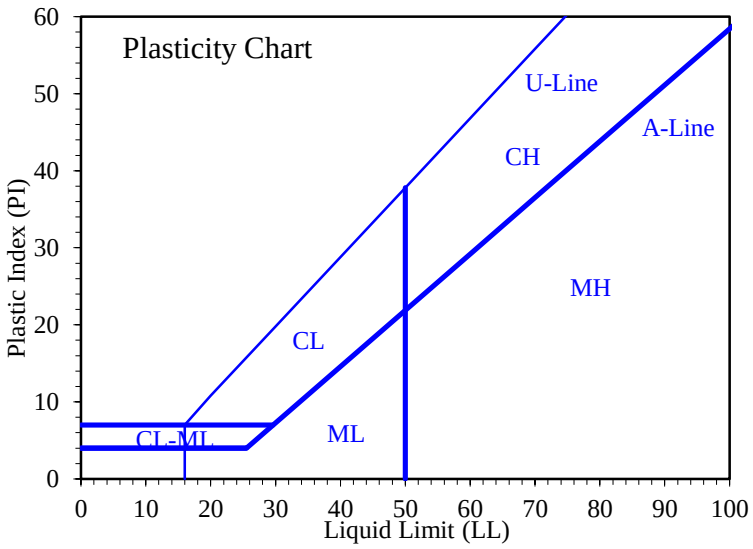
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/8/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-4
Sample:
Depth: 22.0'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.10
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 51.9

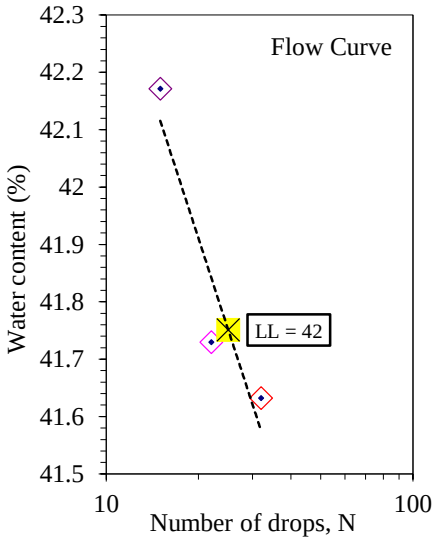
Plastic Limit

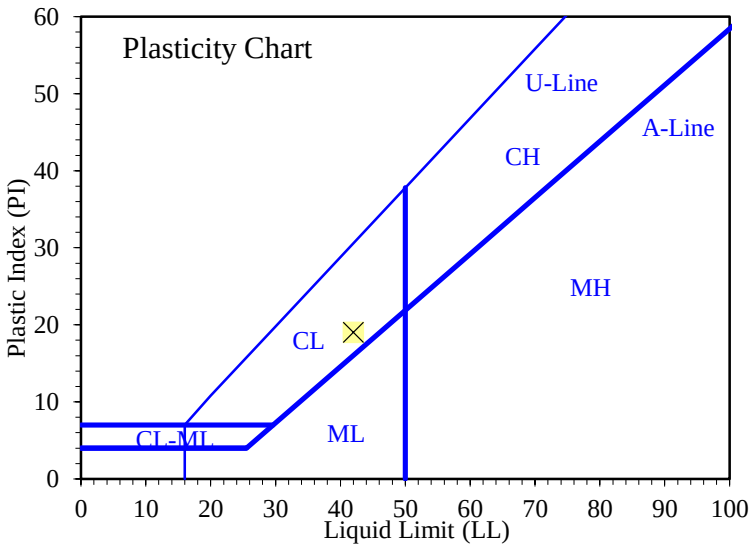
Determination No	1	2				
Wet Soil + Tare (g)	13.66	13.98				
Dry Soil + Tare (g)	12.43	12.76				
Water Loss (g)	1.23	1.22				
Tare (g)	7.07	7.55				
Dry Soil (g)	5.36	5.21				
Water Content, w (%)	22.95	23.42				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	22	15			
Wet Soil + Tare (g)	14.25	14.58	14.62			
Dry Soil + Tare (g)	12.26	12.36	12.60			
Water Loss (g)	1.99	2.22	2.02			
Tare (g)	7.48	7.04	7.81			
Dry Soil (g)	4.78	5.32	4.79			
Water Content, w (%)	41.63	41.73	42.17			
One-Point LL (%)		41				

Liquid Limit, LL (%)	**42**
Plastic Limit, PL (%)	**23**
Plasticity Index, PI (%)	**19**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/10/2019
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: BH19-ITW-4
Sample:
Depth: 25.0'
Description: Grey fat clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: Not required
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 63.6

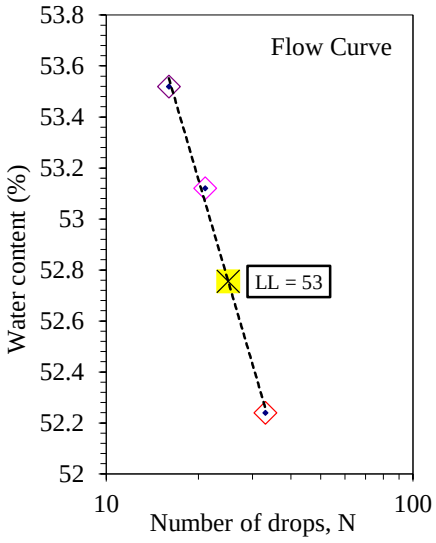
Plastic Limit

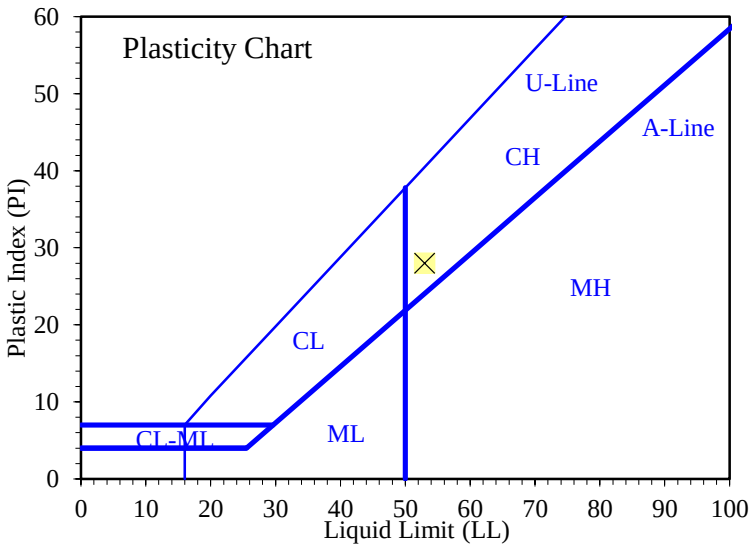
Determination No	1	2				
Wet Soil + Tare (g)	13.66	13.64				
Dry Soil + Tare (g)	12.35	12.34				
Water Loss (g)	1.31	1.30				
Tare (g)	7.13	7.10				
Dry Soil (g)	5.22	5.24				
Water Content, w (%)	25.10	24.81				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	21	16			
Wet Soil + Tare (g)	14.17	16.21	14.64			
Dry Soil + Tare (g)	11.72	13.23	12.13			
Water Loss (g)	2.45	2.98	2.51			
Tare (g)	7.03	7.62	7.44			
Dry Soil (g)	4.69	5.61	4.69			
Water Content, w (%)	52.24	53.12	53.52			
One-Point LL (%)		52				

Liquid Limit, LL (%)	**53**
Plastic Limit, PL (%)	**25**
Plasticity Index, PI (%)	**28**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/8/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-IS-01
Sample: 2B
Depth: 10'
Description: Grey silt

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

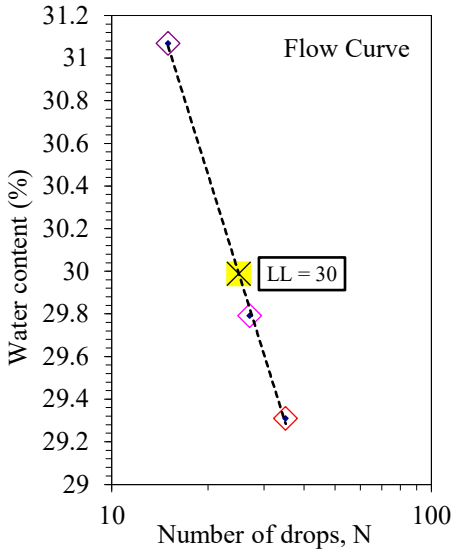
Plastic Limit

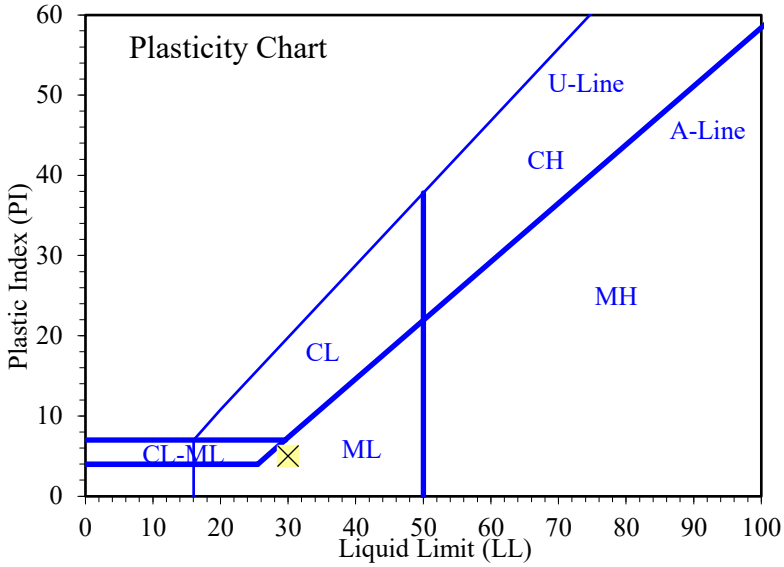
Determination No	1	2				
Wet Soil + Tare (g)	14.97	15.22				
Dry Soil + Tare (g)	13.37	13.57				
Water Loss (g)	1.60	1.65				
Tare (g)	7.05	7.03				
Dry Soil (g)	6.32	6.54				
Water Content, w (%)	25.32	25.23				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	27	15			
Wet Soil + Tare (g)	12.34	14.97	16.86			
Dry Soil + Tare (g)	11.32	13.26	14.71			
Water Loss (g)	1.02	1.71	2.15			
Tare (g)	7.84	7.52	7.79			
Dry Soil (g)	3.48	5.74	6.92			
Water Content, w (%)	29.31	29.79	31.07			
One-Point LL (%)		30				

Liquid Limit, LL (%)	**30**
Plastic Limit, PL (%)	**25**
Plasticity Index, PI (%)	**5**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/5/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-IS-02
Sample: 3A
Depth: 8'
Description: Brown lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

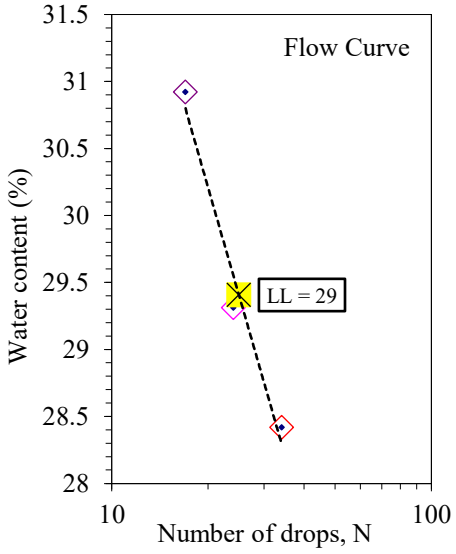
Plastic Limit

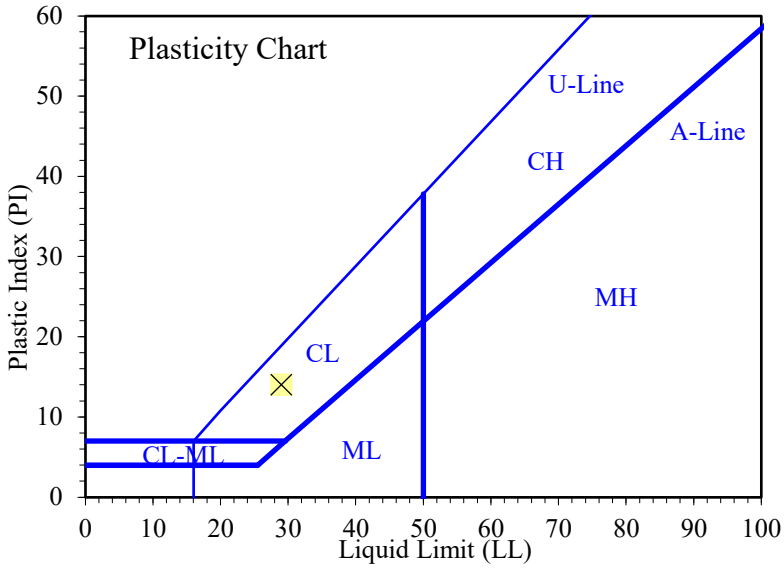
Determination No	1	2				
Wet Soil + Tare (g)	14.32	14.12				
Dry Soil + Tare (g)	13.35	13.18				
Water Loss (g)	0.97	0.94				
Tare (g)	7.10	7.05				
Dry Soil (g)	6.25	6.13				
Water Content, w (%)	15.52	15.33				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	24	17			
Wet Soil + Tare (g)	15.43	16.98	16.70			
Dry Soil + Tare (g)	13.58	14.89	14.52			
Water Loss (g)	1.85	2.09	2.18			
Tare (g)	7.07	7.76	7.47			
Dry Soil (g)	6.51	7.13	7.05			
Water Content, w (%)	28.42	29.31	30.92			
One-Point LL (%)		29				

Liquid Limit, LL (%)	**29**
Plastic Limit, PL (%)	**15**
Plasticity Index, PI (%)	**14**





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Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/8/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-IS-02
Sample: 5
Depth: 16'
Description: Grey silty clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: By hand
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

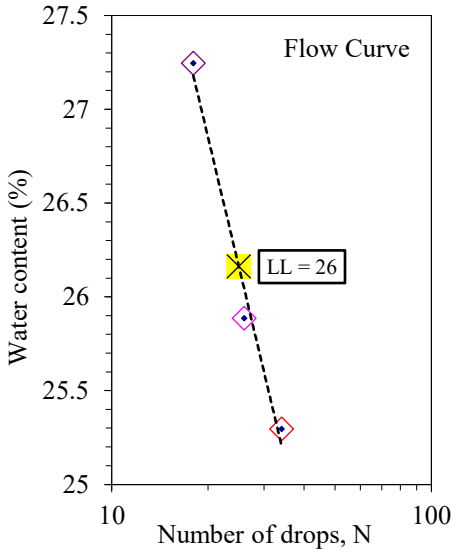
Plastic Limit

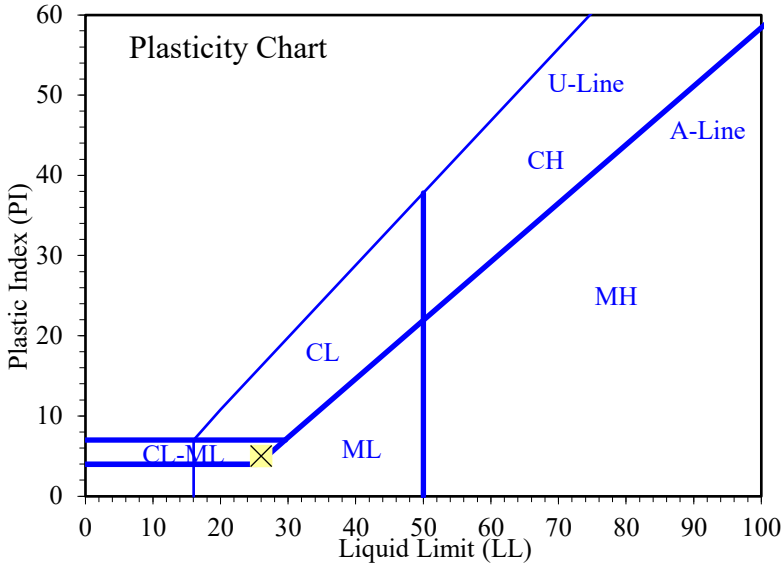
Determination No	1	2				
Wet Soil + Tare (g)	13.67	14.68				
Dry Soil + Tare (g)	12.54	13.44				
Water Loss (g)	1.13	1.24				
Tare (g)	7.12	7.53				
Dry Soil (g)	5.42	5.91				
Water Content, w (%)	20.85	20.98				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	26	18			
Wet Soil + Tare (g)	13.71	15.54	15.56			
Dry Soil + Tare (g)	12.43	13.86	13.74			
Water Loss (g)	1.28	1.68	1.82			
Tare (g)	7.37	7.37	7.06			
Dry Soil (g)	5.06	6.49	6.68			
Water Content, w (%)	25.30	25.89	27.25			
One-Point LL (%)		26				

Liquid Limit, LL (%)	**26**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**5**





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Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/8/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-IS-03
Sample: 3
Depth: 10'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: By hand
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

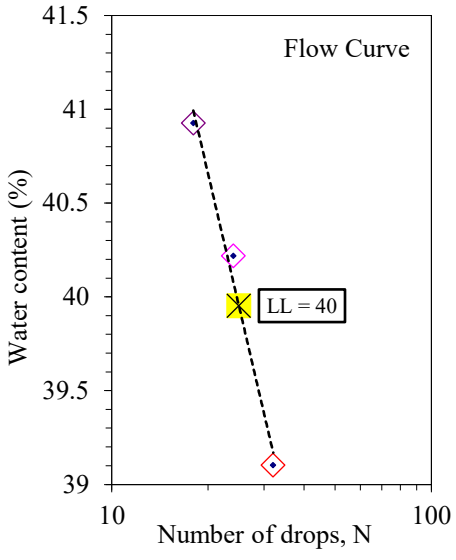
Plastic Limit

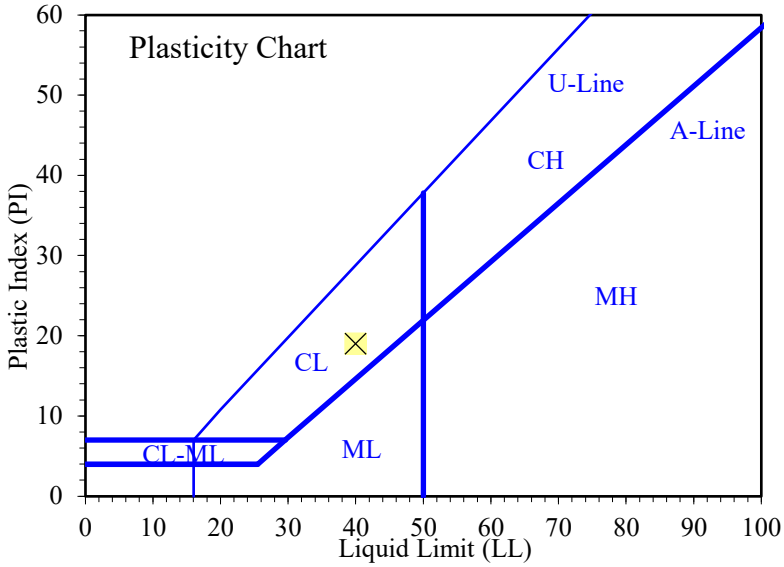
Determination No	1	2				
Wet Soil + Tare (g)	13.48	13.40				
Dry Soil + Tare (g)	12.38	12.32				
Water Loss (g)	1.10	1.08				
Tare (g)	7.08	7.07				
Dry Soil (g)	5.30	5.25				
Water Content, w (%)	20.75	20.57				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	24	18			
Wet Soil + Tare (g)	13.60	15.08	15.43			
Dry Soil + Tare (g)	11.77	12.88	13.22			
Water Loss (g)	1.83	2.20	2.21			
Tare (g)	7.09	7.41	7.82			
Dry Soil (g)	4.68	5.47	5.40			
Water Content, w (%)	39.10	40.22	40.93			
One-Point LL (%)		40				

Liquid Limit, LL (%)	**40**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**19**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-IS-04
Sample: 1
Depth: 6'
Description: Brown lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

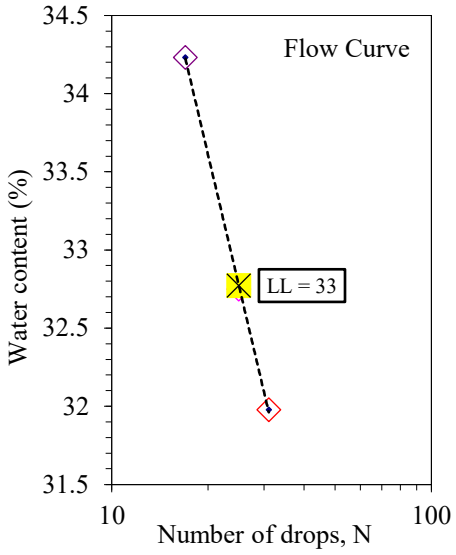
Plastic Limit

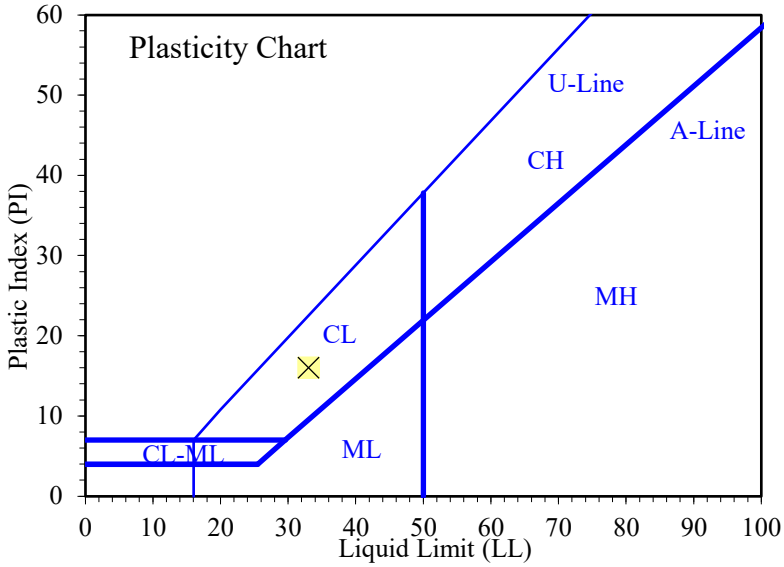
Determination No	1	2				
Wet Soil + Tare (g)	14.98	14.24				
Dry Soil + Tare (g)	13.86	13.18				
Water Loss (g)	1.12	1.06				
Tare (g)	7.41	7.10				
Dry Soil (g)	6.45	6.08				
Water Content, w (%)	17.36	17.43				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	31	25	17			
Wet Soil + Tare (g)	16.47	15.69	15.39			
Dry Soil + Tare (g)	14.19	13.63	13.36			
Water Loss (g)	2.28	2.06	2.03			
Tare (g)	7.06	7.34	7.43			
Dry Soil (g)	7.13	6.29	5.93			
Water Content, w (%)	31.98	32.75	34.23			
One-Point LL (%)		33				

Liquid Limit, LL (%)	**33**
Plastic Limit, PL (%)	**17**
Plasticity Index, PI (%)	**16**





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Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/8/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-IS-04
Sample: 4
Depth: 15'
Description: Grey fat clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.4
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

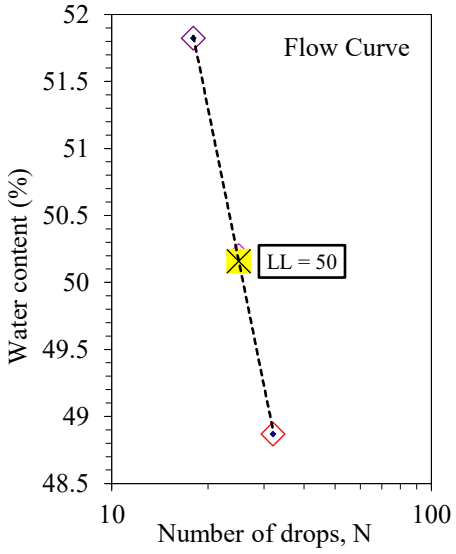
Plastic Limit

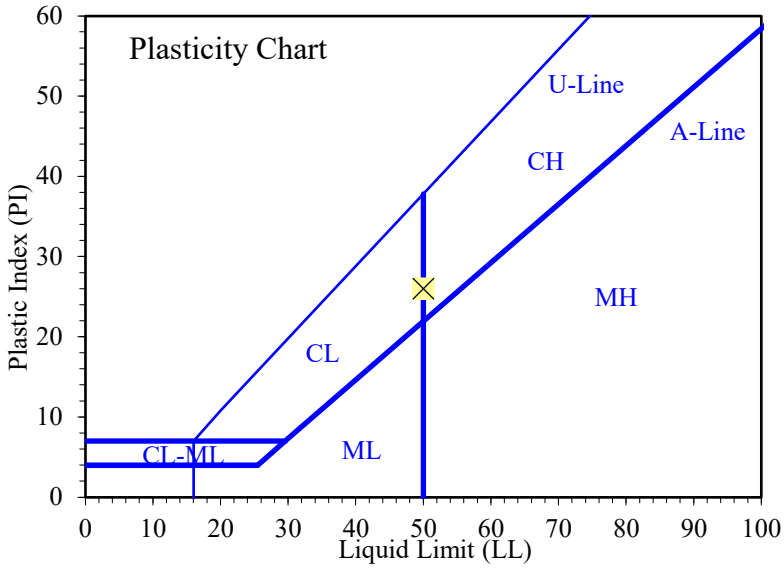
Determination No	1	2				
Wet Soil + Tare (g)	13.56	13.81				
Dry Soil + Tare (g)	12.32	12.63				
Water Loss (g)	1.24	1.18				
Tare (g)	7.04	7.63				
Dry Soil (g)	5.28	5.00				
Water Content, w (%)	23.48	23.60				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	25	18			
Wet Soil + Tare (g)	15.03	14.48	15.36			
Dry Soil + Tare (g)	12.44	11.99	12.66			
Water Loss (g)	2.59	2.49	2.70			
Tare (g)	7.14	7.03	7.45			
Dry Soil (g)	5.30	4.96	5.21			
Water Content, w (%)	48.87	50.20	51.82			
One-Point LL (%)		50				

Liquid Limit, LL (%)	**50**
Plastic Limit, PL (%)	**24**
Plasticity Index, PI (%)	**26**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/8/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-IS-05
Sample: 2
Depth: 10'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: By hand
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

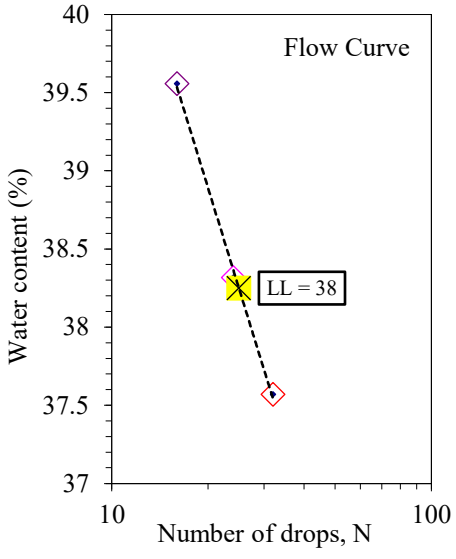
Plastic Limit

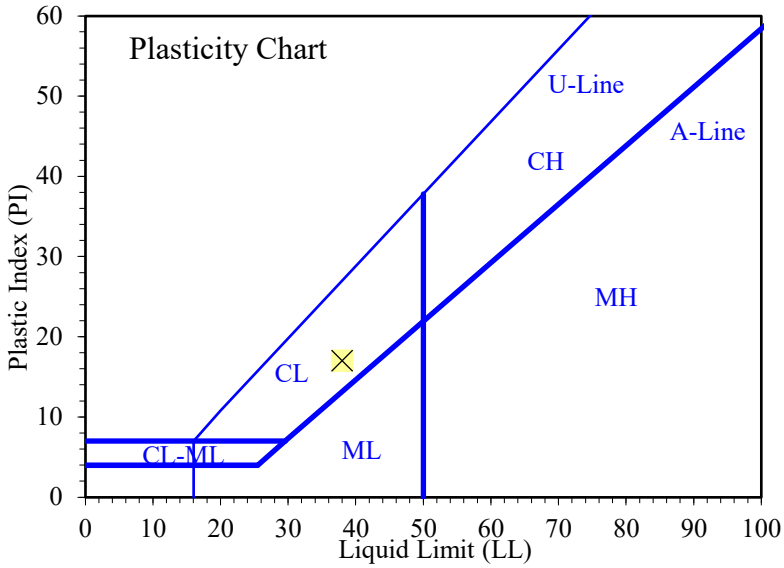
Determination No	1	2				
Wet Soil + Tare (g)	14.29	13.82				
Dry Soil + Tare (g)	13.05	12.64				
Water Loss (g)	1.24	1.18				
Tare (g)	7.10	6.97				
Dry Soil (g)	5.95	5.67				
Water Content, w (%)	20.84	20.81				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	24	16			
Wet Soil + Tare (g)	15.03	15.52	16.17			
Dry Soil + Tare (g)	12.99	13.29	13.84			
Water Loss (g)	2.04	2.23	2.33			
Tare (g)	7.56	7.47	7.95			
Dry Soil (g)	5.43	5.82	5.89			
Water Content, w (%)	37.57	38.32	39.56			
One-Point LL (%)		38				

Liquid Limit, LL (%)	**38**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**17**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/8/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-IS-05
Sample: 4B
Depth: 15'
Description: Grey silt

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

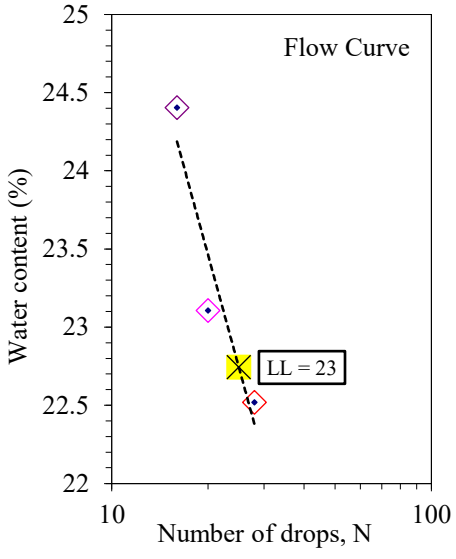
Plastic Limit

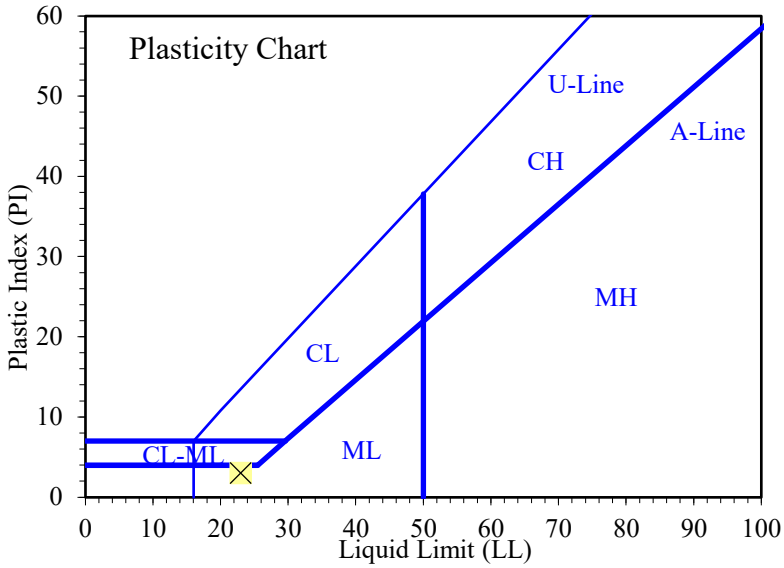
Determination No	1	2				
Wet Soil + Tare (g)	13.70	13.63				
Dry Soil + Tare (g)	12.60	12.56				
Water Loss (g)	1.10	1.07				
Tare (g)	7.06	7.12				
Dry Soil (g)	5.54	5.44				
Water Content, w (%)	19.86	19.67				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	20	16			
Wet Soil + Tare (g)	13.49	13.53	13.44			
Dry Soil + Tare (g)	12.31	12.31	12.21			
Water Loss (g)	1.18	1.22	1.23			
Tare (g)	7.07	7.03	7.17			
Dry Soil (g)	5.24	5.28	5.04			
Water Content, w (%)	22.52	23.11	24.40			
One-Point LL (%)	23	22				

Liquid Limit, LL (%)	**23**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**3**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/14/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-IS-06
Sample: 4
Depth: 14'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

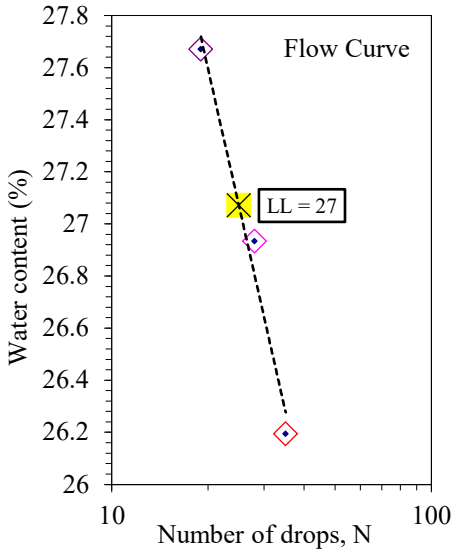
Plastic Limit

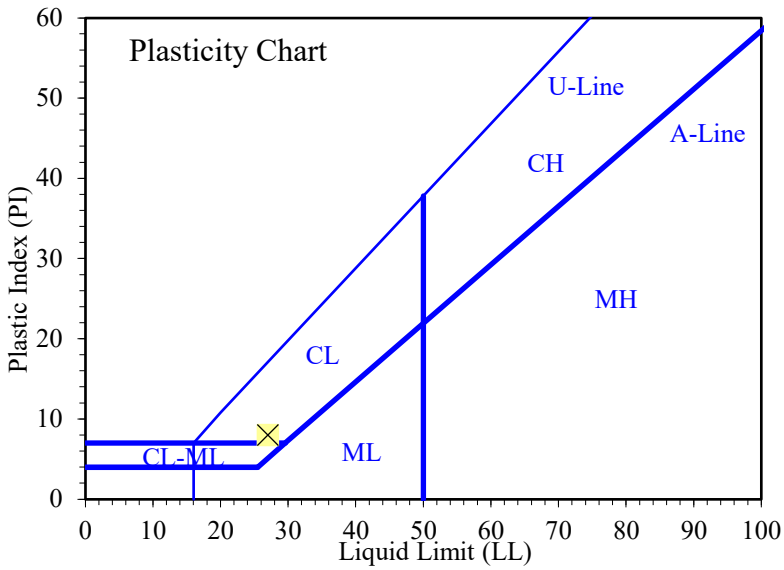
Determination No	1	2				
Wet Soil + Tare (g)	14.29	14.70				
Dry Soil + Tare (g)	13.14	13.53				
Water Loss (g)	1.15	1.17				
Tare (g)	7.17	7.43				
Dry Soil (g)	5.97	6.10				
Water Content, w (%)	19.26	19.18				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	28	19			
Wet Soil + Tare (g)	14.73	15.95	17.08			
Dry Soil + Tare (g)	13.14	14.07	15.06			
Water Loss (g)	1.59	1.88	2.02			
Tare (g)	7.07	7.09	7.76			
Dry Soil (g)	6.07	6.98	7.30			
Water Content, w (%)	26.19	26.93	27.67			
One-Point LL (%)		27				

Liquid Limit, LL (%)	**27**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**8**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/5/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-IS-06
Sample: 8B
Depth: 30'
Description: Grey silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): Not requested

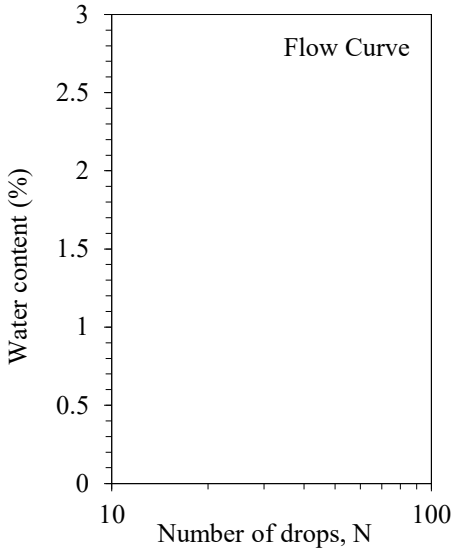
Plastic Limit

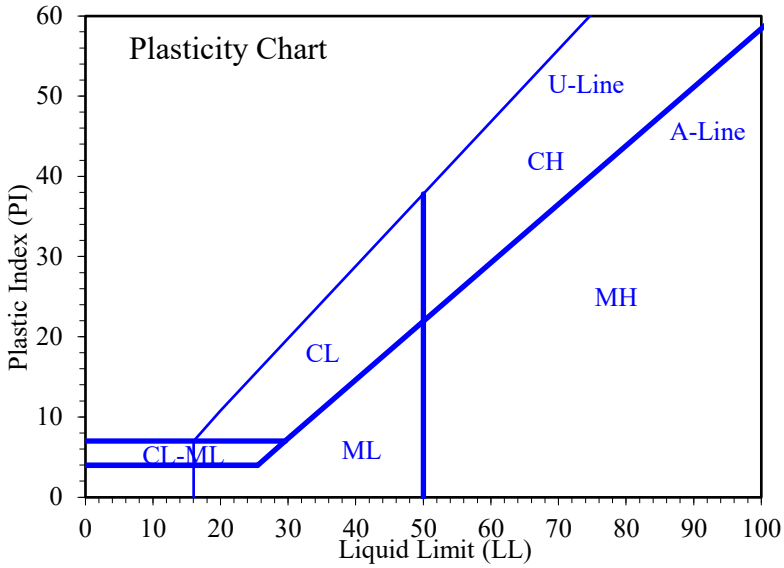
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-01
Sample: 2
Depth: 6'
Description: Brown silty clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

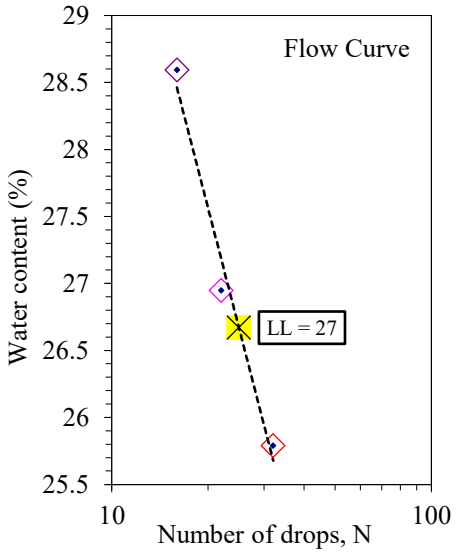
Plastic Limit

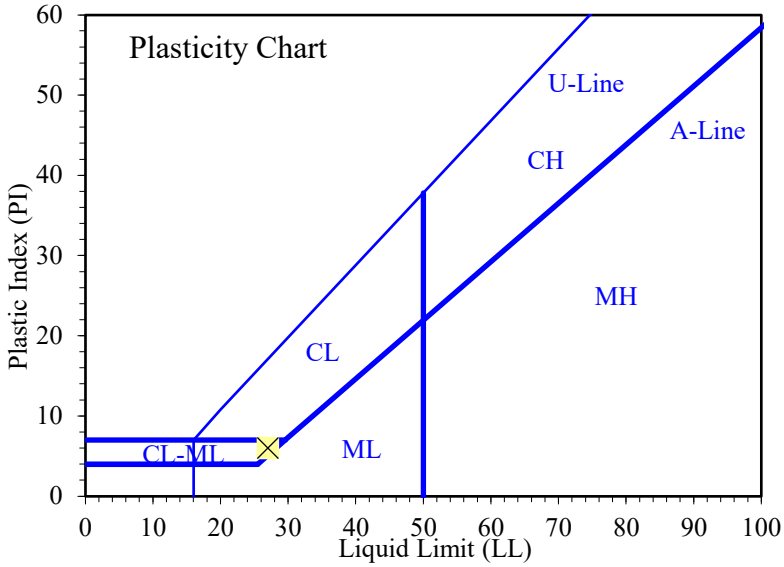
Determination No	1	2				
Wet Soil + Tare (g)	15.52	14.48				
Dry Soil + Tare (g)	14.14	13.31				
Water Loss (g)	1.38	1.17				
Tare (g)	7.47	7.70				
Dry Soil (g)	6.67	5.61				
Water Content, w (%)	20.69	20.86				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	22	16			
Wet Soil + Tare (g)	16.67	15.62	16.22			
Dry Soil + Tare (g)	14.79	13.89	14.31			
Water Loss (g)	1.88	1.73	1.91			
Tare (g)	7.50	7.47	7.63			
Dry Soil (g)	7.29	6.42	6.68			
Water Content, w (%)	25.79	26.95	28.59			
One-Point LL (%)		27				

Liquid Limit, LL (%)	**27**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**6**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-01
Sample: 4B
Depth: 20'
Description: Grey silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

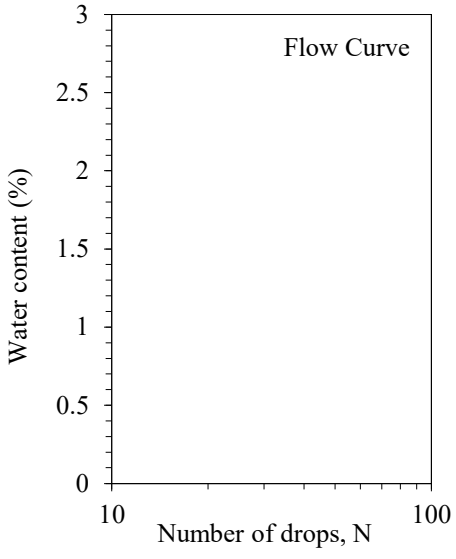
Plastic Limit

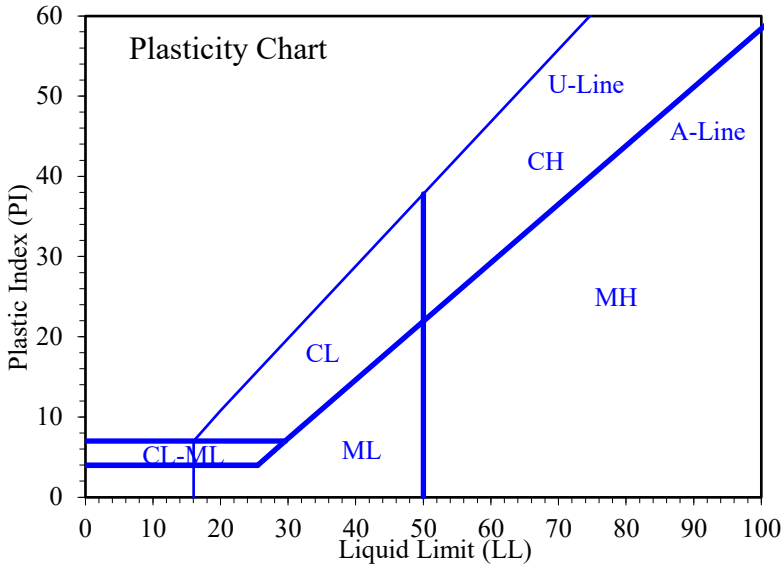
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





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Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 51.1

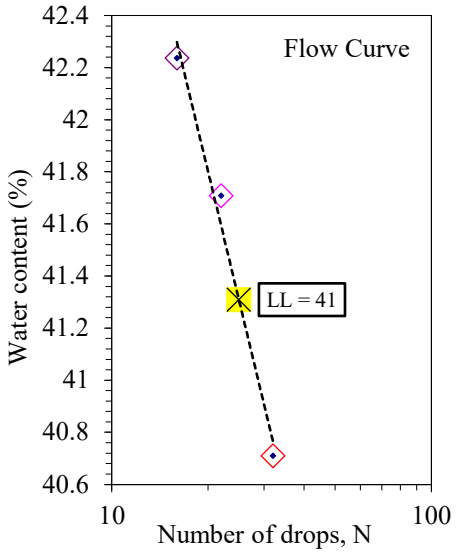
Plastic Limit

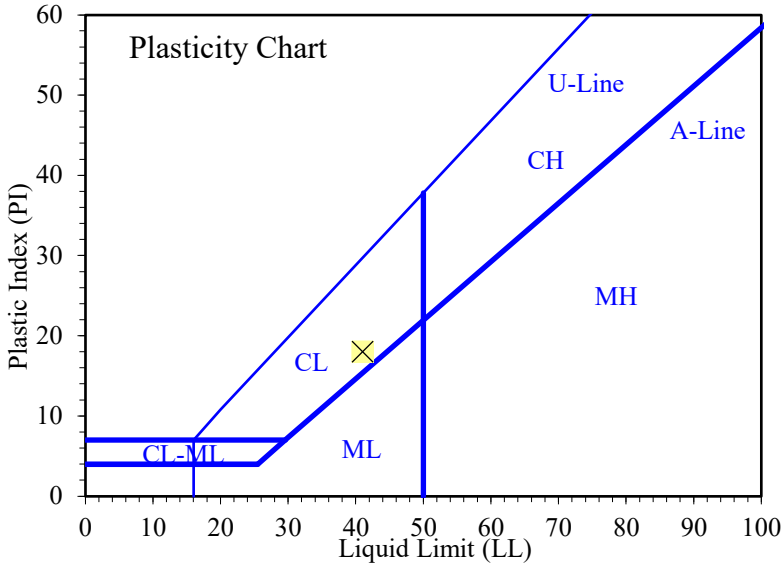
Determination No	1	2				
Wet Soil + Tare (g)	14.00	14.88				
Dry Soil + Tare (g)	12.68	13.40				
Water Loss (g)	1.32	1.48				
Tare (g)	7.04	7.04				
Dry Soil (g)	5.64	6.36				
Water Content, w (%)	23.40	23.27				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	22	16			
Wet Soil + Tare (g)	15.38	16.20	16.53			
Dry Soil + Tare (g)	12.97	13.71	13.81			
Water Loss (g)	2.41	2.49	2.72			
Tare (g)	7.05	7.74	7.37			
Dry Soil (g)	5.92	5.97	6.44			
Water Content, w (%)	40.71	41.71	42.24			
One-Point LL (%)		41				

Liquid Limit, LL (%)	**41**
Plastic Limit, PL (%)	**23**
Plasticity Index, PI (%)	**18**





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Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-02
Sample: 3
Depth: 14'
Description: Grey silt

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

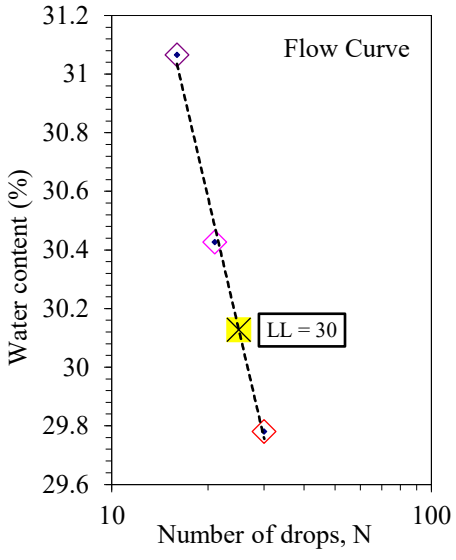
Plastic Limit

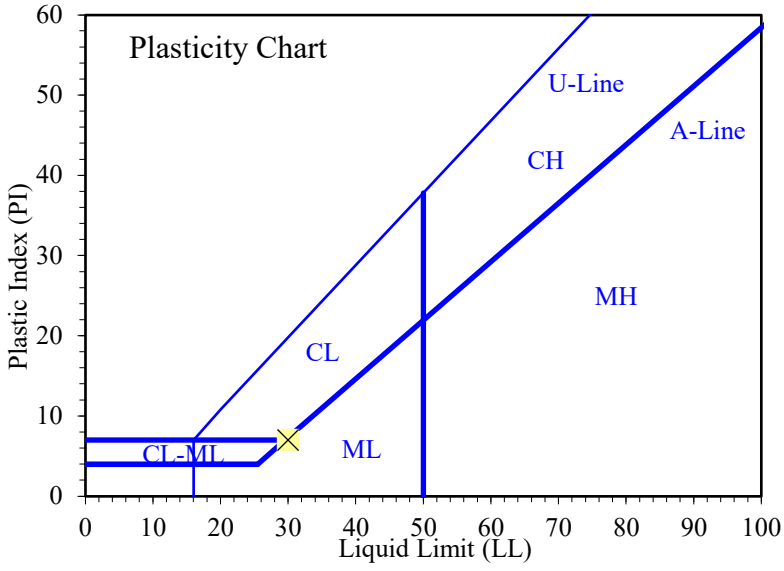
Determination No	1	2				
Wet Soil + Tare (g)	14.11	14.33				
Dry Soil + Tare (g)	12.80	12.98				
Water Loss (g)	1.31	1.35				
Tare (g)	7.09	7.07				
Dry Soil (g)	5.71	5.91				
Water Content, w (%)	22.94	22.84				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	30	21	16			
Wet Soil + Tare (g)	14.74	14.34	14.56			
Dry Soil + Tare (g)	12.98	12.63	12.87			
Water Loss (g)	1.76	1.71	1.69			
Tare (g)	7.07	7.01	7.43			
Dry Soil (g)	5.91	5.62	5.44			
Water Content, w (%)	29.78	30.43	31.07			
One-Point LL (%)	30	30				

Liquid Limit, LL (%)	**30**
Plastic Limit, PL (%)	**23**
Plasticity Index, PI (%)	**7**





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Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-02
Sample: 4A
Depth: 18'
Description: Grey silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

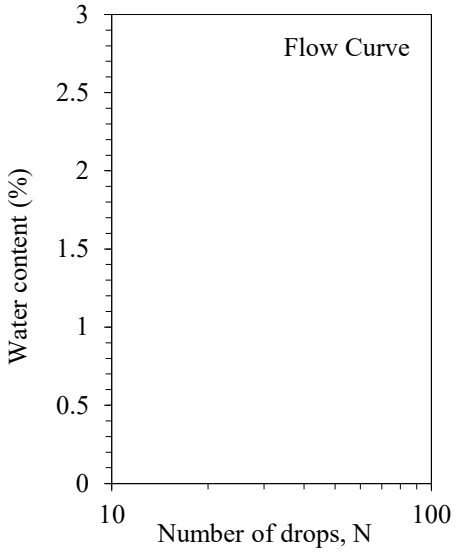
Plastic Limit

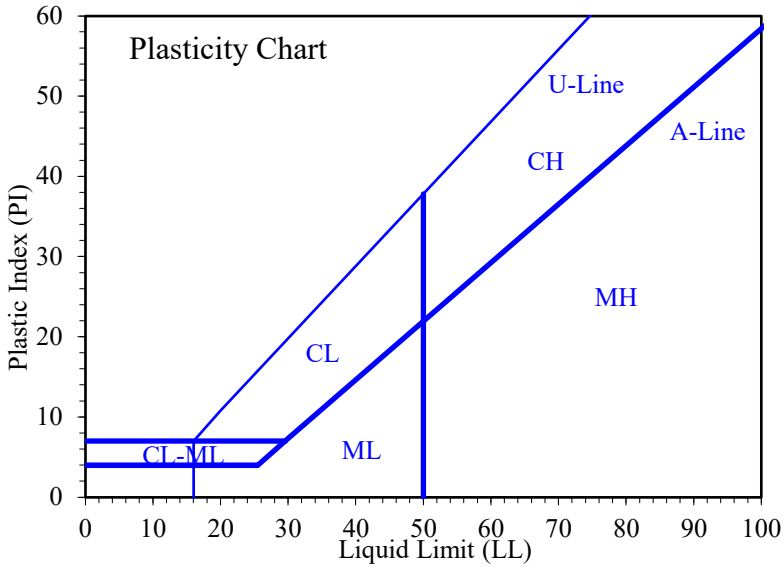
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





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Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/8/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-02
Sample: 6
Depth: 30'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

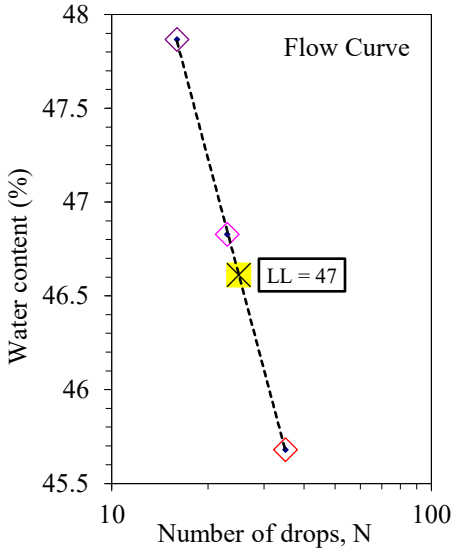
Plastic Limit

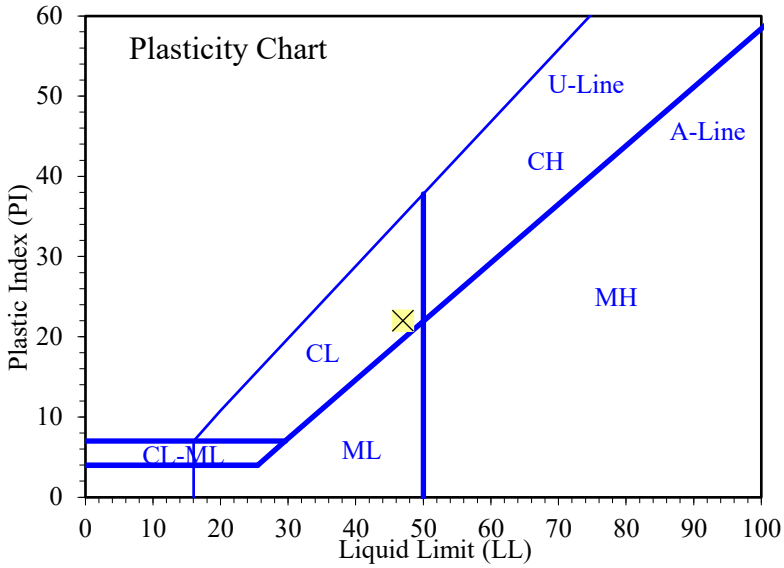
Determination No	1	2				
Wet Soil + Tare (g)	13.82	14.31				
Dry Soil + Tare (g)	12.55	12.93				
Water Loss (g)	1.27	1.38				
Tare (g)	7.44	7.30				
Dry Soil (g)	5.11	5.63				
Water Content, w (%)	24.85	24.51				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	23	16			
Wet Soil + Tare (g)	11.83	15.40	15.35			
Dry Soil + Tare (g)	10.35	12.89	12.77			
Water Loss (g)	1.48	2.51	2.58			
Tare (g)	7.11	7.53	7.38			
Dry Soil (g)	3.24	5.36	5.39			
Water Content, w (%)	45.68	46.83	47.87			
One-Point LL (%)		46				

Liquid Limit, LL (%)	**47**
Plastic Limit, PL (%)	**25**
Plasticity Index, PI (%)	**22**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 36.8

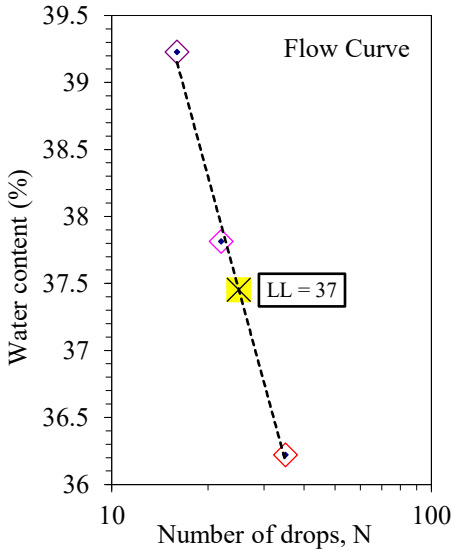
Plastic Limit

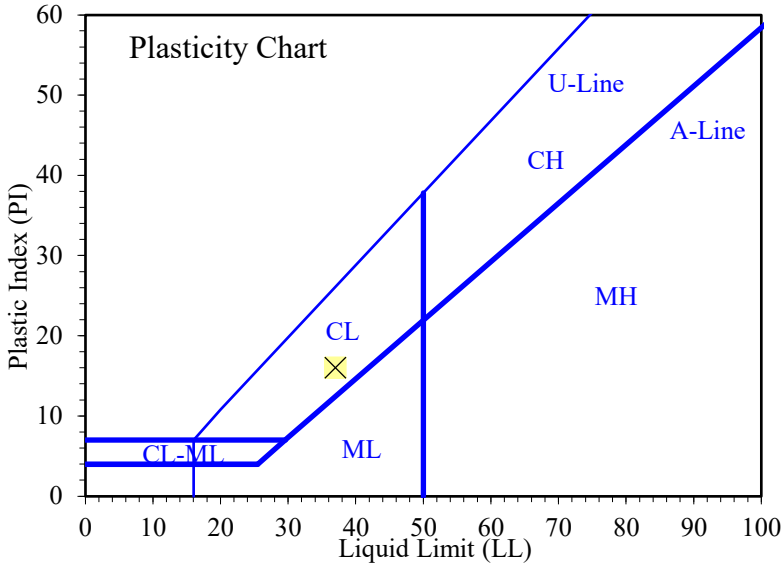
Determination No	1	2				
Wet Soil + Tare (g)	14.18	14.06				
Dry Soil + Tare (g)	13.03	12.86				
Water Loss (g)	1.15	1.20				
Tare (g)	7.51	7.02				
Dry Soil (g)	5.52	5.84				
Water Content, w (%)	20.83	20.55				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	22	16			
Wet Soil + Tare (g)	16.14	15.22	17.02			
Dry Soil + Tare (g)	13.84	13.11	14.38			
Water Loss (g)	2.30	2.11	2.64			
Tare (g)	7.49	7.53	7.65			
Dry Soil (g)	6.35	5.58	6.73			
Water Content, w (%)	36.22	37.81	39.23			
One-Point LL (%)		37				

Liquid Limit, LL (%)	**37**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**16**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-03
Sample: 3
Depth: 15'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: By hand
Approximate maximum grain size: No.20
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

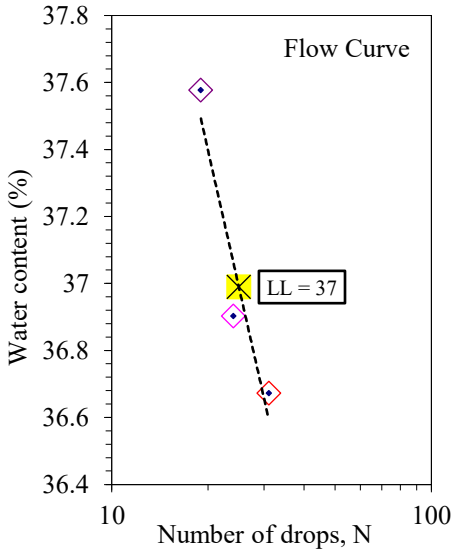
Plastic Limit

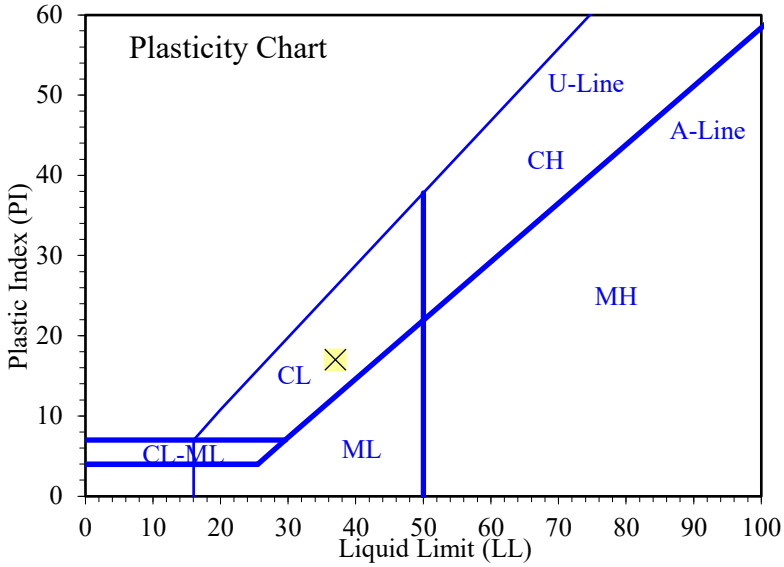
Determination No	1	2				
Wet Soil + Tare (g)	13.63	13.85				
Dry Soil + Tare (g)	12.53	12.71				
Water Loss (g)	1.10	1.14				
Tare (g)	7.06	7.05				
Dry Soil (g)	5.47	5.66				
Water Content, w (%)	20.11	20.14				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	31	24	19			
Wet Soil + Tare (g)	14.92	14.48	16.27			
Dry Soil + Tare (g)	12.87	12.55	13.85			
Water Loss (g)	2.05	1.93	2.42			
Tare (g)	7.28	7.32	7.41			
Dry Soil (g)	5.59	5.23	6.44			
Water Content, w (%)	36.67	36.90	37.58			
One-Point LL (%)		37				

Liquid Limit, LL (%)	**37**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**17**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-04
Sample: 6A
Depth: 24'
Description: Grey silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: 3/8"
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): Not requested

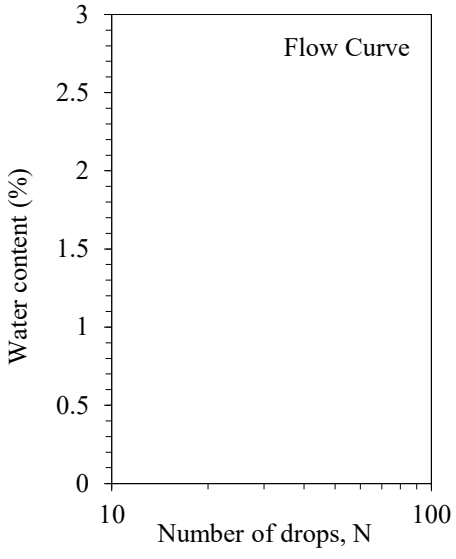
Plastic Limit

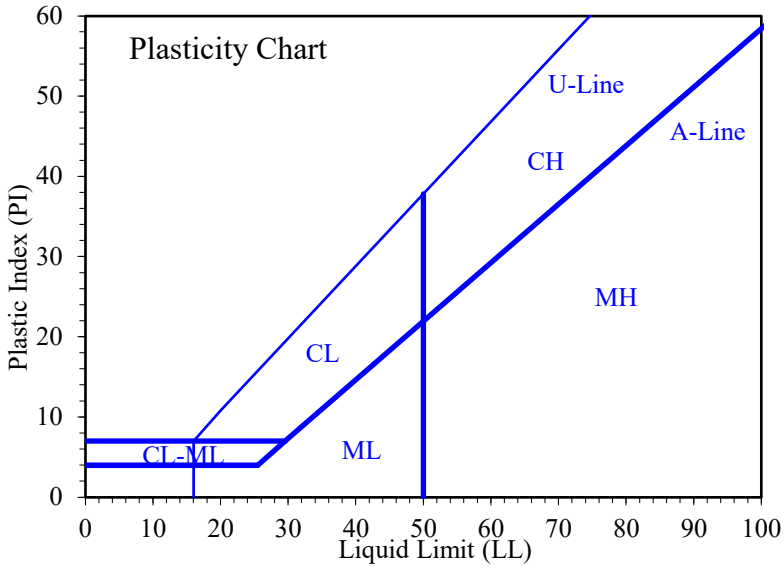
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-05
Sample: 5B
Depth: 21'
Description: Grey silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

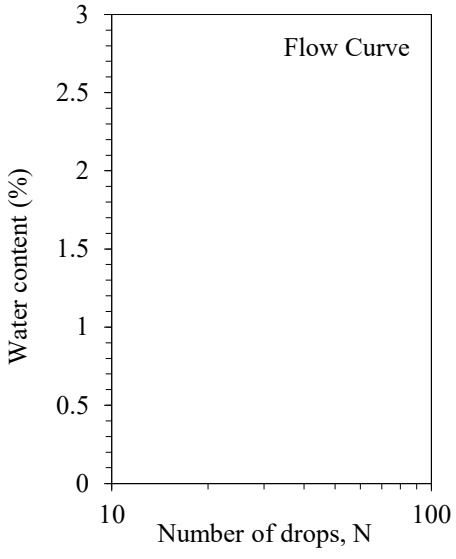
Plastic Limit

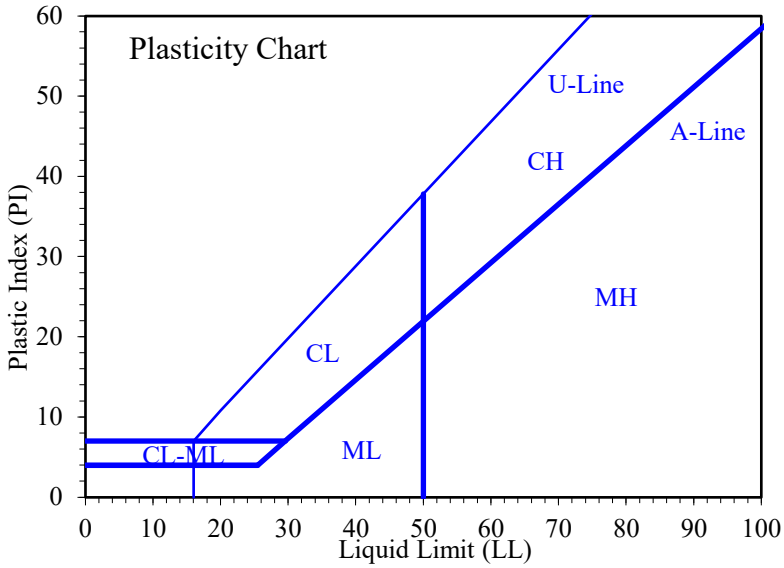
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/14/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.4
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 51.5

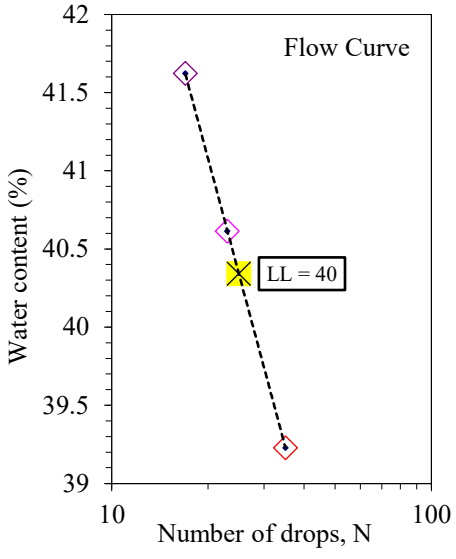
Plastic Limit

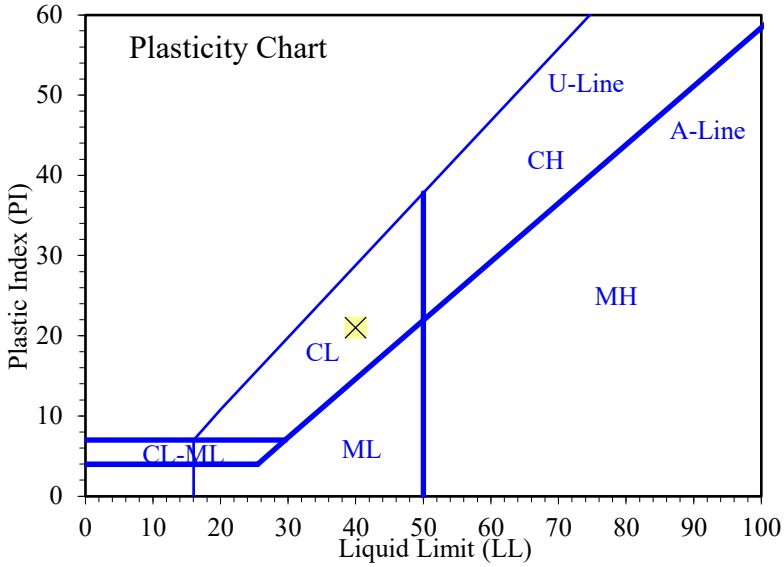
Determination No	1	2				
Wet Soil + Tare (g)	13.52	15.18				
Dry Soil + Tare (g)	12.49	13.97				
Water Loss (g)	1.03	1.21				
Tare (g)	7.04	7.54				
Dry Soil (g)	5.45	6.43				
Water Content, w (%)	18.90	18.82				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	23	17			
Wet Soil + Tare (g)	16.12	15.35	15.55			
Dry Soil + Tare (g)	13.68	12.97	13.14			
Water Loss (g)	2.44	2.38	2.41			
Tare (g)	7.46	7.11	7.35			
Dry Soil (g)	6.22	5.86	5.79			
Water Content, w (%)	39.23	40.61	41.62			
One-Point LL (%)		40				

Liquid Limit, LL (%)	**40**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**21**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: By hand
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 53.3

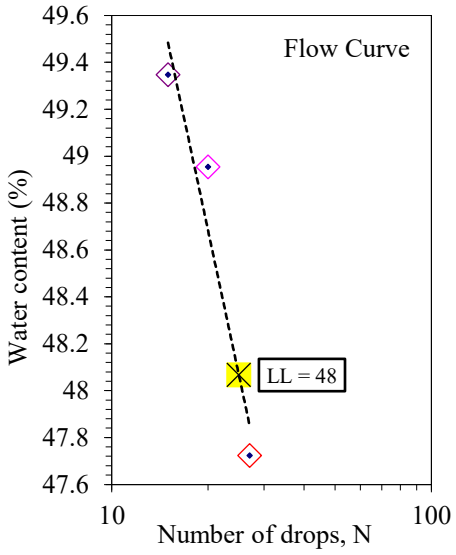
Plastic Limit

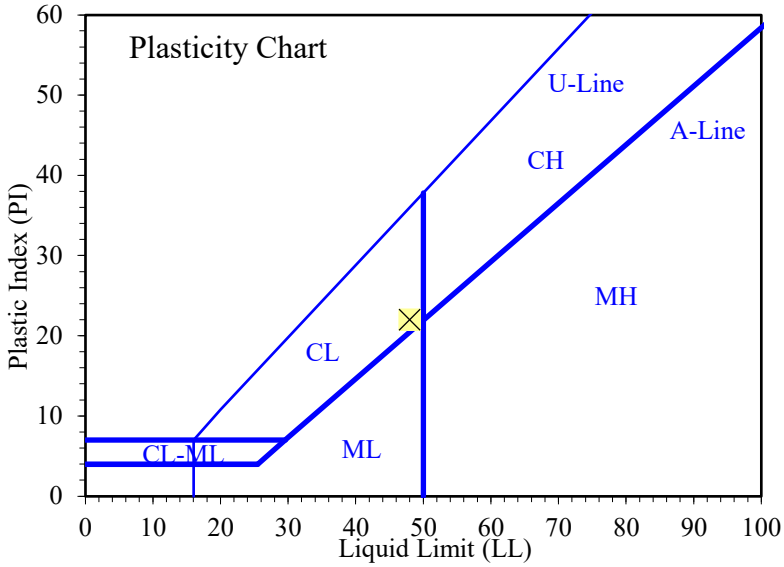
Determination No	1	2				
Wet Soil + Tare (g)	13.49	14.13				
Dry Soil + Tare (g)	12.15	12.66				
Water Loss (g)	1.34	1.47				
Tare (g)	7.06	7.10				
Dry Soil (g)	5.09	5.56				
Water Content, w (%)	26.33	26.44				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	27	20	15			
Wet Soil + Tare (g)	14.50	14.47	14.22			
Dry Soil + Tare (g)	12.09	12.13	11.95			
Water Loss (g)	2.41	2.34	2.27			
Tare (g)	7.04	7.35	7.35			
Dry Soil (g)	5.05	4.78	4.60			
Water Content, w (%)	47.72	48.95	49.35			
One-Point LL (%)	48	48				

Liquid Limit, LL (%)	**48**
Plastic Limit, PL (%)	**26**
Plasticity Index, PI (%)	**22**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'
Description: Brown fat clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: By hand
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 44.7

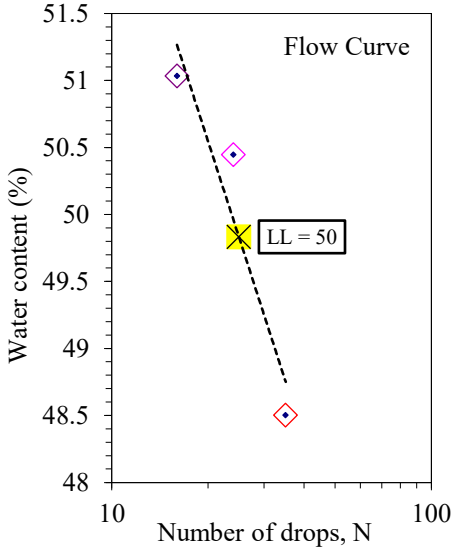
Plastic Limit

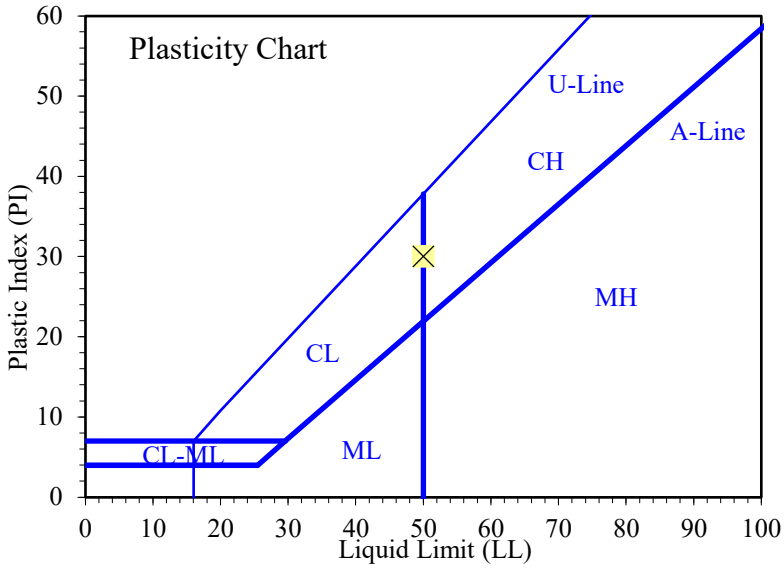
Determination No	1	2				
Wet Soil + Tare (g)	15.06	15.10				
Dry Soil + Tare (g)	13.78	13.82				
Water Loss (g)	1.28	1.28				
Tare (g)	7.46	7.46				
Dry Soil (g)	6.32	6.36				
Water Content, w (%)	20.25	20.13				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	24	16			
Wet Soil + Tare (g)	14.88	13.83	14.18			
Dry Soil + Tare (g)	12.45	11.57	11.96			
Water Loss (g)	2.43	2.26	2.22			
Tare (g)	7.44	7.09	7.61			
Dry Soil (g)	5.01	4.48	4.35			
Water Content, w (%)	48.50	50.45	51.03			
One-Point LL (%)		50				

Liquid Limit, LL (%)	**50**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**30**





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Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/14/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-07
Sample: 3B
Depth: 12'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

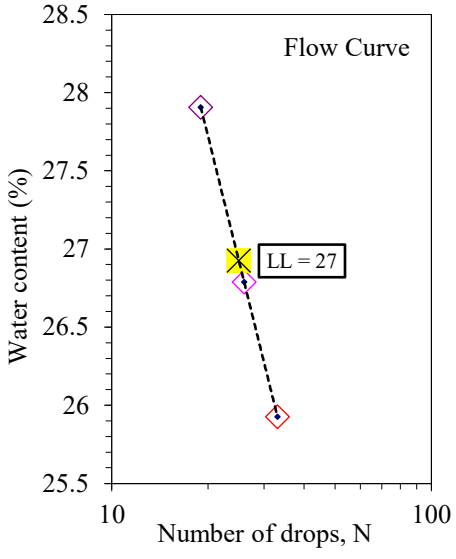
Plastic Limit

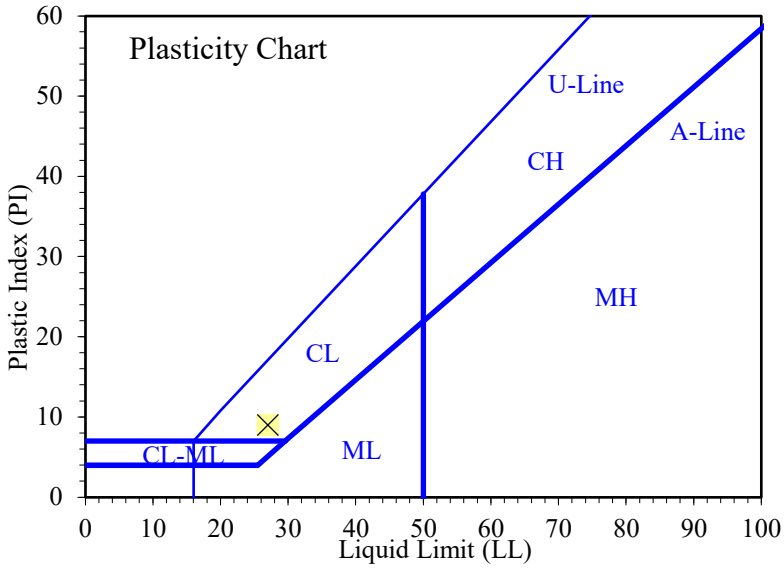
Determination No	1	2				
Wet Soil + Tare (g)	14.53	15.12				
Dry Soil + Tare (g)	13.36	13.89				
Water Loss (g)	1.17	1.23				
Tare (g)	7.08	7.11				
Dry Soil (g)	6.28	6.78				
Water Content, w (%)	18.63	18.14				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	26	19			
Wet Soil + Tare (g)	15.28	14.67	17.68			
Dry Soil + Tare (g)	13.67	13.06	15.52			
Water Loss (g)	1.61	1.61	2.16			
Tare (g)	7.46	7.05	7.78			
Dry Soil (g)	6.21	6.01	7.74			
Water Content, w (%)	25.93	26.79	27.91			
One-Point LL (%)		27				

Liquid Limit, LL (%)	**27**
Plastic Limit, PL (%)	**18**
Plasticity Index, PI (%)	**9**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-07
Sample: 4
Depth: 14'
Description: Grey silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

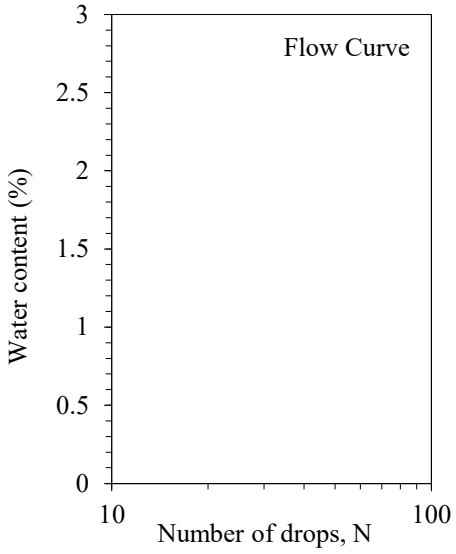
Plastic Limit

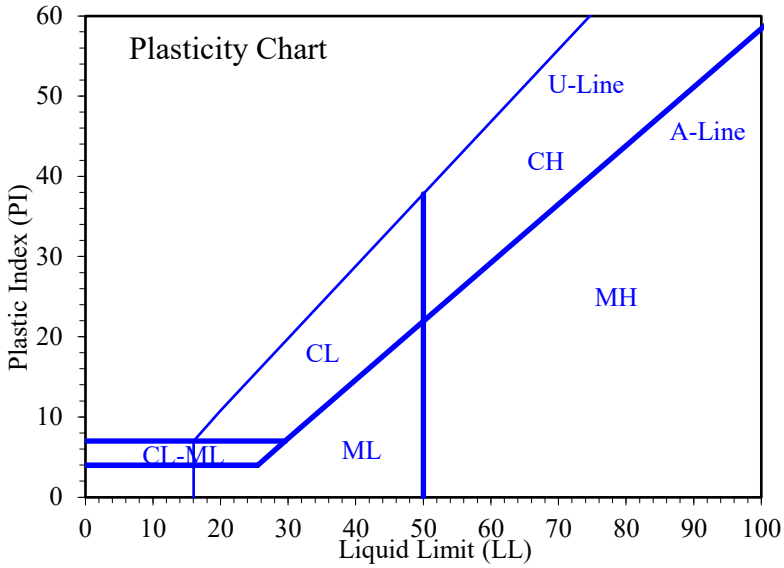
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'
Description: Dark grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: No
Larger particles removed: By hand
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 42.7

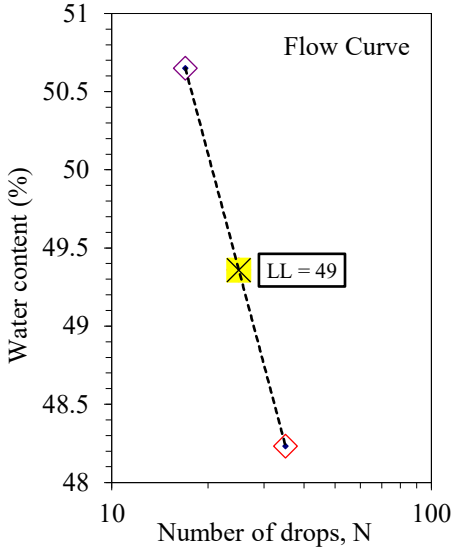
Plastic Limit

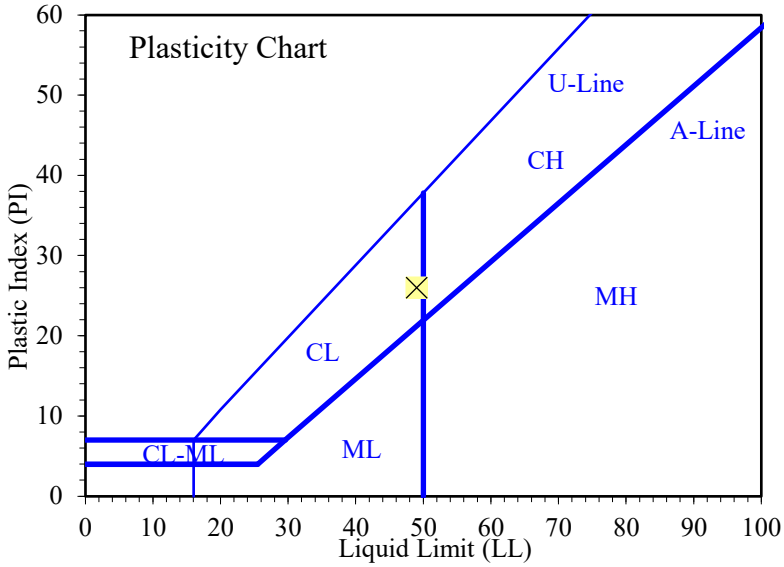
Determination No	1	2				
Wet Soil + Tare (g)	13.65	13.94				
Dry Soil + Tare (g)	12.43	12.73				
Water Loss (g)	1.22	1.21				
Tare (g)	7.06	7.40				
Dry Soil (g)	5.37	5.33				
Water Content, w (%)	22.72	22.70				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	25	17			
Wet Soil + Tare (g)	15.34	15.20	15.53			
Dry Soil + Tare (g)	12.75	12.50	12.80			
Water Loss (g)	2.59	2.70	2.73			
Tare (g)	7.38	7.03	7.41			
Dry Soil (g)	5.37	5.47	5.39			
Water Content, w (%)	48.23	49.36	50.65			
One-Point LL (%)		49				

Liquid Limit, LL (%)	**49**
Plastic Limit, PL (%)	**23**
Plasticity Index, PI (%)	**26**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-08
Sample: 3
Depth: 12'
Description: Grey silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

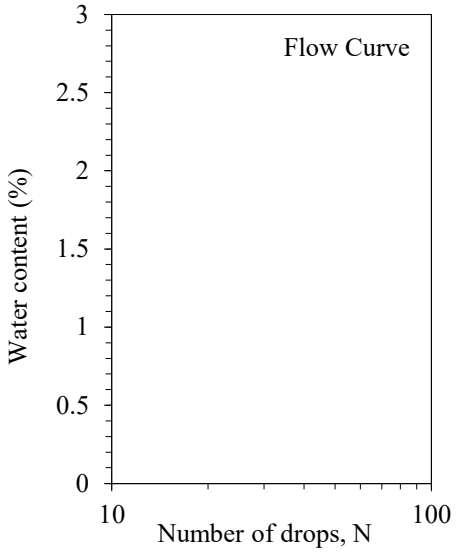
Plastic Limit

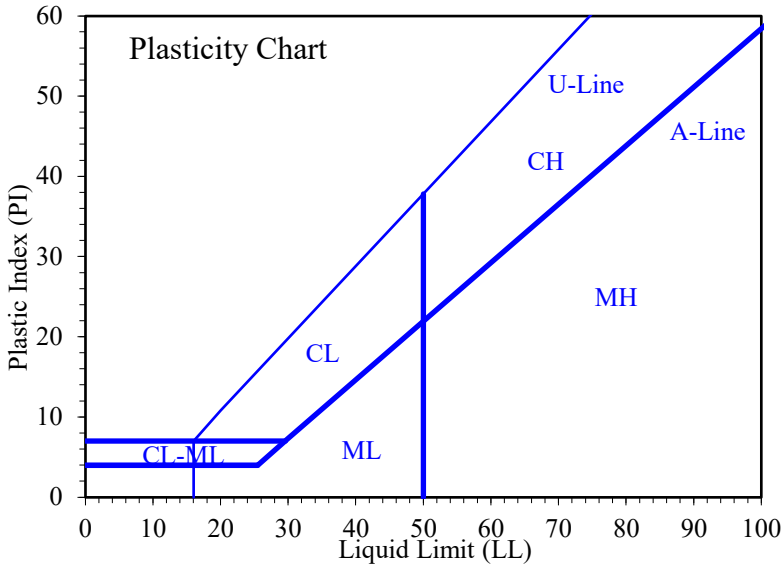
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 44.4

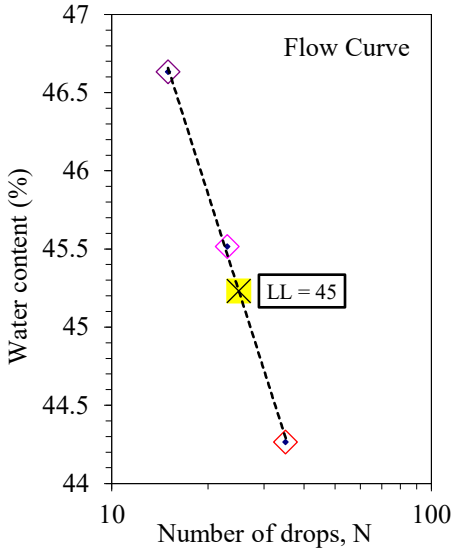
Plastic Limit

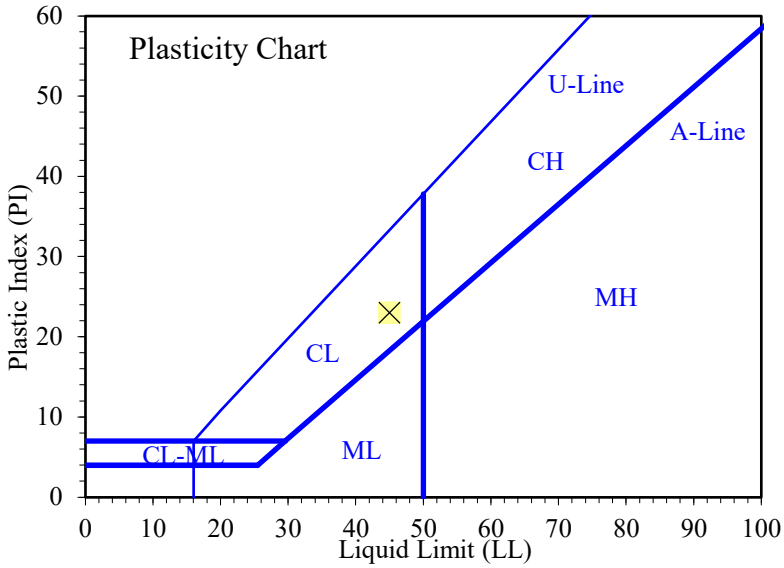
Determination No	1	2				
Wet Soil + Tare (g)	13.78	14.64				
Dry Soil + Tare (g)	12.56	13.28				
Water Loss (g)	1.22	1.36				
Tare (g)	7.07	7.04				
Dry Soil (g)	5.49	6.24				
Water Content, w (%)	22.22	21.79				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	23	15			
Wet Soil + Tare (g)	14.28	15.78	16.33			
Dry Soil + Tare (g)	12.08	13.04	13.49			
Water Loss (g)	2.20	2.74	2.84			
Tare (g)	7.11	7.02	7.40			
Dry Soil (g)	4.97	6.02	6.09			
Water Content, w (%)	44.27	45.51	46.63			
One-Point LL (%)		45				

Liquid Limit, LL (%)	**45**
Plastic Limit, PL (%)	**22**
Plasticity Index, PI (%)	**23**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/14/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-09
Sample: 8B
Depth: 45'
Description: Grey silt

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

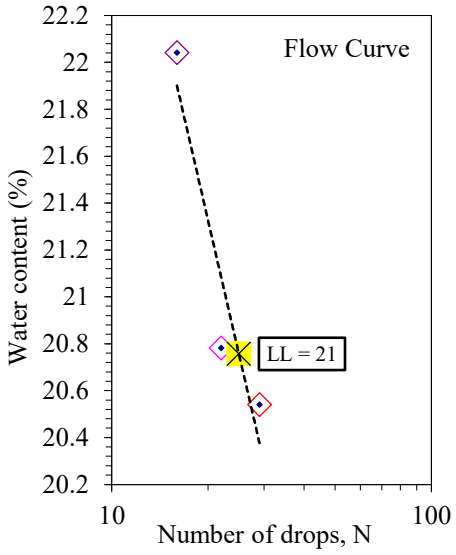
Plastic Limit

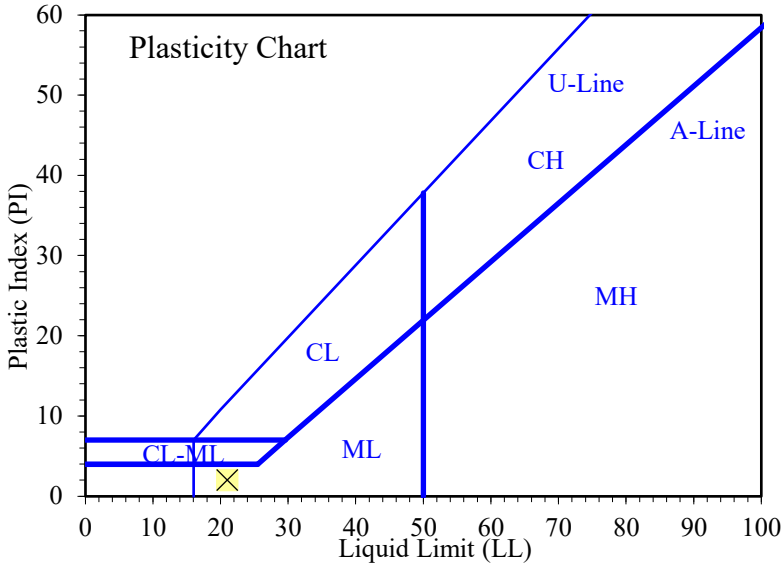
Determination No	1	2				
Wet Soil + Tare (g)	13.75	14.70				
Dry Soil + Tare (g)	12.68	13.49				
Water Loss (g)	1.07	1.21				
Tare (g)	7.06	7.04				
Dry Soil (g)	5.62	6.45				
Water Content, w (%)	19.04	18.76				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	29	22	16			
Wet Soil + Tare (g)	15.47	15.19	15.35			
Dry Soil + Tare (g)	14.10	13.86	13.99			
Water Loss (g)	1.37	1.33	1.36			
Tare (g)	7.43	7.46	7.82			
Dry Soil (g)	6.67	6.40	6.17			
Water Content, w (%)	20.54	20.78	22.04			
One-Point LL (%)	21	20				

Liquid Limit, LL (%)	**21**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**2**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/5/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-09
Sample: 10
Depth: 55'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.4
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

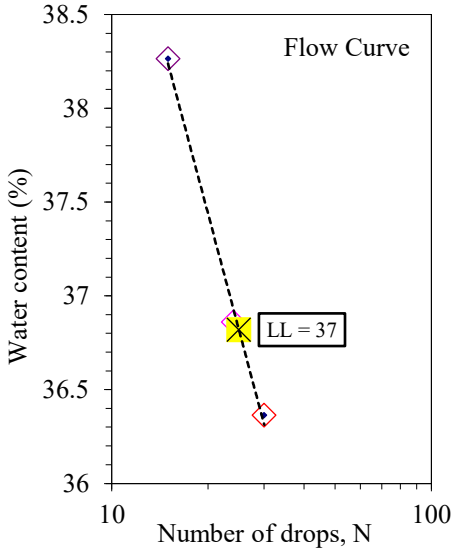
Plastic Limit

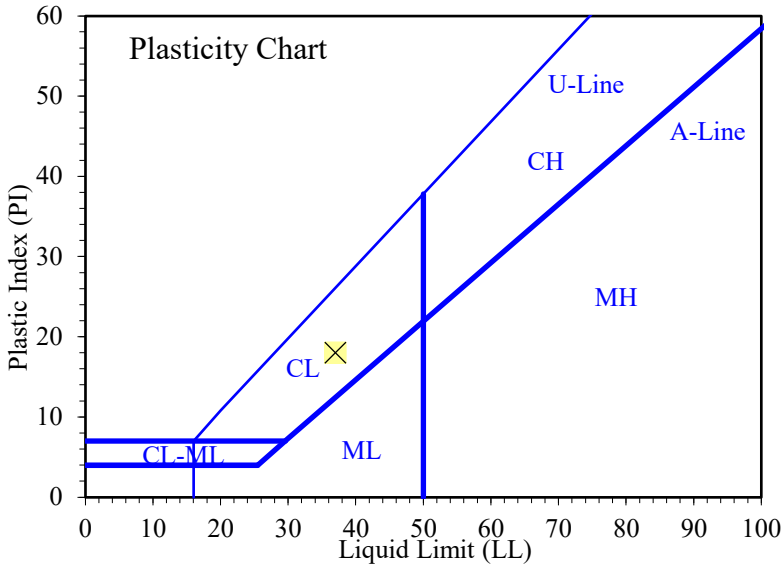
Determination No	1	2				
Wet Soil + Tare (g)	13.66	13.55				
Dry Soil + Tare (g)	12.61	12.53				
Water Loss (g)	1.05	1.02				
Tare (g)	7.04	7.06				
Dry Soil (g)	5.57	5.47				
Water Content, w (%)	18.85	18.65				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	30	24	15			
Wet Soil + Tare (g)	16.42	15.91	14.48			
Dry Soil + Tare (g)	13.94	13.68	12.54			
Water Loss (g)	2.48	2.23	1.94			
Tare (g)	7.12	7.63	7.47			
Dry Soil (g)	6.82	6.05	5.07			
Water Content, w (%)	36.36	36.86	38.26			
One-Point LL (%)	37	37				

Liquid Limit, LL (%)	**37**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**18**





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-09
Sample: 14
Depth: 75'
Description: Brown silt

Preparation method: Wet
Liquid Limit: Could not be determined (N.P.)
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.10
Estimated percent retained on No.40: Not requested
As-received water content (%): Not requested

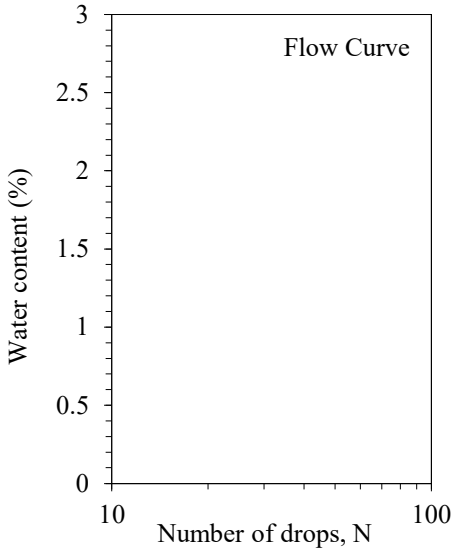
Plastic Limit

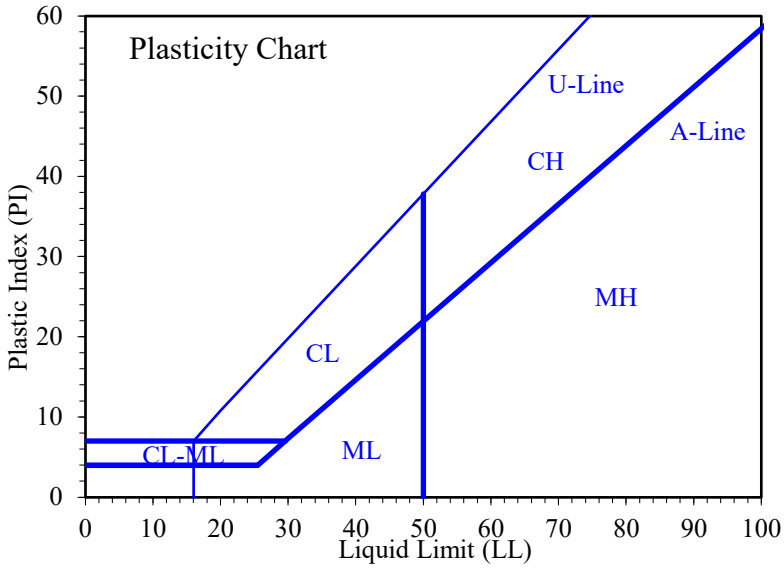
Determination No						
Wet Soil + Tare (g)						
Dry Soil + Tare (g)		Difficult to thread.				
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						

Liquid Limit: Could not be determined (N.P.)

Determination No						
Number of Drops, N						
Wet Soil + Tare (g)	Unable to obtain an adequate blow count.					
Dry Soil + Tare (g)						
Water Loss (g)						
Tare (g)						
Dry Soil (g)						
Water Content, w (%)						
One-Point LL (%)						

Liquid Limit, LL (%)	**Nonplastic (N.P.)**
Plastic Limit, PL (%)	
Plasticity Index, PI (%)	





Entered by:_____
Reviewed:_____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'
Description: Grey lean clay

Preparation method: Wet
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Wet sieved
Approximate maximum grain size: No.20
Estimated percent retained on No.40: See Particle Size Distribution
As-received water content (%): 34.8

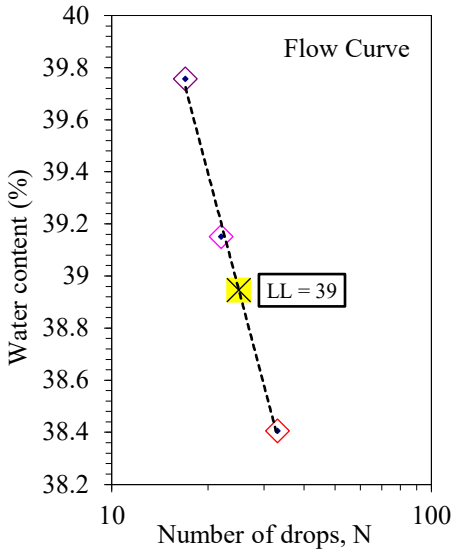
Plastic Limit

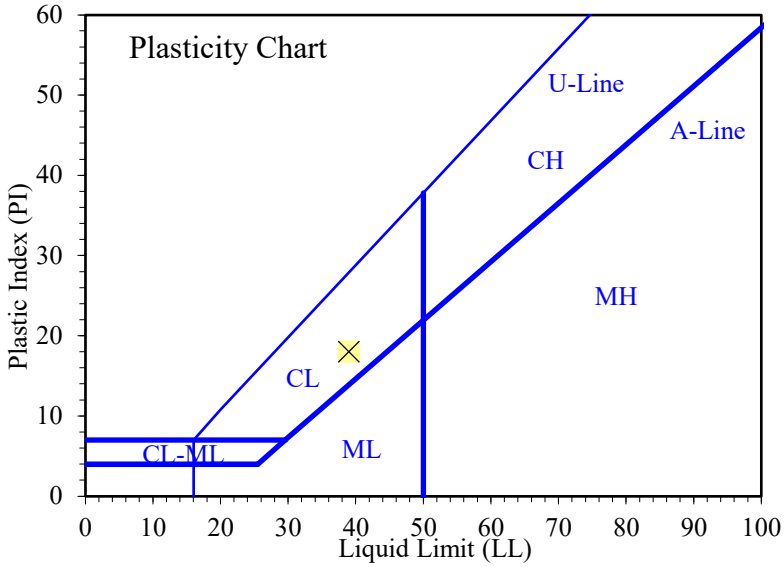
Determination No	1	2				
Wet Soil + Tare (g)	14.34	14.78				
Dry Soil + Tare (g)	13.08	13.46				
Water Loss (g)	1.26	1.32				
Tare (g)	7.00	7.06				
Dry Soil (g)	6.08	6.40				
Water Content, w (%)	20.72	20.63				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	22	17			
Wet Soil + Tare (g)	14.99	15.63	15.50			
Dry Soil + Tare (g)	12.87	13.23	13.21			
Water Loss (g)	2.12	2.40	2.29			
Tare (g)	7.35	7.10	7.45			
Dry Soil (g)	5.52	6.13	5.76			
Water Content, w (%)	38.41	39.15	39.76			
One-Point LL (%)		39				

Liquid Limit, LL (%)	**39**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**18**





Entered by:_____
Reviewed:_____

Particle-Size Distribution Test Results

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 12/17/2018
By: JDF

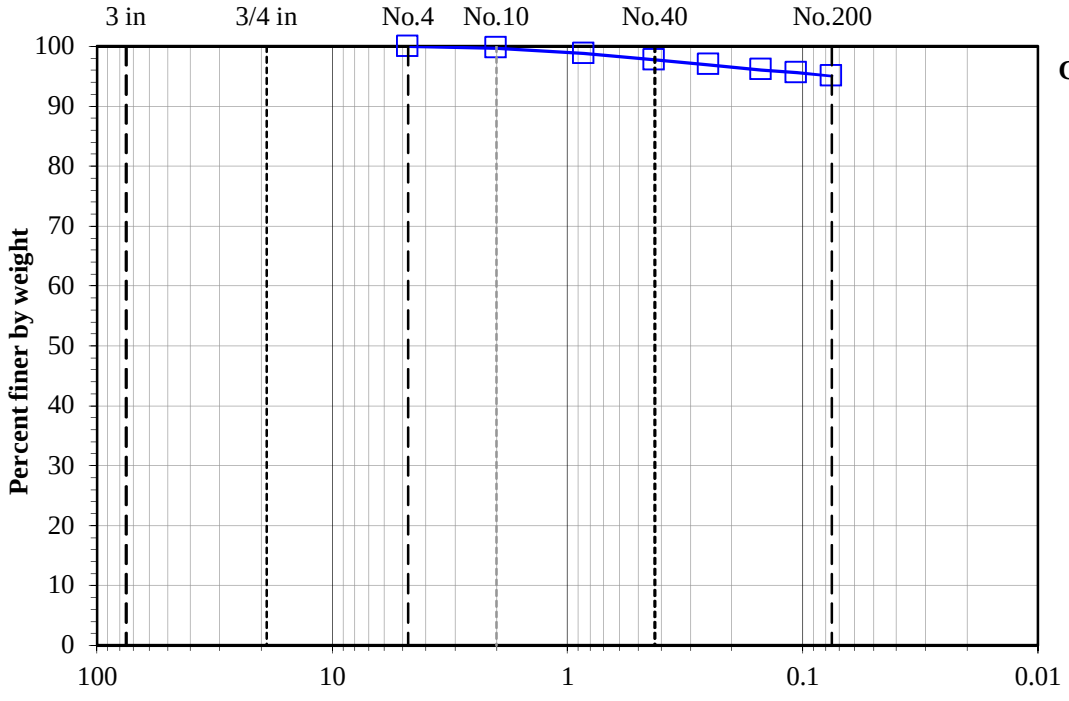
Boring No.: BH18-PC-1
Sample: 6
Depth: 39'
Description: Grey clay

Split:	No	
	-	
	Moist	Dry
Total sample wt. (g):	140.01	94.10
Split fraction:	1.000	

Water content data

Moist soil + tare (g):	-	365.12
Dry soil + tare (g):	-	319.21
Tare (g):	-	225.11
Water content (%):	0.0	48.8

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
8"	-	200	-
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	0.28	2	99.7
No.20	1.14	0.85	98.8
No.40	2.12	0.425	97.7
No.60	2.91	0.25	96.9
No.100	3.70	0.15	96.1
No.140	4.17	0.106	95.6
No.200	4.70	0.075	95.0



Gravel (%): 0.0
Sand (%): 5.0
Fines (%): 95.0

Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 12/18/2018
By: JP

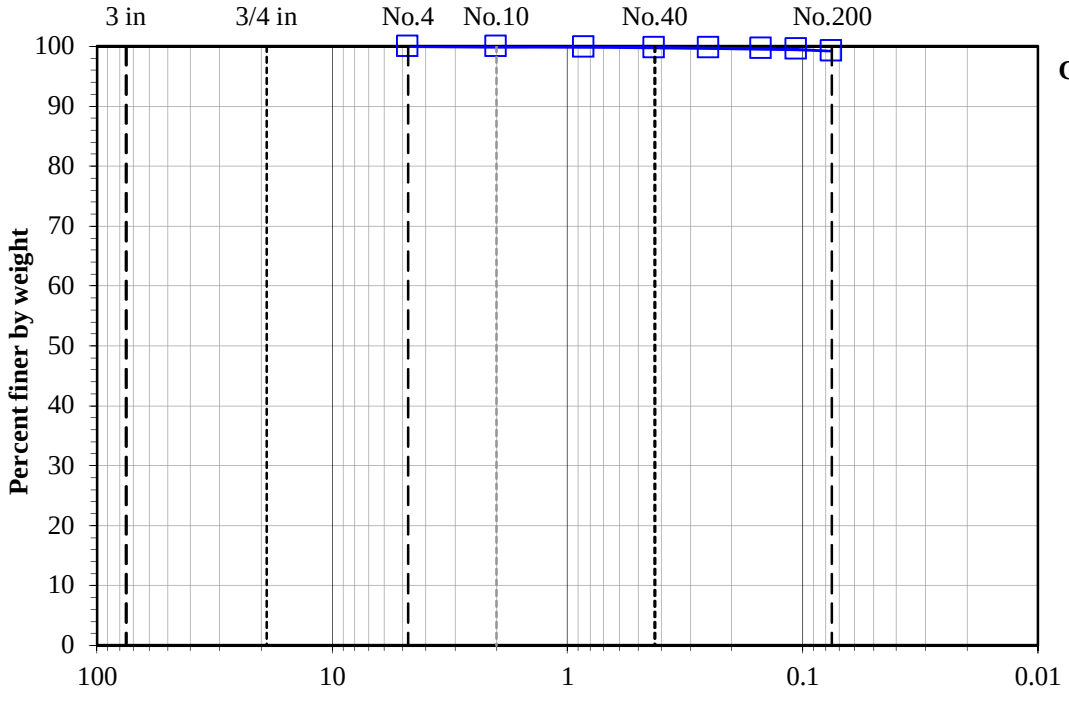
Boring No.: BH18-PC-1
Sample: 16B
Depth: 85'
Description: Grey clay

Split:	No	
	-	
	Moist	Dry
Total sample wt. (g):	161.04	121.50
Split fraction:	1.000	

Water content data

Moist soil + tare (g):	-	287.98
Dry soil + tare (g):	-	248.44
Tare (g):	-	126.94
Water content (%):	0.0	32.5

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
8"	-	200	-
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	0.09	2	99.9
No.20	0.16	0.85	99.9
No.40	0.27	0.425	99.8
No.60	0.35	0.25	99.7
No.100	0.46	0.15	99.6
No.140	0.60	0.106	99.5
No.200	0.99	0.075	99.2



Gravel (%): 0.0
Sand (%): 0.8
Fines (%): 99.2

Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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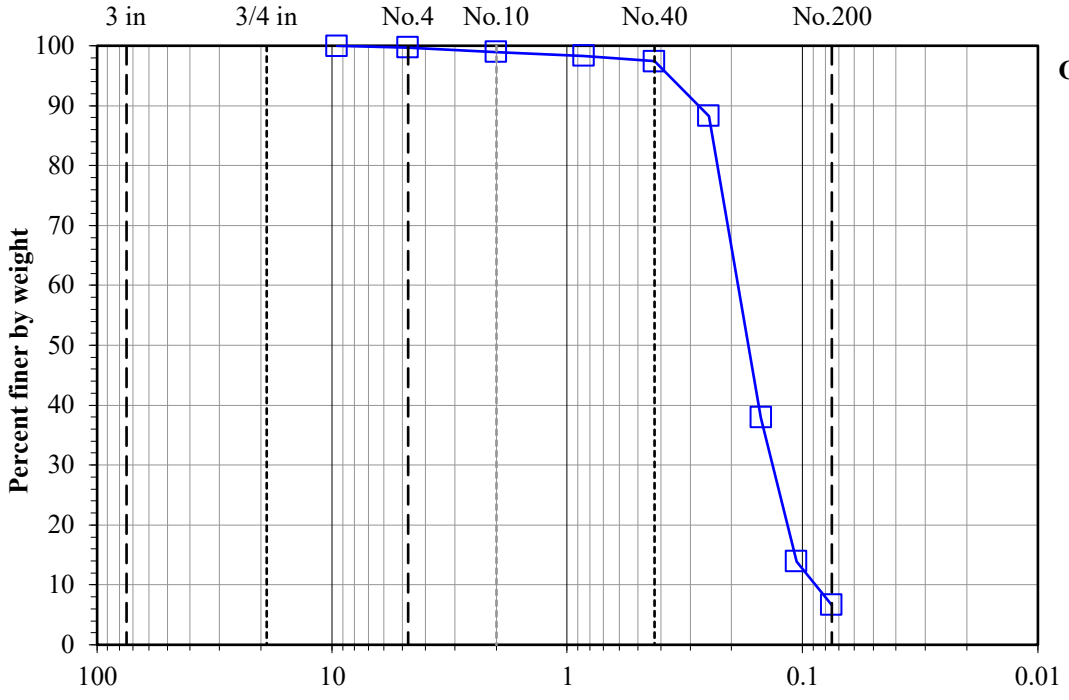
Project: SLCWRF
No: 00100-015, 3G2 (XXIII)
Location: Salt Lake City, Utah
Date: 8/4/2021
By: RT

Boring No.: BH18-IT-5
Sample:
Depth: 20.0'
Description: Brown sand with silt

Split:	No	
	Moist	Dry
Total sample wt. (g):	334.47	279.67
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	455.19
Dry soil + tare (g):	-	400.39
Tare (g):	-	120.72
Water content (%):	0.0	19.6

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	100.0
No.4	0.85	4.75	99.7
No.10	2.86	2	99.0
No.20	4.70	0.85	98.3
No.40	7.23	0.425	97.4
No.60	32.81	0.25	88.3
No.100	173.45	0.15	38.0
No.140	240.81	0.106	13.9
No.200	261.14	0.075	6.6



Gravel (%): 0.3
Sand (%): 93.1
Fines (%): 6.6

Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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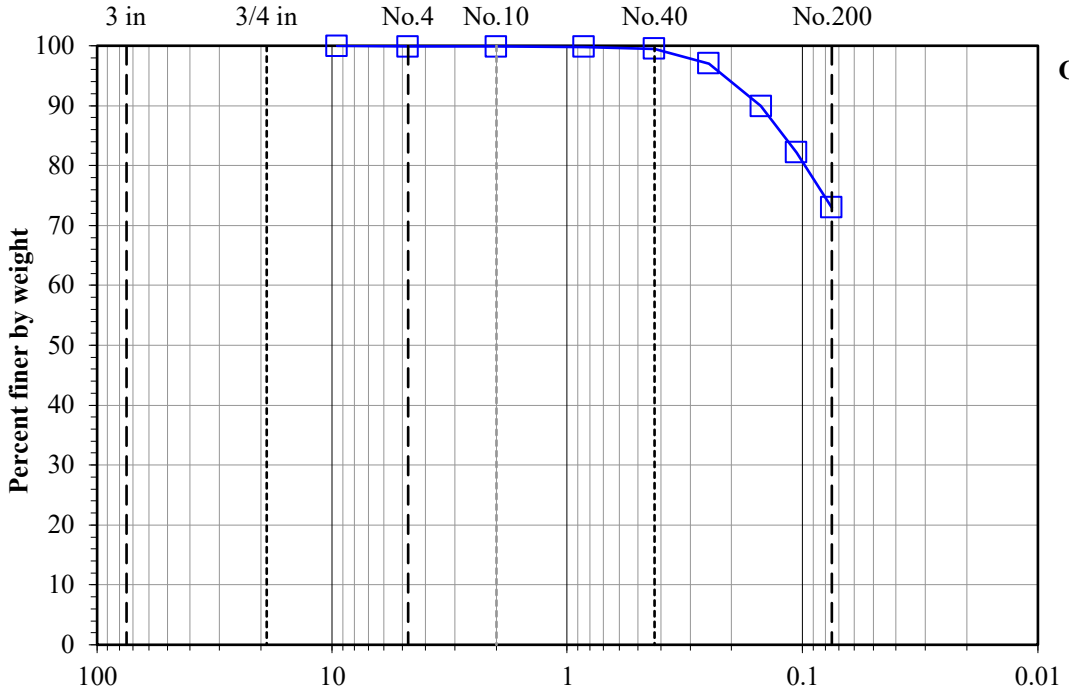
Project: SLCWRF
No: 00100-015, 3G2 (XXIII)
Location: Salt Lake City, Utah
Date: 8/6/2021
By: JWB

Boring No.: BH18-IT-5
Sample:
Depth: 56.0'
Description: Brown silt with sand

Split:	No	
	Moist	Dry
Total sample wt. (g):	233.36	201.70
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	362.23
Dry soil + tare (g):	-	330.57
Tare (g):	-	128.87
Water content (%):	0.0	15.7

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	100.0
No.4	0.28	4.75	99.9
No.10	0.32	2	99.8
No.20	0.42	0.85	99.8
No.40	1.07	0.425	99.5
No.60	5.96	0.25	97.0
No.100	20.35	0.15	89.9
No.140	35.93	0.106	82.2
No.200	54.36	0.075	73.0



Gravel (%): 0.1
Sand (%): 26.8
Fines (%): 73.0

Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

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Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/13/2019
By: JP/BRR

Boring No.: BH18-IT-6
Sample:
Depth: 15.0'
Description: Grey sandy silt

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	187.62	130.80
Hydrometer fraction (g):	66.69	59.54

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"		150	-
4"		100	-
3"		75	-
1.5"		37.5	-
1"		25	-
3/4"		19	-
3/8"		9.5	-
No.4		4.75	100.0
No.10	0.24	2	99.8
No.20	1.40	0.85	98.9
No.40	3.18	0.425	97.6
No.60	5.31	0.25	95.9
No.100	15.10	0.15	88.5
No.140	30.94	0.106	76.3
No.200	46.85	0.075	64.2

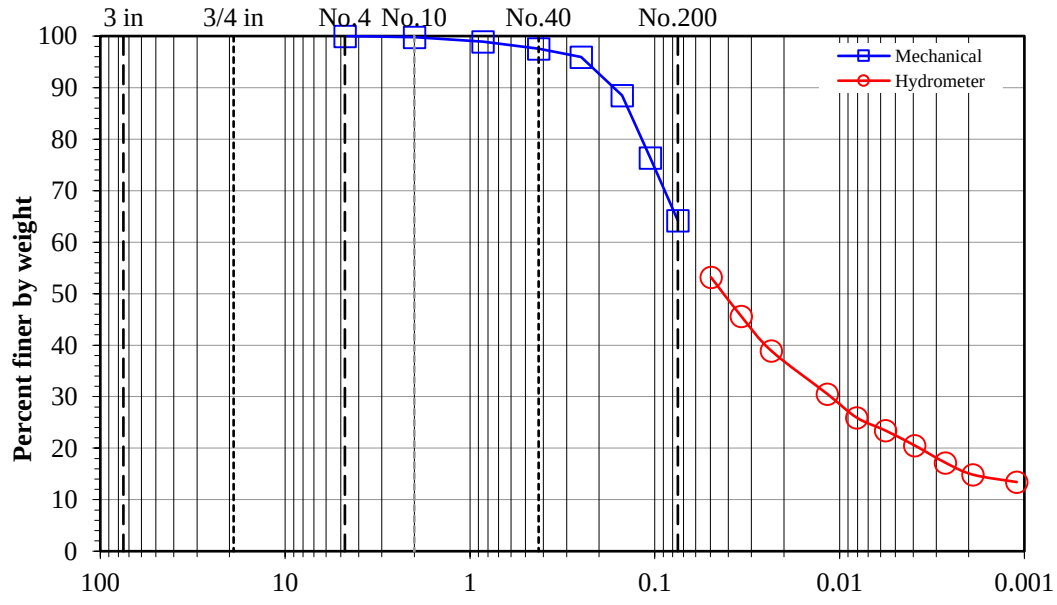
Water content data		S.F.	Hyd.(-No.10)
Moist soil + tare (g):		311.31	52.36
Dry soil + tare (g):		254.49	49.26
Tare (g):		123.69	23.44
Water content (%):		43.44	12.01

Hydrometer data			
Hyd. split:	No.10		
Gs:	2.65	Assumed	
Bulb No.	6	Hyd. fraction:	99.82
Cylinder ID:	T1	Dispersion device:	Air-jet

<=Split hyd.

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	22.1	36.5	0.0496	53.18
2	22.1	32	0.0341	45.64
4	22.1	28	0.0234	38.93
15	22.1	23	0.0117	30.55
30	22.1	20.25	0.0081	25.94
60	22.1	18.75	0.0056	23.42
120	22.2	17	0.0039	20.55
250	22.2	15	0.0027	17.20
483	22.5	13.5	0.0019	14.87
1425	22.2	12.75	0.0011	13.43

Gravel (%): 0.0
Sand (%): 35.8
Fines (%): 64.2



Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

© IGES 2019, 2019

Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/10/2019
By: JP/EZ/BRR

Boring No.: BH18-IT-6
Sample:
Depth: 20.0'
Description: Grey clay

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	302.64	202.81
Hydrometer fraction (g):	62.07	55.11

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"		150	-	
4"		100	-	
3"		75	-	
1.5"		37.5	-	
1"		25	-	
3/4"		19	-	
3/8"		9.5	-	
No.4		4.75	-	
No.10		2	100.0	<=Split hyd.
No.20	0.06	0.85	100.0	
No.40	0.46	0.425	99.8	
No.60	1.22	0.25	99.4	
No.100	4.08	0.15	98.0	
No.140	6.71	0.106	96.7	
No.200	14.61	0.075	92.8	

Water content data

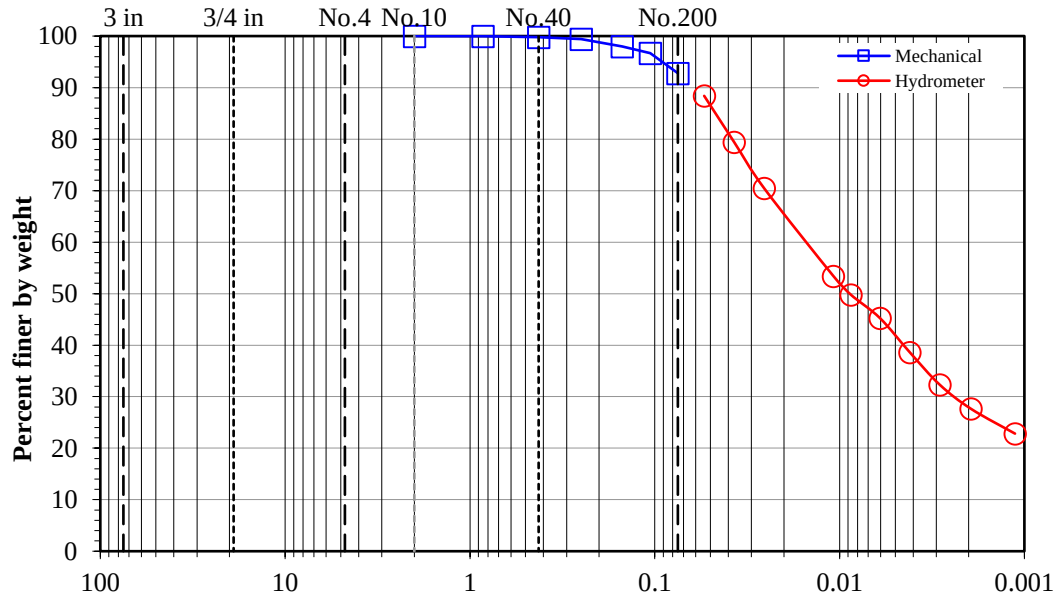
	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	454.38	37.74
Dry soil + tare (g):	354.55	34.91
Tare (g):	151.74	12.51
Water content (%):	49.22	12.63

Hydrometer data

Hyd. split: No.10
Gs: 2.7 Assumed
Bulb No. 6 Hyd. fraction: 100.00
Cylinder ID: N18 Dispersion device: Air-jet

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	22.2	54	0.0540	88.39
2	22.2	49	0.0372	79.42
4	22.2	44	0.0256	70.45
20	22.2	34.5	0.0108	53.40
30	22.2	32.5	0.0087	49.81
60	22.1	30	0.0060	45.26
120	22.2	26.25	0.0042	38.60
240	22.2	22.75	0.0029	32.32
500	22.6	20	0.0019	27.65
1440	22.1	17.5	0.0011	22.83

Gravel (%): 0.0
Sand (%): 7.2
Fines (%): 92.8



Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

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Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/10/2019
By: JP/EZ/BRR

Boring No.: BH19-ITW-2
Sample:
Depth: 12.5'
Description: Grey clay

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	295.14	209.56
Hydrometer fraction (g):	67.95	62.41

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"		150	-
4"		100	-
3"		75	-
1.5"		37.5	-
1"		25	-
3/4"		19	-
3/8"		9.5	100.0
No.4	1.97	4.75	99.1
No.10	2.45	2	98.8
No.20	4.82	0.85	97.7
No.40	7.73	0.425	96.3
No.60	9.65	0.25	95.4
No.100	13.51	0.15	93.6
No.140	16.18	0.106	92.3
No.200	18.57	0.075	91.1

Water content data

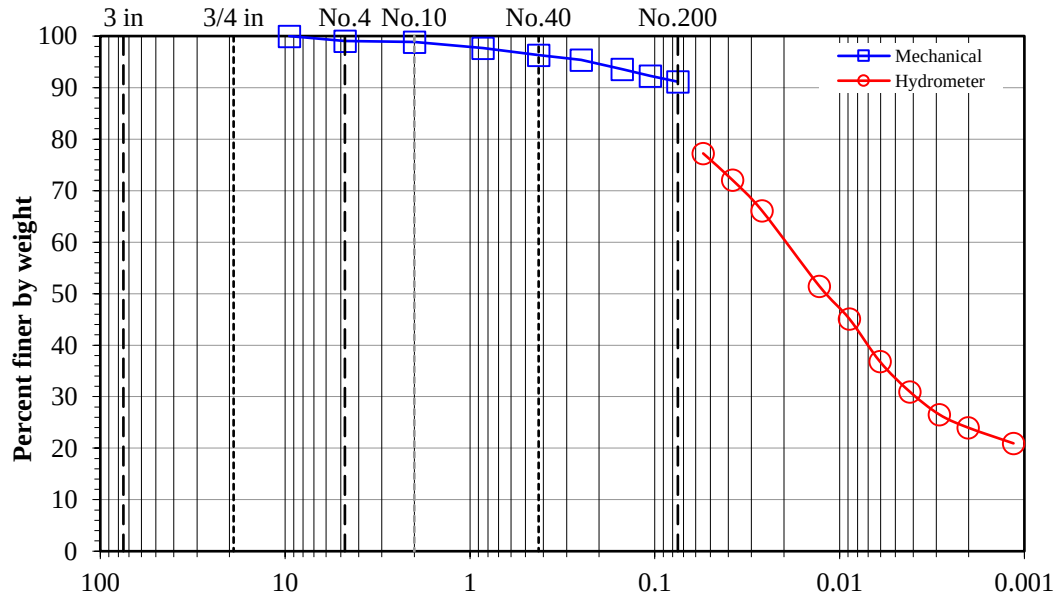
	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	421.96	58.35
Dry soil + tare (g):	336.38	54.62
Tare (g):	126.82	12.64
Water content (%):	40.84	8.89

Hydrometer data

Hyd. split: No.10
Gs: 2.65 Assumed
Bulb No. 6 Hyd. fraction: 98.83
Cylinder ID: T3 Dispersion device: Air-jet

	Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
	1	22.2	53.5	0.0547	77.22
	2	22.2	50.25	0.0380	72.07
	4	22.2	46.5	0.0263	66.13
	15	22.2	37.25	0.0129	51.48
	30	22.2	33.25	0.0089	45.15
	60	22.2	28	0.0061	36.83
	120	22.3	24.25	0.0042	30.95
	240	22.2	21.5	0.0029	26.54
	476	22.6	19.75	0.0020	24.00
<=Split hyd.	1440	22.1	18	0.0011	20.94

Gravel (%): 0.9
Sand (%): 7.9
Fines (%): 91.1



Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

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Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/13/2019
By: EZ/BRR

Boring No.: BH19-ITW-2
Sample:
Depth: 15.0'
Description: Grey clay

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	96.82	63.09
Hydrometer fraction (g):	59.18	50.65

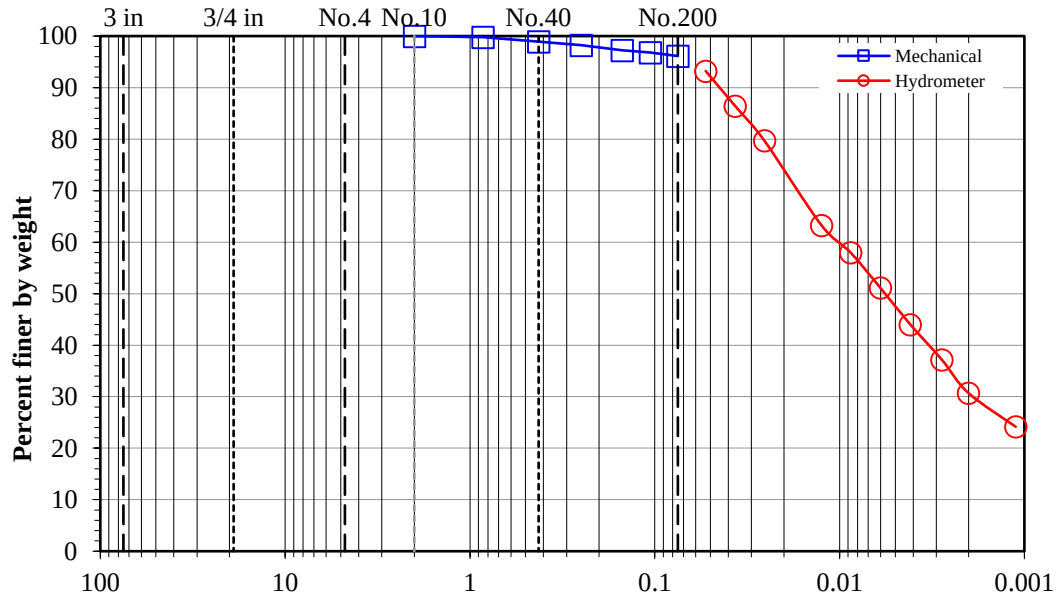
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"		150	-	
4"		100	-	
3"		75	-	
1.5"		37.5	-	
1"		25	-	
3/4"		19	-	
3/8"		9.5	-	
No.4		4.75	-	
No.10		2	100.0	<=Split hyd.
No.20	0.13	0.85	99.8	
No.40	0.67	0.425	98.9	
No.60	1.13	0.25	98.2	
No.100	1.73	0.15	97.3	
No.140	2.03	0.106	96.8	
No.200	2.45	0.075	96.1	

Water content data	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	218.31	50.47
Dry soil + tare (g):	184.58	46.59
Tare (g):	121.49	23.54
Water content (%):	53.46	16.83

Hydrometer data
Hyd. split: No.10
Gs: 2.75 Assumed
Bulb No. 6 Hyd. fraction: 100.00
Cylinder ID: N12 Dispersion device: Air-jet

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	22.2	53	0.0530	93.21
2	22.2	49.5	0.0368	86.45
4	22.2	46	0.0255	79.69
15	22.2	37.5	0.0125	63.28
30	22.2	34.75	0.0087	57.96
60	22.1	31.25	0.0060	51.13
120	22.3	27.5	0.0041	44.03
250	22.2	24	0.0028	37.20
460	22.6	20.5	0.0020	30.73
1420	22.2	17.25	0.0011	24.16

Gravel (%): 0.0
Sand (%): 3.9
Fines (%): 96.1



Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

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Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/9/2019
By: JP/EZ/BRR

Boring No.: BH19-ITW-2
Sample:
Depth: 17.0'
Description: Grey clay

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	201.33	136.19
Hydrometer fraction (g):	61.36	54.37

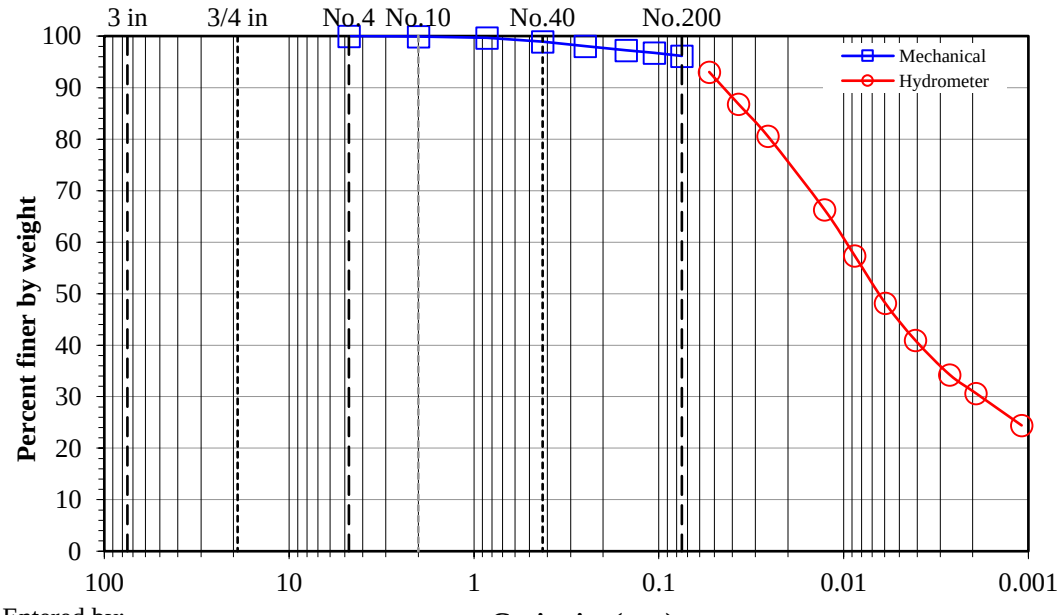
Water content data	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	328.24	34.52
Dry soil + tare (g):	263.10	32.01
Tare (g):	126.91	12.50
Water content (%):	47.83	12.87

Hydrometer data
Hyd. split: No.10
Gs: 2.8 Assumed
Bulb No. 6 Hyd. fraction: 99.92
Cylinder ID: N3 Dispersion device: Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"		150	-
4"		100	-
3"		75	-
1.5"		37.5	-
1"		25	-
3/4"		19	-
3/8"		9.5	-
No.4		4.75	100.0
No.10	0.11	2	99.9
No.20	0.44	0.85	99.7
No.40	1.47	0.425	98.9
No.60	2.62	0.25	98.1
No.100	3.74	0.15	97.3
No.140	4.41	0.106	96.8
No.200	5.25	0.075	96.1

	Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
	1	22.2	57	0.0533	93.02
	2	22.2	53.5	0.0370	86.79
	4	22.2	50	0.0257	80.56
	15	22.2	42	0.0127	66.32
	30	22.1	37	0.0087	57.36
	60	22.2	31.8	0.0060	48.17
	120	22.2	27.75	0.0041	40.96
	267	22.2	24	0.0027	34.28
	500	22.1	22	0.0019	30.66
	1475	22.1	18.5	0.0011	24.43
<=Split hyd.					

Gravel (%): 0.0
Sand (%): 3.9
Fines (%): 96.1



Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

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Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/9/2019
By: JP/BRR

Boring No.: BH19-ITW-2
Sample:
Depth: 22.0'
Description: Grey clay

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	169.51	118.90
Hydrometer fraction (g):	66.71	59.82

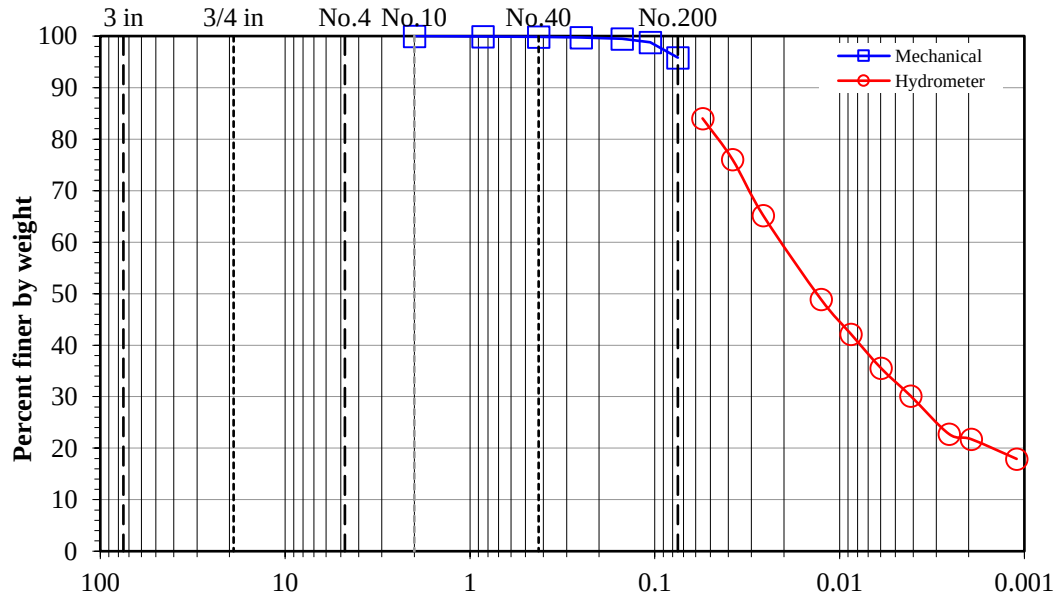
Water content data	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	346.81	38.18
Dry soil + tare (g):	296.20	35.54
Tare (g):	177.30	12.61
Water content (%):	42.57	11.51

Hydrometer data
Hyd. split: No.10
Gs: 2.65 Assumed
Bulb No. 6 — Hyd. fraction: 100.00
Cylinder ID: T1 — Dispersion device: Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"		150	-	
4"		100	-	
3"		75	-	
1.5"		37.5	-	
1"		25	-	
3/4"		19	-	
3/8"		9.5	-	
No.4		4.75	-	
No.10		2	100.0	<=Split hyd.
No.20	0.09	0.85	99.9	
No.40	0.20	0.425	99.8	
No.60	0.30	0.25	99.7	
No.100	0.63	0.15	99.5	
No.140	1.43	0.106	98.8	
No.200	4.97	0.075	95.8	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	22.2	55	0.0551	84.01
2	22.2	50.25	0.0380	76.07
4	22.2	43.75	0.0259	65.21
15	22.2	34	0.0126	48.91
30	22.1	30	0.0087	42.16
60	22.2	26	0.0060	35.54
120	22.1	22.8	0.0041	30.13
291	21.8	18.5	0.0026	22.76
500	22.2	17.75	0.0019	21.75
1493	22.1	15.5	0.0011	17.92

Gravel (%): 0.0
Sand (%): 4.2
Fines (%): 95.8



Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

© IGES 2019, 2019

Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/13/2019
By: JP/BRR

Boring No.: BH19-ITW-2
Sample:
Depth: 25.0'
Description: Grey clay

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	173.97	101.07
Hydrometer fraction (g):	60.17	49.78

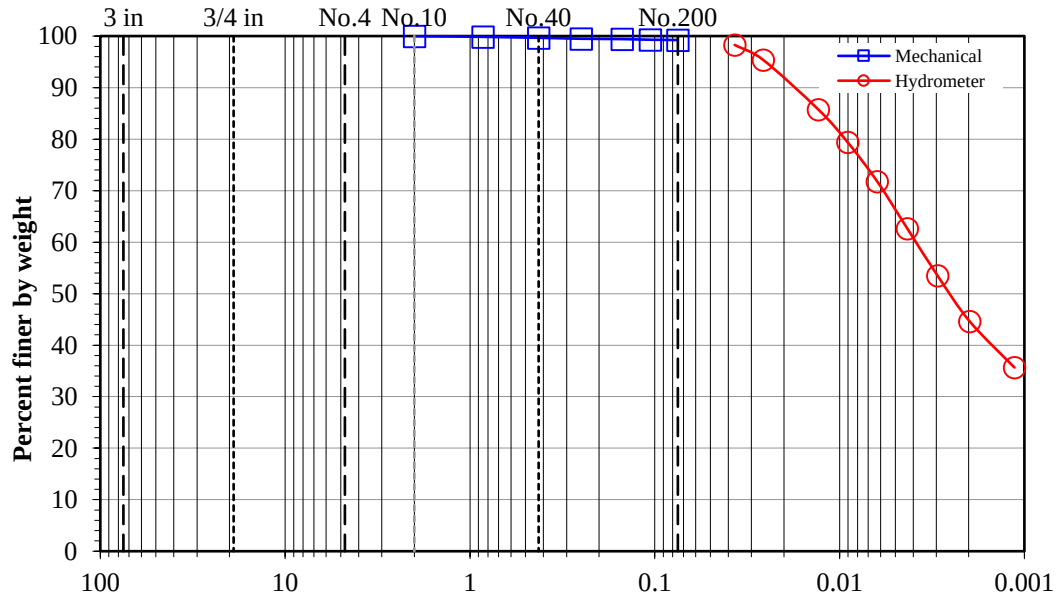
Water content data	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	388.99	80.44
Dry soil + tare (g):	316.09	70.58
Tare (g):	215.02	23.32
Water content (%):	72.13	20.86

Hydrometer data
Hyd. split: No.10
Gs: 2.85 Assumed
Bulb No. 6 Hyd. fraction: 100.00
Cylinder ID: N3 Dispersion device: Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"		150	-	
4"		100	-	
3"		75	-	
1.5"		37.5	-	
1"		25	-	
3/4"		19	-	
3/8"		9.5	-	
No.4		4.75	-	
No.10		2	100.0	<=Split hyd.
No.20	0.14	0.85	99.9	
No.40	0.37	0.425	99.6	
No.60	0.50	0.25	99.5	
No.100	0.61	0.15	99.4	
No.140	0.72	0.106	99.3	
No.200	0.78	0.075	99.2	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
2	22.2	55.75	0.0370	98.28
4	22.2	54.25	0.0259	95.39
15	22.2	49.25	0.0130	85.75
30	22.1	46	0.0091	79.42
60	22.2	42	0.0063	71.79
120	22.2	37.25	0.0043	62.64
240	22.2	32.5	0.0029	53.48
500	22.6	27.75	0.0020	44.62
1429	22.2	23.25	0.0011	35.66

Gravel (%): 0.0
Sand (%): 0.8
Fines (%): 99.2



Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

© IGES 2019, 2019

Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/9/2019
By: EZ/BRR

Boring No.: BH19-ITW-4
Sample:
Depth: 12.5'
Description: Grey clay

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	193.57	124.88
Hydrometer fraction (g):	64.86	55.07

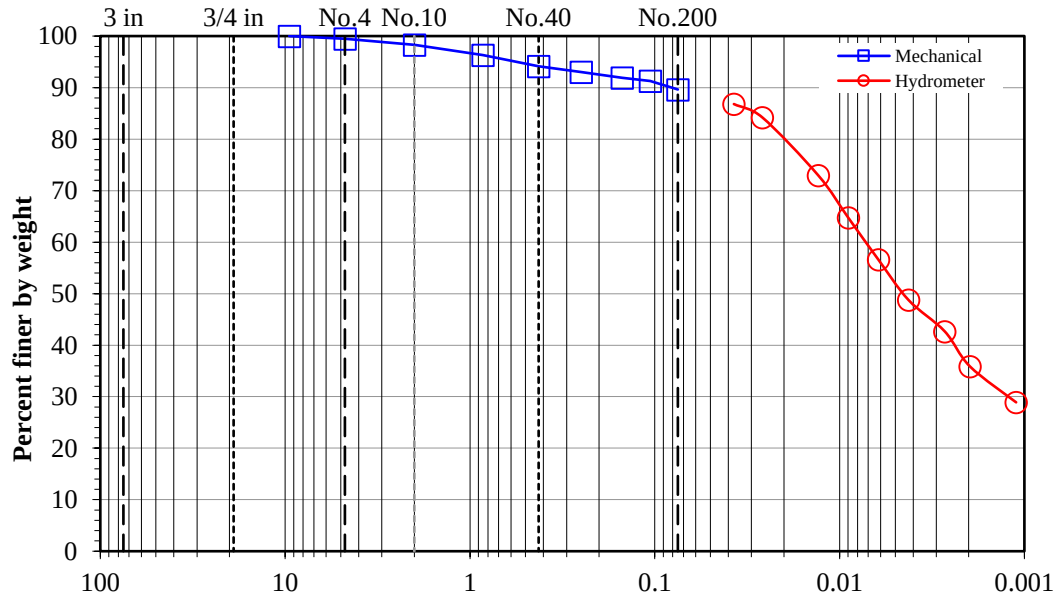
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"		150	-
4"		100	-
3"		75	-
1.5"		37.5	-
1"		25	-
3/4"		19	-
3/8"		9.5	100.0
No.4	0.65	4.75	99.5
No.10	2.15	2	98.3
No.20	4.61	0.85	96.3
No.40	7.30	0.425	94.2
No.60	8.71	0.25	93.0
No.100	10.13	0.15	91.9
No.140	10.89	0.106	91.3
No.200	12.95	0.075	89.6

Water content data		S.F.	Hyd.(-No.10)
Moist soil + tare (g):		313.74	29.68
Dry soil + tare (g):		245.05	27.10
Tare (g):		120.17	12.58
Water content (%):		55.00	17.77

Hydrometer data			
Hyd. split:	No.10		
Gs:	2.8	Assumed	
Bulb No.	6	Hyd. fraction:	98.28
Cylinder ID:	T6	Dispersion device:	Air-jet

	Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
	2	22.1	55	0.0373	86.80
	4	22.1	53.5	0.0262	84.21
	15	22.1	47	0.0131	72.97
	30	22.1	42.25	0.0090	64.76
	60	22.2	37.5	0.0062	56.62
	120	22.1	33	0.0042	48.78
	283	22	29.5	0.0027	42.67
	500	22.2	25.5	0.0020	35.88
<=Split hyd.	1490	22.1	21.5	0.0011	28.90

Gravel (%): 0.5
Sand (%): 9.8
Fines (%): 89.6



Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

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Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/13/2019
By: EZ/BRR

Boring No.: BH19-ITW-4
Sample:
Depth: 15.0'
Description: Grey silty clay

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	214.69	159.72
Hydrometer fraction (g):	60.62	55.72

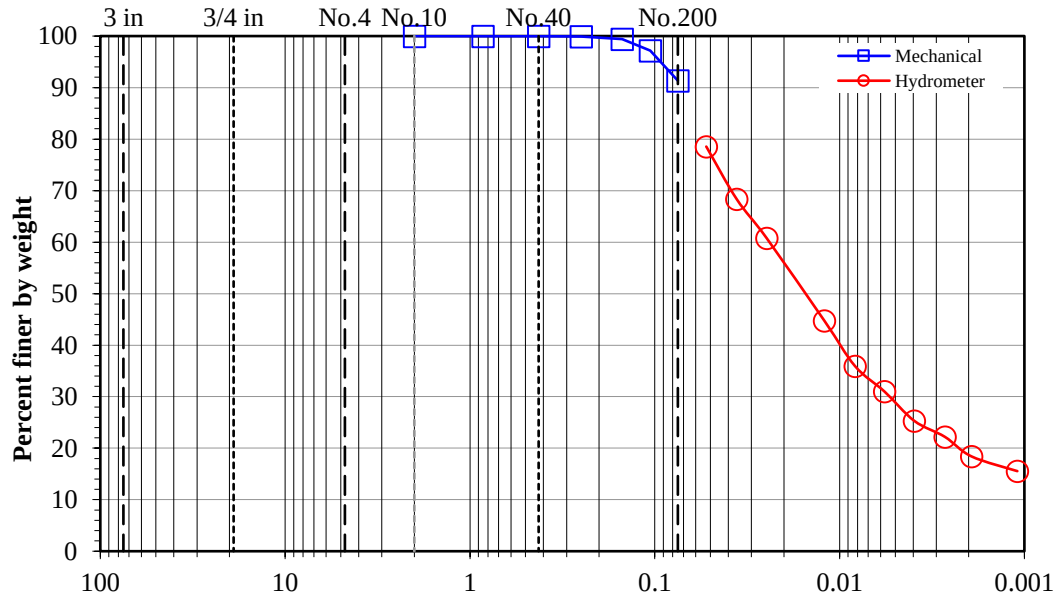
Water content data	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	436.63	57.49
Dry soil + tare (g):	381.66	54.76
Tare (g):	221.94	23.70
Water content (%):	34.42	8.79

Hydrometer data
Hyd. split: No.10
Gs: 2.7 Assumed
Bulb No. 6 Hyd. fraction: 100.00
Cylinder ID: 11 Dispersion device: Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"		150	-	
4"		100	-	
3"		75	-	
1.5"		37.5	-	
1"		25	-	
3/4"		19	-	
3/8"		9.5	-	
No.4		4.75	-	
No.10		2	100.0	<=Split hyd.
No.20	0.01	0.85	100.0	
No.40	0.04	0.425	100.0	
No.60	0.12	0.25	99.9	
No.100	0.93	0.15	99.4	
No.140	4.47	0.106	97.2	
No.200	13.83	0.075	91.3	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	22.2	49	0.0526	78.54
2	22.2	43.25	0.0360	68.34
4	22.2	39	0.0248	60.80
15	22.1	30	0.0121	44.76
30	22.2	25	0.0083	35.95
60	22.1	22.25	0.0057	31.01
120	22.2	19	0.0039	25.31
250	22.2	17.25	0.0027	22.20
467	22.5	15	0.0019	18.40
1425	22.2	13.5	0.0011	15.55

Gravel (%): 0.0
Sand (%): 8.7
Fines (%): 91.3



Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

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Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/13/2019
By: EZ/BRR

Boring No.: BH19-ITW-4
Sample:
Depth: 17.0'
Description: Grey clay

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	140.17	99.35
Hydrometer fraction (g):	64.74	56.69

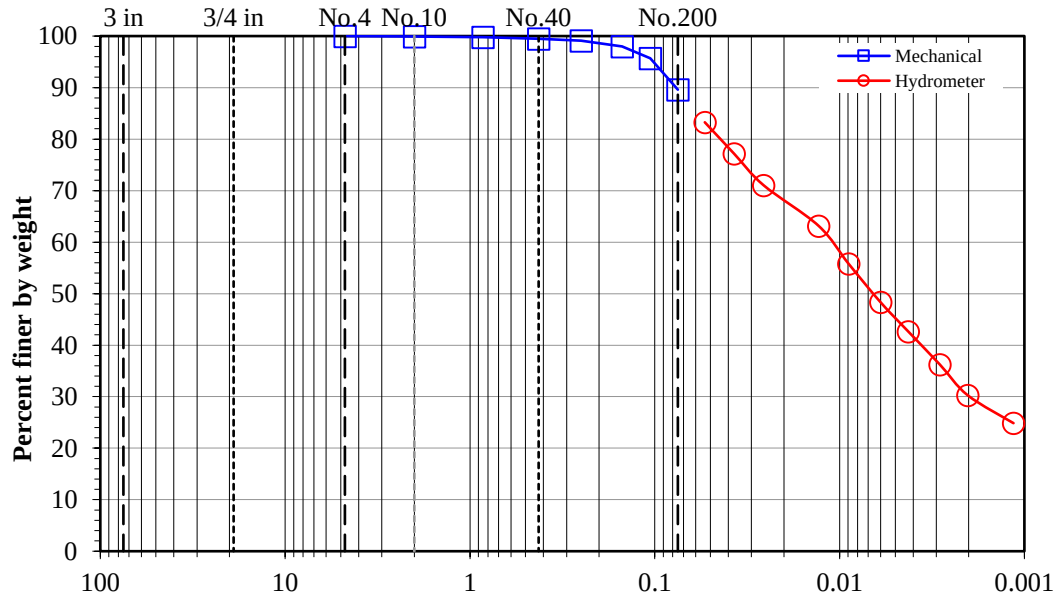
Water content data	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	320.46	63.76
Dry soil + tare (g):	279.64	58.75
Tare (g):	180.29	23.47
Water content (%):	41.09	14.20

Hydrometer data
Hyd. split: No.10
Gs: 2.7 Assumed
Bulb No. 6 Hyd. fraction: 99.94
Cylinder ID: T6 Dispersion device: Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"		150	-
4"		100	-
3"		75	-
1.5"		37.5	-
1"		25	-
3/4"		19	-
3/8"		9.5	-
No.4		4.75	100.0
No.10	0.06	2	99.9
No.20	0.23	0.85	99.8
No.40	0.53	0.425	99.5
No.60	0.91	0.25	99.1
No.100	2.01	0.15	98.0
No.140	4.27	0.106	95.7
No.200	10.33	0.075	89.6

	Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
	1	22.2	52.5	0.0536	83.26
	2	22.2	49	0.0372	77.16
	4	22.2	45.5	0.0258	71.06
	15	22.1	41	0.0130	63.15
	30	22.2	36.75	0.0089	55.80
	63	22.1	32.5	0.0060	48.33
	120	22.1	29.25	0.0043	42.66
	250	22.3	25.5	0.0029	36.25
	475	22.5	22	0.0020	30.28
<=Split hyd.	1420	22.2	19	0.0011	24.86

Gravel (%): 0.0
Sand (%): 10.4
Fines (%): 89.6



Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

© IGES 2019, 2019

Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/10/2019
By: EH/EZ/BRR

Boring No.: BH19-ITW-4
Sample:
Depth: 20.0'
Description: Grey sandy silt

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	637.02	491.60
Hydrometer fraction (g):	65.73	62.88

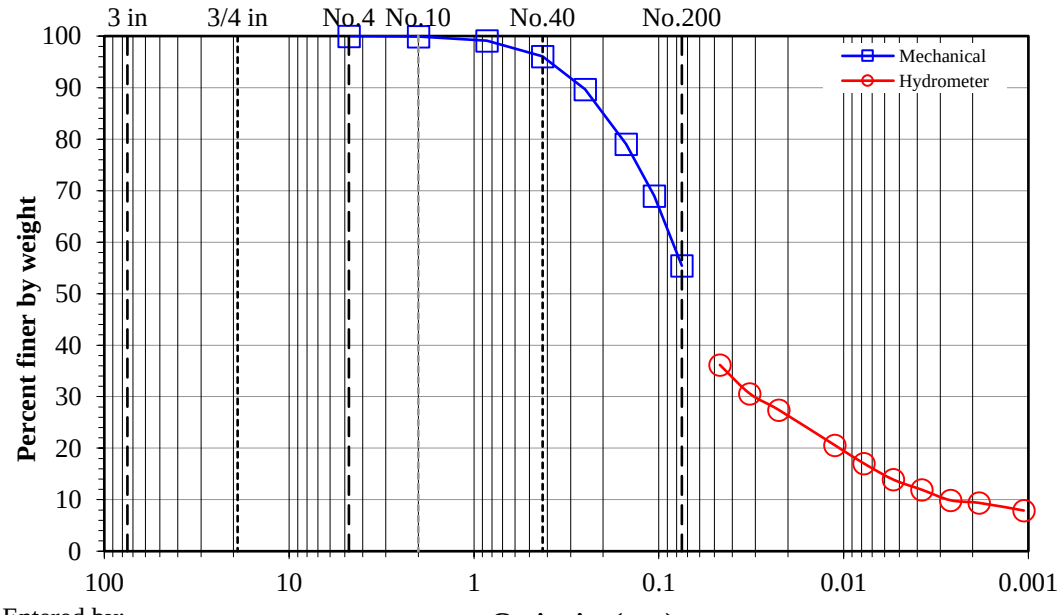
Water content data	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	970.18	39.94
Dry soil + tare (g):	824.76	38.75
Tare (g):	333.16	12.45
Water content (%):	29.58	4.52

Hydrometer data
Hyd. split: No.10
Gs: 2.65 Assumed
Bulb No. 6 Hyd. fraction: 99.92
Cylinder ID: N33 Dispersion device: Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"		150	-
4"		100	-
3"		75	-
1.5"		37.5	-
1"		25	-
3/4"		19	-
3/8"		9.5	-
No.4		4.75	100.0
No.10	0.38	2	99.9
No.20	4.28	0.85	99.1
No.40	19.37	0.425	96.1
No.60	50.68	0.25	89.7
No.100	103.08	0.15	79.0
No.140	152.44	0.106	69.0
No.200	219.13	0.075	55.4

	Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
	1	22.2	27.5	0.0467	36.16
	2	22.2	24	0.0322	30.60
	4	22.2	22	0.0224	27.42
	15	22.1	17.75	0.0112	20.61
	30	22.1	15.5	0.0078	17.04
	60	22.2	13.5	0.0054	13.92
	120	22.2	12.25	0.0038	11.93
	240	22.1	11	0.0026	9.89
	483	22.6	10.5	0.0018	9.39
	1450	22.1	9.75	0.0011	7.90
<=Split hyd.					

Gravel (%): 0.0
Sand (%): 44.6
Fines (%): 55.4



Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

© IGES 2019, 2019

Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/13/2019
By: EZ/BRR

Boring No.: BH19-ITW-4
Sample:
Depth: 22.0'
Description: Grey clay with sand

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	64.93	54.58
Hydrometer fraction (g):	64.93	54.58

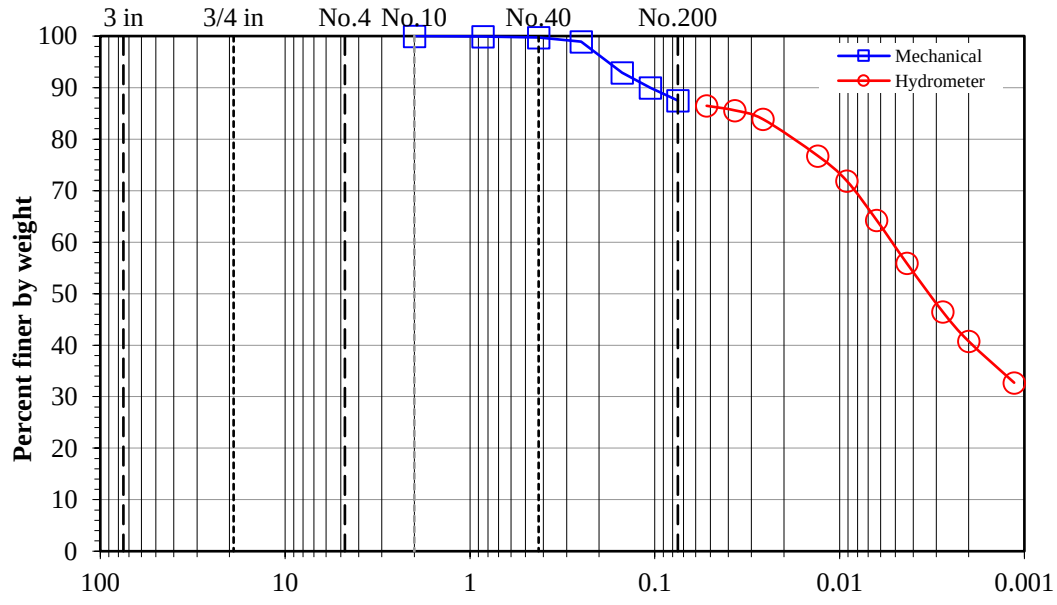
Water content data	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	59.76	59.76
Dry soil + tare (g):	52.22	52.22
Tare (g):	12.48	12.48
Water content (%):	18.97	18.97

Hydrometer data
Hyd. split: No.10
Gs: 2.8 Assumed
Bulb No. 6 Hyd. fraction: 100.00
Cylinder ID: 11 Dispersion device: Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"		150	-	
4"		100	-	
3"		75	-	
1.5"		37.5	-	
1"		25	-	
3/4"		19	-	
3/8"		9.5	-	
No.4		4.75	-	
No.10		2	100.0	<=Split hyd.
No.20	0.05	0.85	99.9	
No.40	0.14	0.425	99.7	
No.60	0.59	0.25	98.9	
No.100	3.88	0.15	92.9	
No.140	5.48	0.106	90.0	
No.200	6.83	0.075	87.5	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	22.1	53.5	0.0524	86.46
2	22.1	53	0.0369	85.58
4	22.2	52	0.0260	83.87
15	22.2	48	0.0131	76.77
30	22.2	45.25	0.0091	71.89
60	22.1	41	0.0063	64.28
120	22.2	36.25	0.0043	55.92
275	22	31	0.0028	46.47
500	22.1	27.75	0.0020	40.77
1458	22	23.25	0.0011	32.72

Gravel (%): 0.0
Sand (%): 12.5
Fines (%): 87.5



Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\015_SLCity_Public_Utilities_Waste Water_\XI\[PSDHYDv4.xlsm]5

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(In general accordance with ASTM D6913 and ASTM D7928)

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Project: SLCWRF
No: 00100-015,3G2 (XI)
Location: N. Salt Lake
Date: 5/10/2019
By: JP/EZ/BRR

Boring No.: BH19-ITW-4
Sample:
Depth: 25.0'
Description: Grey clay

ASTM Standard(s): ASTM D6913 and ASTM D7928
Split: No
Second split: No

	Moist	Dry
Total sample wt. (g):	300.51	183.69
Hydrometer fraction (g):	66.48	56.24

Water content data	S.F.	Hyd.(-No.10)
Moist soil + tare (g):	440.82	71.51
Dry soil + tare (g):	324.00	62.44
Tare (g):	140.31	12.65
Water content (%):	63.60	18.22

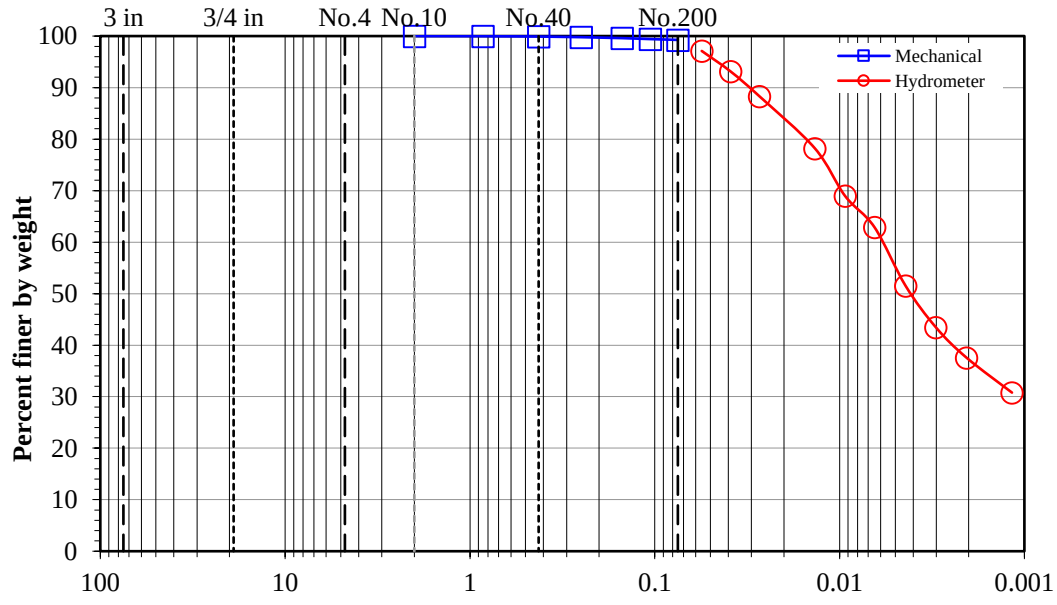
Hydrometer data
Hyd. split: No.10
Gs: 2.7 Assumed
Bulb No. 6 Hyd. fraction: 100.00
Cylinder ID: T5 Dispersion device: Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"		150	-
4"		100	-
3"		75	-
1.5"		37.5	-
1"		25	-
3/4"		19	-
3/8"		9.5	-
No.4		4.75	-
No.10		2	100.0
No.20	0.06	0.85	100.0
No.40	0.20	0.425	99.9
No.60	0.40	0.25	99.8
No.100	0.76	0.15	99.6
No.140	1.05	0.106	99.4
No.200	1.37	0.075	99.3

<=Split hyd.

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
1	22.1	60	0.0557	97.10
2	22.1	57.75	0.0389	93.15
4	22.1	55	0.0272	88.31
15	22.1	49.25	0.0136	78.20
30	22.1	44	0.0093	68.97
60	22.2	40.5	0.0065	62.88
120	22.3	34	0.0044	51.51
240	22.1	29.5	0.0030	43.47
490	22.5	26	0.0021	37.58
1440	22.2	22.25	0.0012	30.79

Gravel (%): 0.0
Sand (%): 0.7
Fines (%): 99.3



Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\015_SLCity_Public_Utilities_Waste Water_\XI\[PSDHYDv4.xlsm]6

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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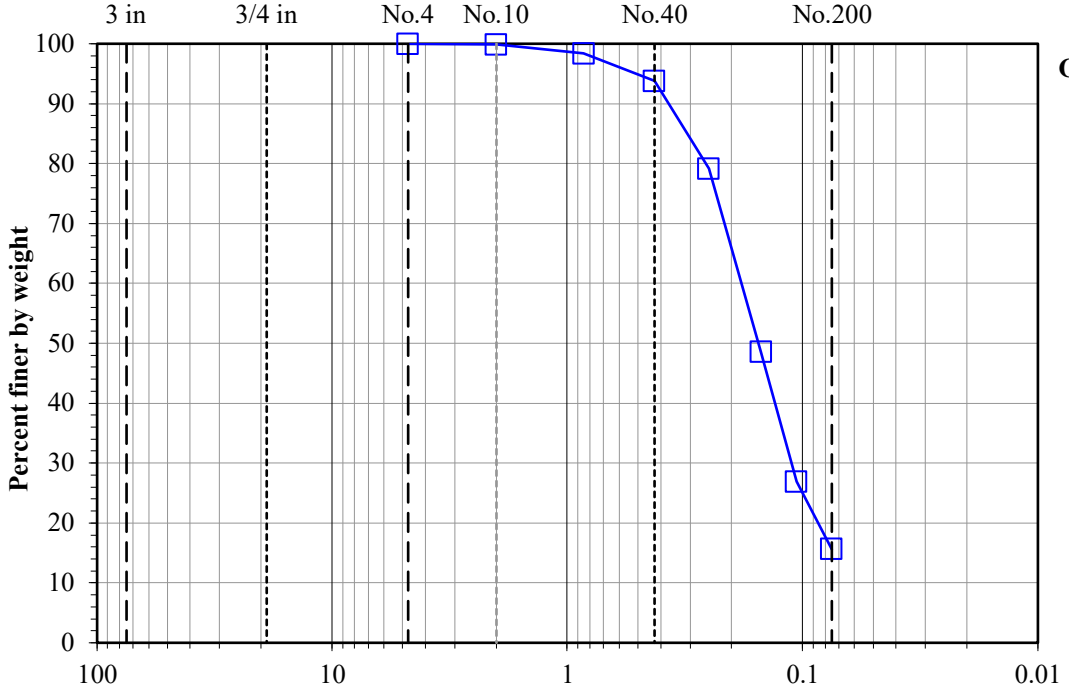
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: FB

Boring No.: B21-IS-01
Sample: 3B
Depth: 15'
Description: Grey silty sand

	Moist	Dry
Split:	No	
Total sample wt. (g):	502.71	393.24
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	630.79
Dry soil + tare (g):	-	521.32
Tare (g):	-	128.08
Water content (%):	0.0	27.8

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	0.53	2	99.9
No.20	6.50	0.85	98.3
No.40	24.53	0.425	93.8
No.60	82.02	0.25	79.1
No.100	202.17	0.15	48.6
No.140	287.42	0.106	26.9
No.200	331.75	0.075	15.6



Gravel (%): 0.0
Sand (%): 84.4
Fines (%): 15.6

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]1

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: FB

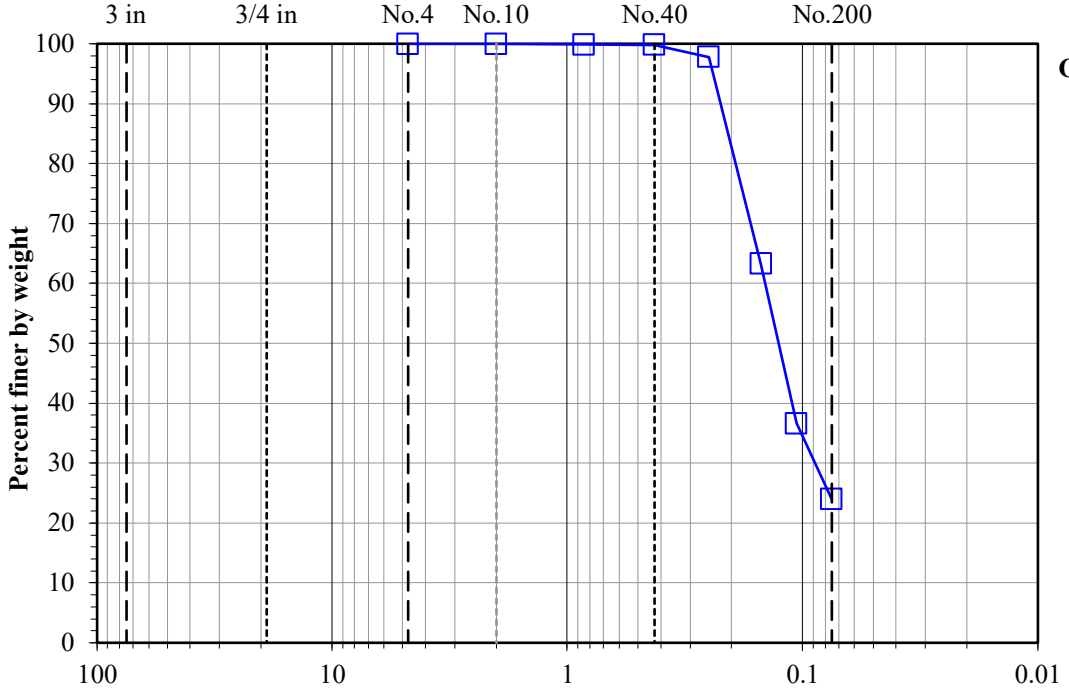
Boring No.: B21-IS-02
Sample: 6
Depth: 18'
Description: Grey clayey sand

	Moist	Dry
Split:	No	
Total sample wt. (g):	719.89	501.43
	-	
Split fraction:	1.000	

Water content data

Moist soil + tare (g):	-	843.96
Dry soil + tare (g):	-	625.50
Tare (g):	-	124.07
Water content (%):	0.0	43.6

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	0.06	2	100.0
No.20	0.56	0.85	99.9
No.40	1.07	0.425	99.8
No.60	11.18	0.25	97.8
No.100	184.12	0.15	63.3
No.140	317.75	0.106	36.6
No.200	381.19	0.075	24.0



Gravel (%): 0.0
Sand (%): 76.0
Fines (%): 24.0

Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: RT

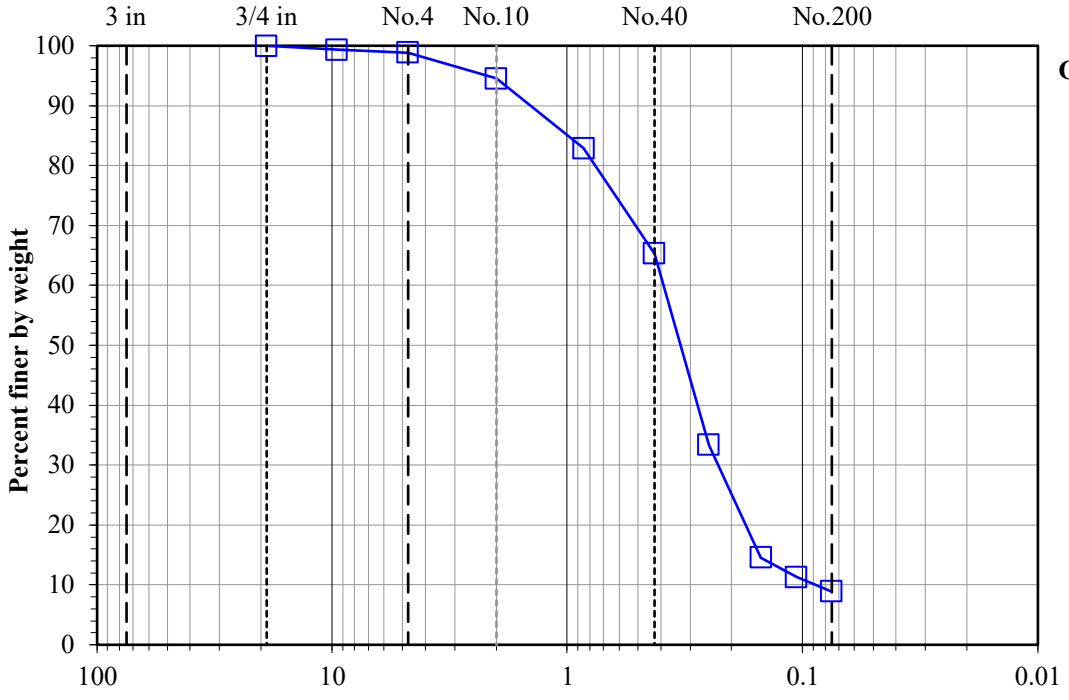
Boring No.: B21-IS-06
Sample: 1A
Depth: 5'
Description: Brown sand with silt

	Moist	Dry
Split:	No	
Total sample wt. (g):	337.26	273.38
	-	
Split fraction:	1.000	

Water content data

Moist soil + tare (g):	-	460.28
Dry soil + tare (g):	-	396.40
Tare (g):	-	123.02
Water content (%):	0.0	23.4

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	100.0
3/8"	1.80	9.5	99.3
No.4	3.10	4.75	98.9
No.10	14.94	2	94.5
No.20	46.83	0.85	82.9
No.40	94.83	0.425	65.3
No.60	182.22	0.25	33.3
No.100	233.56	0.15	14.6
No.140	242.44	0.106	11.3
No.200	248.96	0.075	8.9



Gravel (%): 1.1
Sand (%): 89.9
Fines (%): 8.9

Entered by:_____
Reviewed:_____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: RT

Boring No.: B21-IS-06
Sample: 8B
Depth: 30'
Description: Grey sandy silt

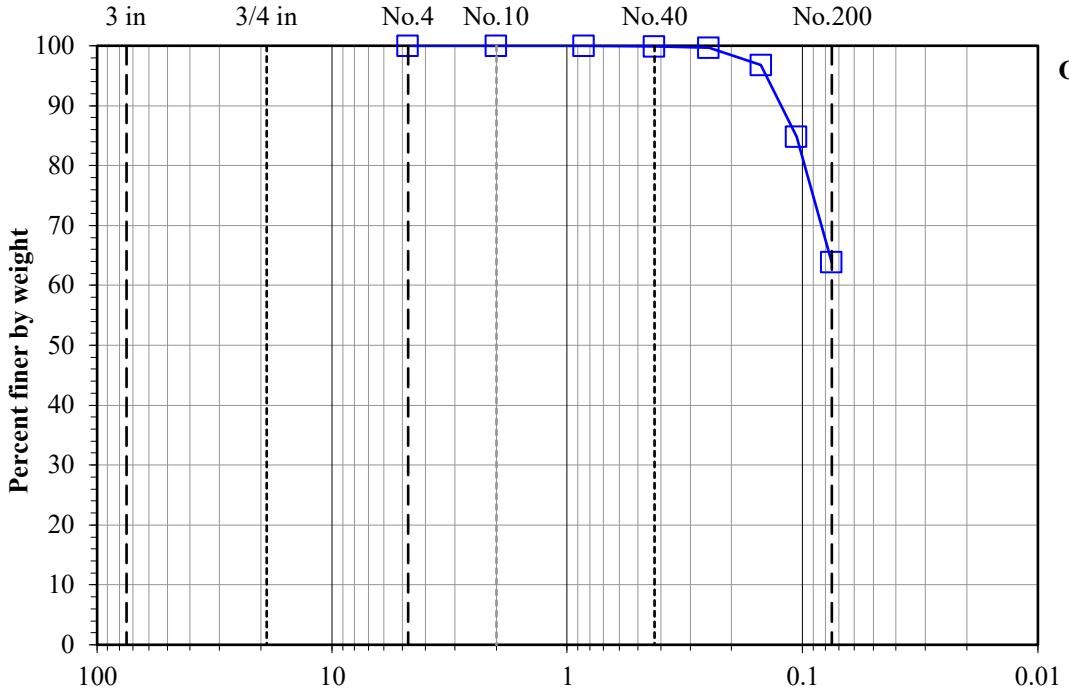
Split: No

	Moist	Dry
Total sample wt. (g):	239.15	186.63
	-	
Split fraction:	1.000	

Water content data

Moist soil + tare (g):	-	362.40
Dry soil + tare (g):	-	309.88
Tare (g):	-	123.25
Water content (%):	0.0	28.1

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	0.01	2	100.0
No.20	0.09	0.85	100.0
No.40	0.20	0.425	99.9
No.60	0.63	0.25	99.7
No.100	6.03	0.15	96.8
No.140	28.40	0.106	84.8
No.200	67.50	0.075	63.8



Gravel (%): 0.0
Sand (%): 36.2
Fines (%): 63.8

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]4

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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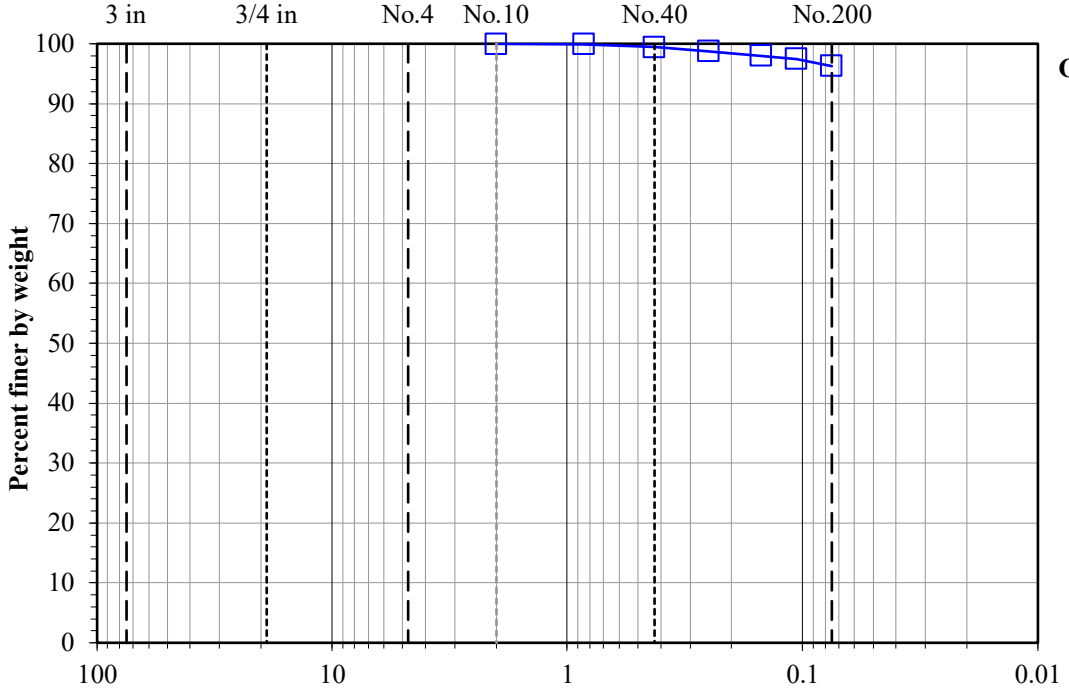
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: EH

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'
Description: Grey clay

	Moist	Dry
Split:	No	
Total sample wt. (g):	260.39	169.13
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	388.44
Dry soil + tare (g):	-	297.18
Tare (g):	-	128.05
Water content (%):	0.0	54.0

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	-
No.10	-	2	100.0
No.20	0.18	0.85	99.9
No.40	0.99	0.425	99.4
No.60	2.13	0.25	98.7
No.100	3.39	0.15	98.0
No.140	4.30	0.106	97.5
No.200	6.30	0.075	96.3



Gravel (%): 0.0
Sand (%): 3.7
Fines (%): 96.3

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]5

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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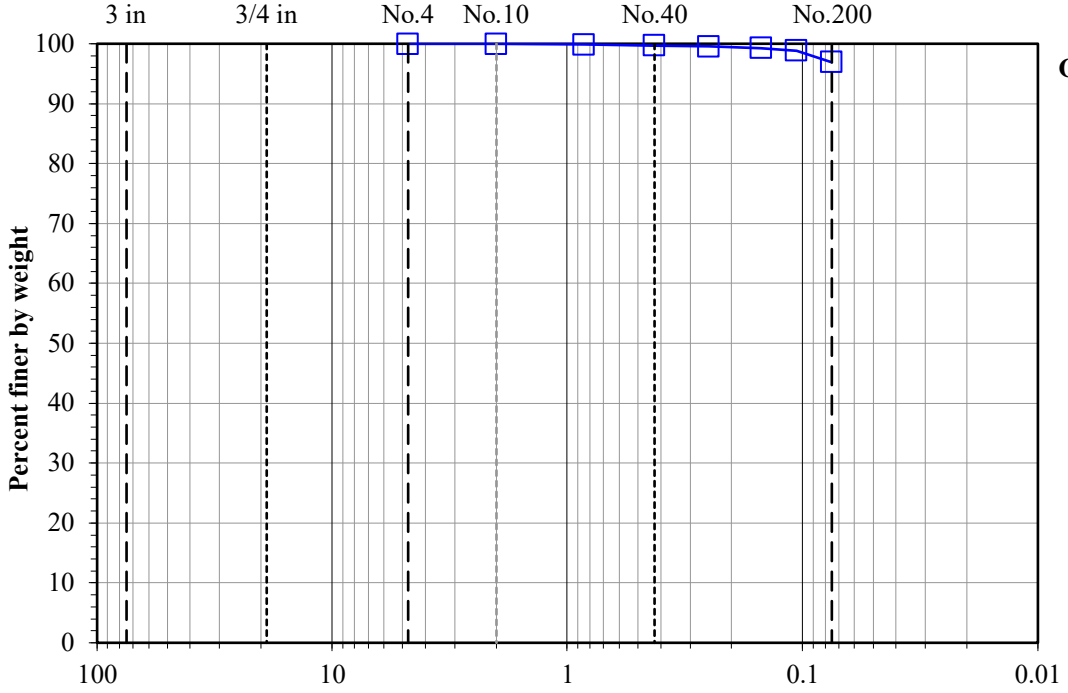
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: EH

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'
Description: Grey clay

	Moist	Dry
Split:	No	
Total sample wt. (g):	258.42	188.96
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	386.84
Dry soil + tare (g):	-	317.38
Tare (g):	-	128.42
Water content (%):	0.0	36.8

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	0.06	2	100.0
No.20	0.28	0.85	99.9
No.40	0.54	0.425	99.7
No.60	0.88	0.25	99.5
No.100	1.32	0.15	99.3
No.140	2.15	0.106	98.9
No.200	5.66	0.075	97.0



Gravel (%): 0.0
Sand (%): 3.0
Fines (%): 97.0

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]6

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: FB

Boring No.: B21-OIPS-O3
Sample: 5
Depth: 22'
Description: Grey silty sand

Split: No

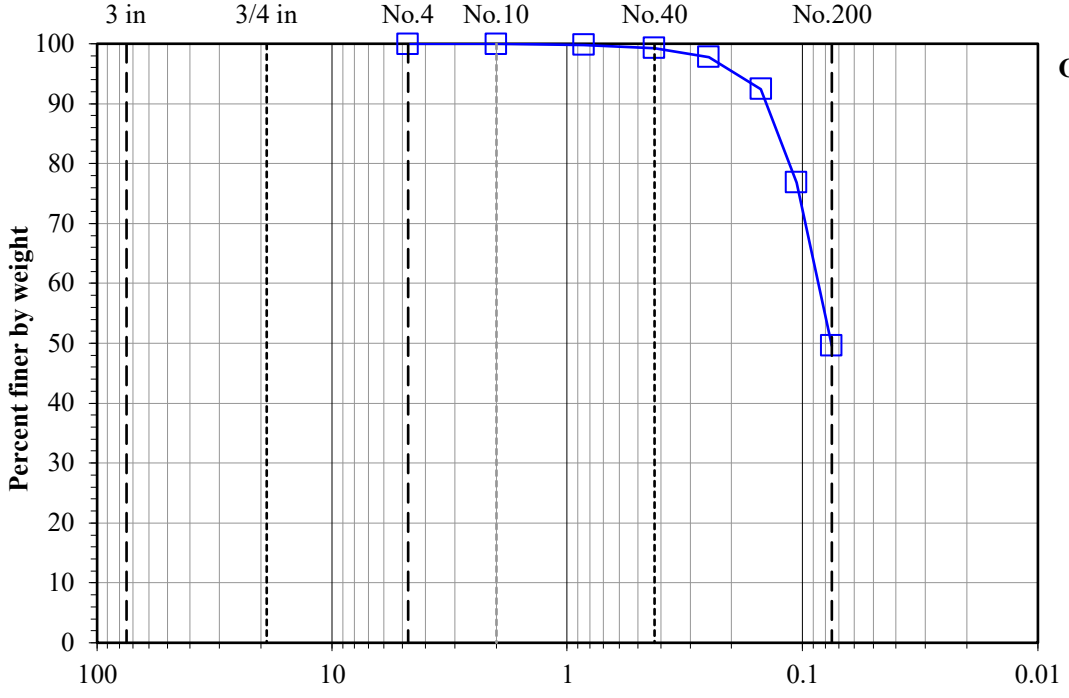
	Moist	Dry
Total sample wt. (g):	296.92	217.45
	-	

Split fraction: 1.000

Water content data

Moist soil + tare (g):	-	419.01
Dry soil + tare (g):	-	339.54
Tare (g):	-	122.09
Water content (%):	0.0	36.5

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	0.04	2	100.0
No.20	0.35	0.85	99.8
No.40	1.55	0.425	99.3
No.60	4.78	0.25	97.8
No.100	16.46	0.15	92.4
No.140	50.33	0.106	76.9
No.200	109.43	0.075	49.7



Gravel (%): 0.0
Sand (%): 50.3
Fines (%): 49.7

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]7

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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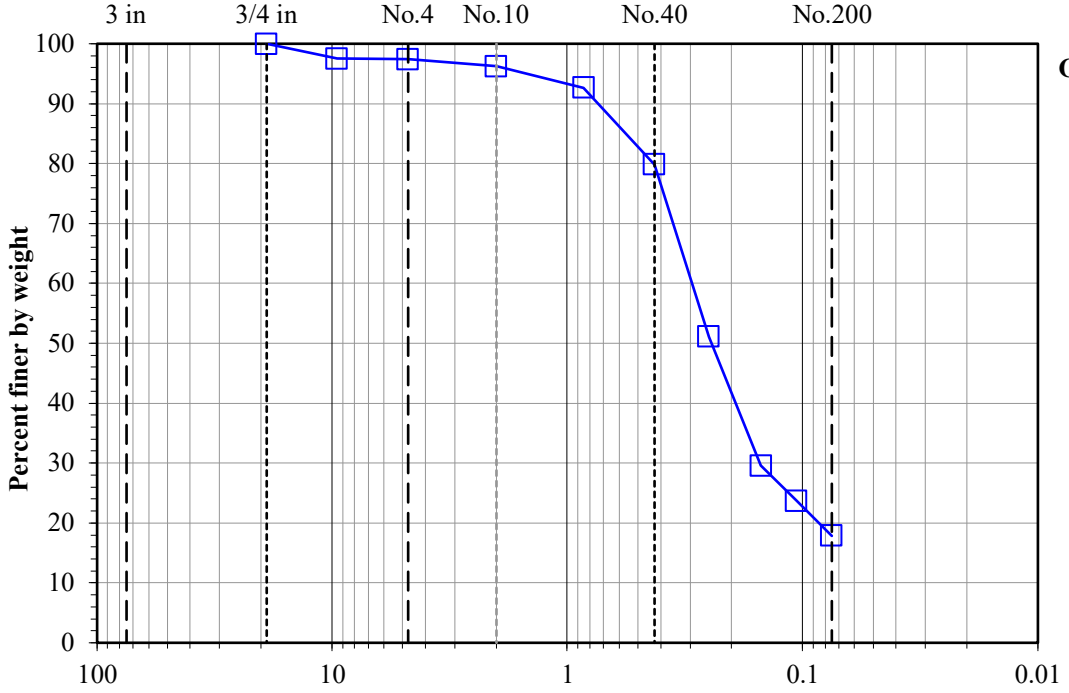
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: FB

Boring No.: B21-OIPS-04
Sample: 6A
Depth: 24'
Description: Grey silty sand

	Moist	Dry
Split:	Yes	
Split sieve:	3/8"	
Total sample wt. (g):	628.06	527.77
+3/8" Coarse fraction (g):	13.69	13.14
-3/8" Split fraction (g):	370.49	310.34
Split fraction:	0.975	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	142.68	494.81
Dry soil + tare (g):	142.09	434.66
Tare (g):	127.92	124.32
Water content (%):	4.2	19.4

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
1"	-	25	-	
3/4"	-	19	100.0	
3/8"	13.14	9.5	97.5	←Split
No.4	0.38	4.75	97.4	
No.10	4.12	2	96.2	
No.20	15.47	0.85	92.6	
No.40	56.19	0.425	79.9	
No.60	147.77	0.25	51.1	
No.100	216.16	0.15	29.6	
No.140	234.88	0.106	23.7	
No.200	253.38	0.075	17.9	



Gravel (%): 2.6
Sand (%): 79.5
Fines (%): 17.9

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]8

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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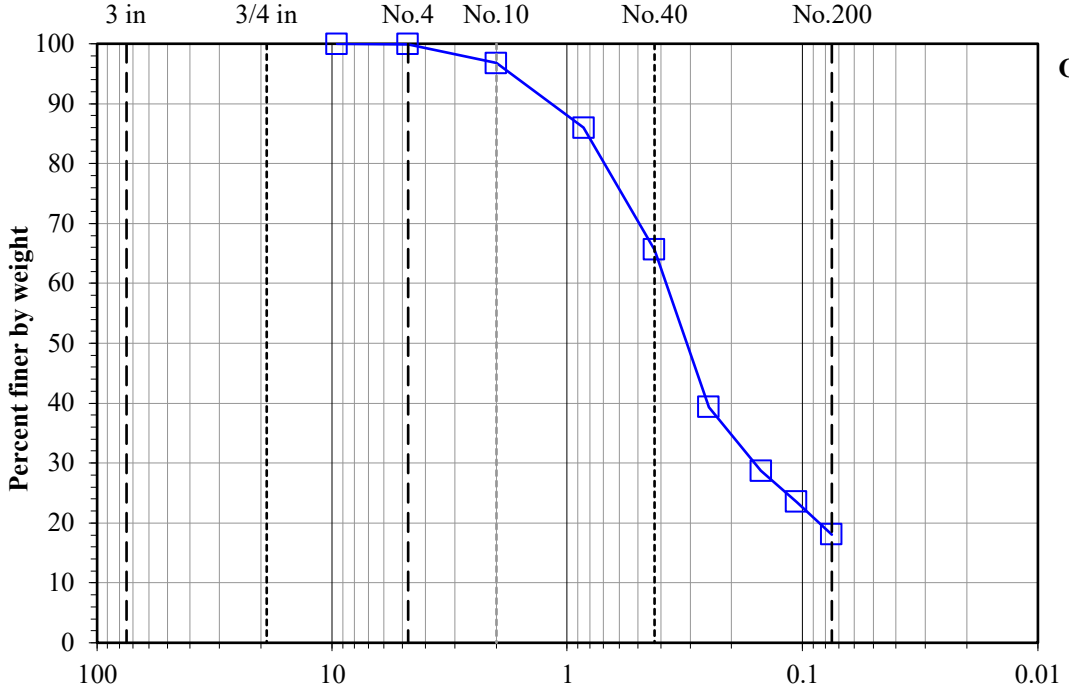
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: FB

Boring No.: B21-OIPS-05
Sample: 4B
Depth: 19'
Description: Grey silty sand

	Moist	Dry
Split:	No	
Total sample wt. (g):	362.62	291.84
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	486.09
Dry soil + tare (g):	-	415.31
Tare (g):	-	123.47
Water content (%):	0.0	24.3

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	100.0
No.4	0.24	4.75	99.9
No.10	9.36	2	96.8
No.20	40.89	0.85	86.0
No.40	100.37	0.425	65.6
No.60	177.05	0.25	39.3
No.100	208.01	0.15	28.7
No.140	223.16	0.106	23.5
No.200	239.12	0.075	18.1



Gravel (%): 0.1
Sand (%): 81.9
Fines (%): 18.1

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]9

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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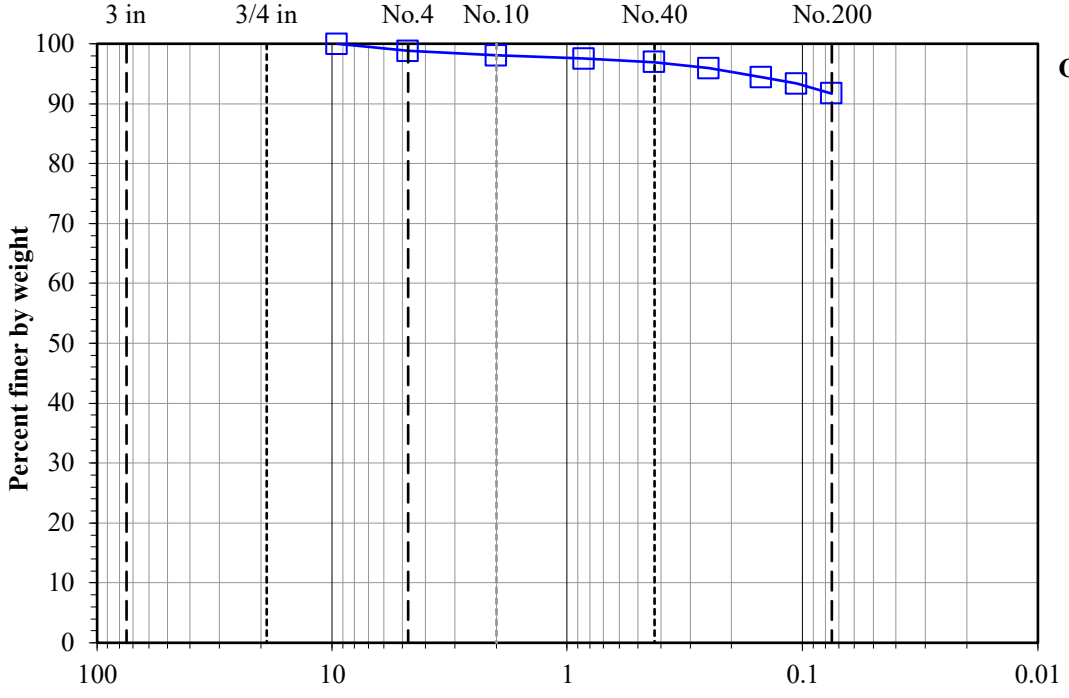
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/14/2021
By: BSS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'
Description: Grey clay

Split:	No	
	Moist	Dry
Total sample wt. (g):	349.66	224.84
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	576.25
Dry soil + tare (g):	-	451.43
Tare (g):	-	226.59
Water content (%):	0.0	55.5

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	100.0
No.4	2.68	4.75	98.8
No.10	4.39	2	98.0
No.20	5.57	0.85	97.5
No.40	6.87	0.425	96.9
No.60	9.24	0.25	95.9
No.100	12.56	0.15	94.4
No.140	14.99	0.106	93.3
No.200	18.60	0.075	91.7



Gravel (%): 1.2
Sand (%): 7.1
Fines (%): 91.7

Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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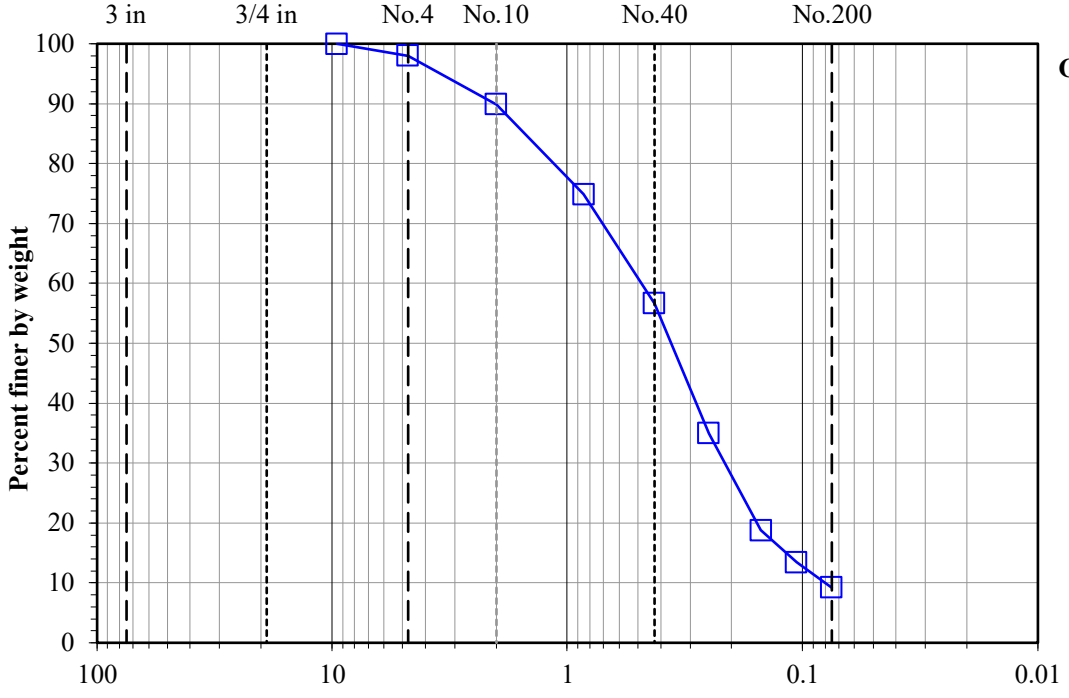
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: FB

Boring No.: B21-OIPS-06
Sample: 4
Depth: 19'
Description: Grey sand with silt

Split:	No	
	Moist	Dry
Total sample wt. (g):	295.90	250.28
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	422.63
Dry soil + tare (g):	-	377.01
Tare (g):	-	126.73
Water content (%):	0.0	18.2

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	100.0
No.4	5.00	4.75	98.0
No.10	25.30	2	89.9
No.20	62.84	0.85	74.9
No.40	108.45	0.425	56.7
No.60	162.80	0.25	35.0
No.100	203.24	0.15	18.8
No.140	216.71	0.106	13.4
No.200	227.04	0.075	9.3



Gravel (%): 2.0
Sand (%): 88.7
Fines (%): 9.3

Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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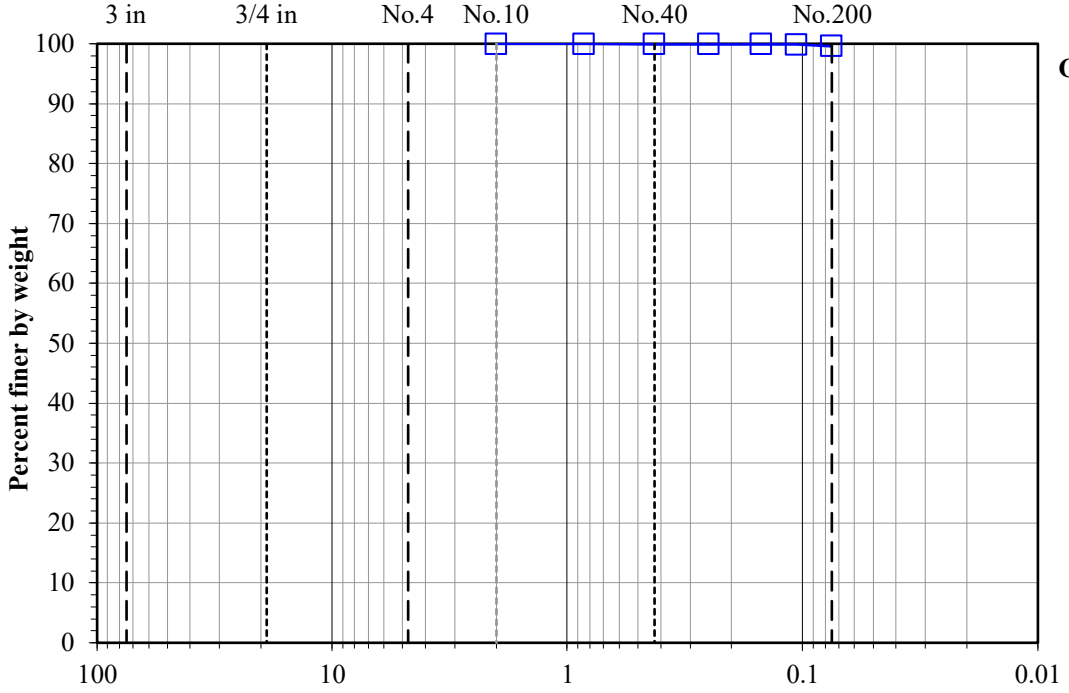
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: EH

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'
Description: Grey clay

	Moist	Dry
Split:	No	
Total sample wt. (g):	223.02	145.51
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	345.37
Dry soil + tare (g):	-	267.86
Tare (g):	-	122.35
Water content (%):	0.0	53.3

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	-
No.10	-	2	100.0
No.20	0.04	0.85	100.0
No.40	0.08	0.425	99.9
No.60	0.09	0.25	99.9
No.100	0.15	0.15	99.9
No.140	0.19	0.106	99.9
No.200	0.49	0.075	99.7



Gravel (%): 0.0
Sand (%): 0.3
Fines (%): 99.7

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]12

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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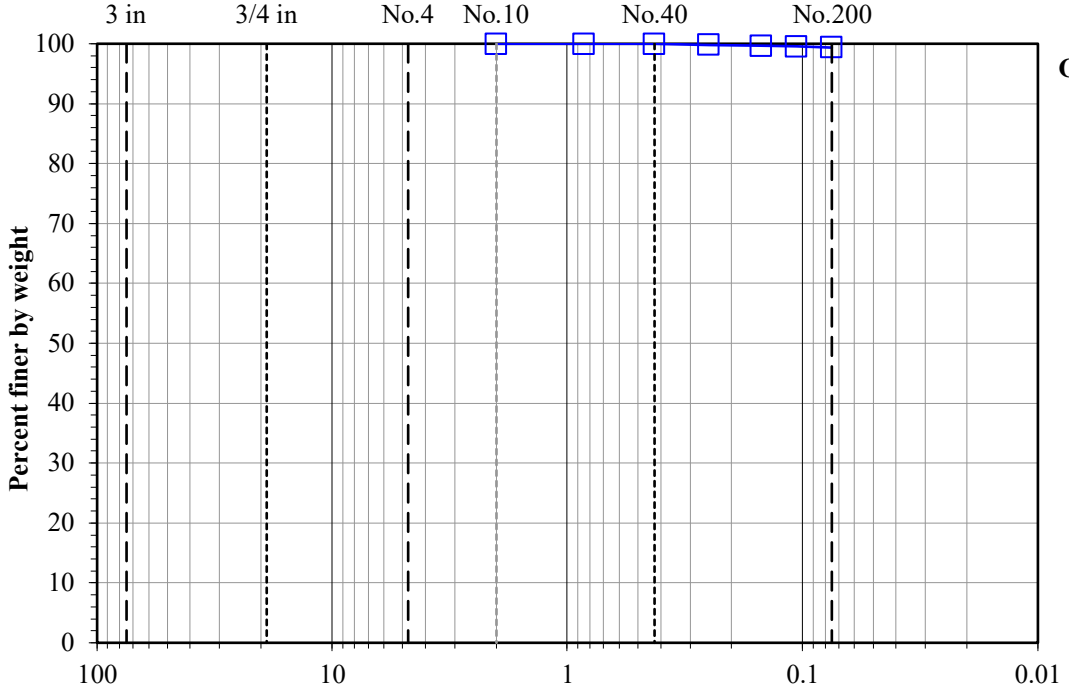
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: EH

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'
Description: Brown clay

	Moist	Dry
Split:	No	
Total sample wt. (g):	224.37	155.09
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	347.04
Dry soil + tare (g):	-	277.76
Tare (g):	-	122.67
Water content (%):	0.0	44.7

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	-
No.10	-	2	100.0
No.20	0.04	0.85	100.0
No.40	0.08	0.425	99.9
No.60	0.26	0.25	99.8
No.100	0.50	0.15	99.7
No.140	0.68	0.106	99.6
No.200	0.88	0.075	99.4



Gravel (%): 0.0
Sand (%): 0.6
Fines (%): 99.4

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]13

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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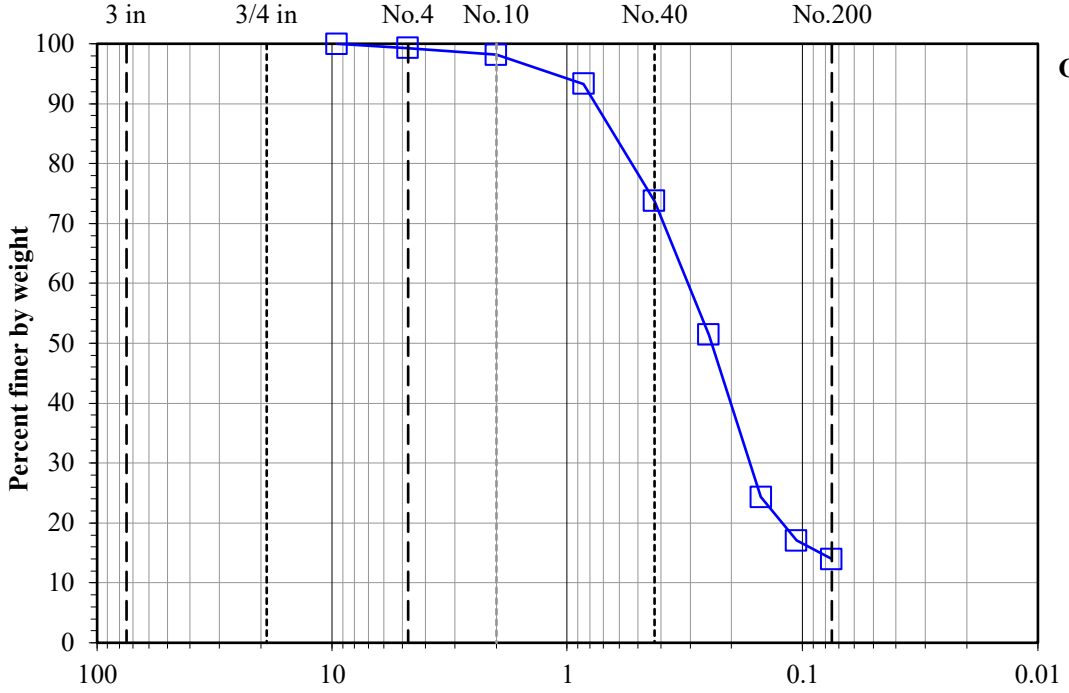
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: RT

Boring No.: B21-OIPS-07
Sample: 6
Depth: 20'
Description: Grey silty sand

	Moist	Dry
Split:	No	
Total sample wt. (g):	282.66	233.62
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	497.65
Dry soil + tare (g):	-	448.61
Tare (g):	-	214.99
Water content (%):	0.0	21.0

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	100.0
No.4	1.69	4.75	99.3
No.10	4.29	2	98.2
No.20	15.62	0.85	93.3
No.40	61.29	0.425	73.8
No.60	113.54	0.25	51.4
No.100	176.80	0.15	24.3
No.140	193.73	0.106	17.1
No.200	200.93	0.075	14.0



Gravel (%): 0.7
Sand (%): 85.3
Fines (%): 14.0

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]14

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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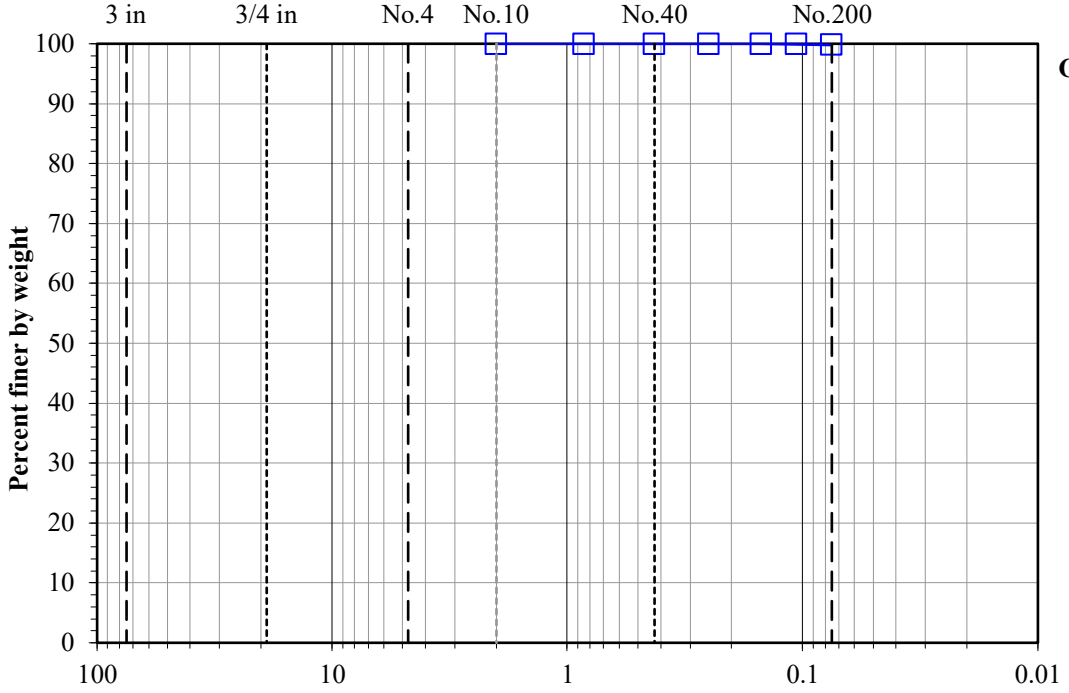
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/10/2021
By: EH

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'
Description: Dark grey clay

	Moist	Dry
Split:	No	
Total sample wt. (g):	204.37	143.23
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	329.05
Dry soil + tare (g):	-	267.91
Tare (g):	-	124.68
Water content (%):	0.0	42.7

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	-
No.10	-	2	100.0
No.20	0.03	0.85	100.0
No.40	0.03	0.425	100.0
No.60	0.04	0.25	100.0
No.100	0.06	0.15	100.0
No.140	0.11	0.106	99.9
No.200	0.22	0.075	99.8



Gravel (%): 0.0
Sand (%): 0.2
Fines (%): 99.8

Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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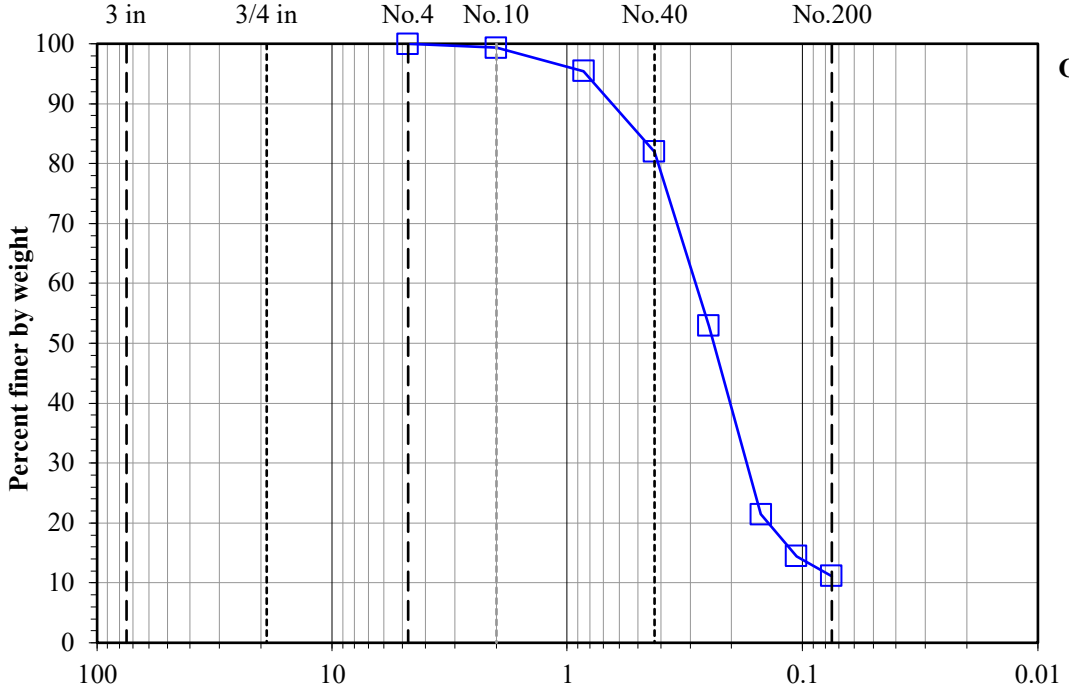
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: FB

Boring No.: B21-OIPS-08
Sample: 4
Depth: 15'
Description: Grey sand with silt

Split:	No	
	Moist	Dry
Total sample wt. (g):	219.05	177.58
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	359.37
Dry soil + tare (g):	-	317.90
Tare (g):	-	140.32
Water content (%):	0.0	23.4

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	1.23	2	99.3
No.20	8.13	0.85	95.4
No.40	32.05	0.425	82.0
No.60	83.58	0.25	52.9
No.100	139.46	0.15	21.5
No.140	151.89	0.106	14.5
No.200	157.80	0.075	11.1



Gravel (%): 0.0
Sand (%): 88.9
Fines (%): 11.1

Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: EH

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'
Description: Grey clay

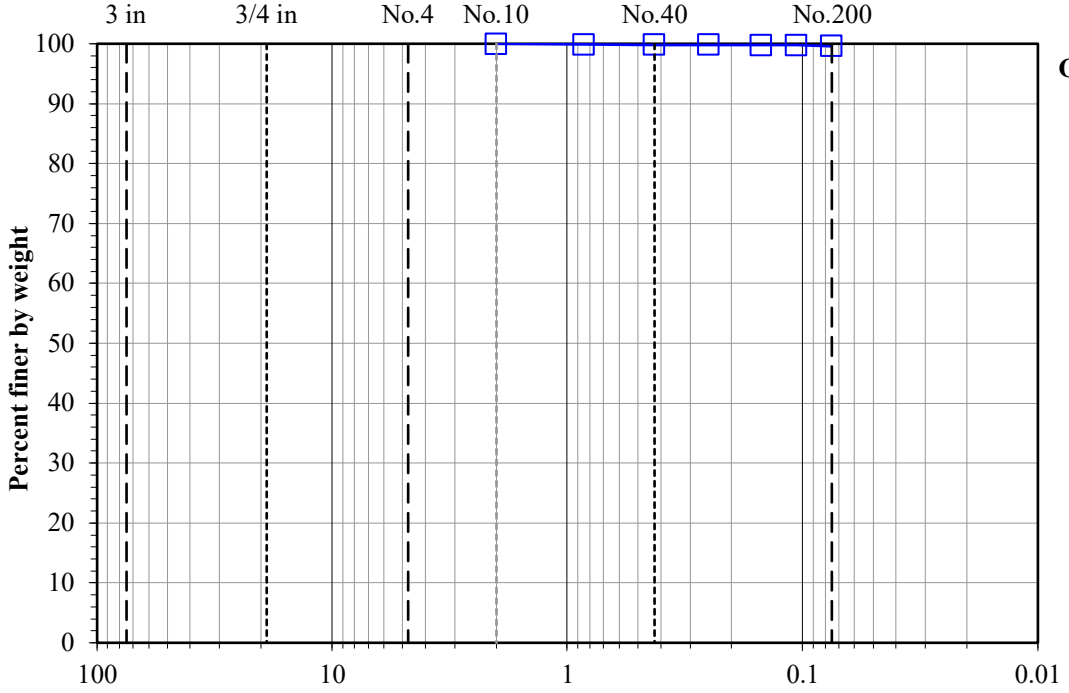
Split: No

	Moist	Dry
Total sample wt. (g):	215.35	149.16
	-	
Split fraction:	1.000	

Water content data

Moist soil + tare (g):	-	337.78
Dry soil + tare (g):	-	271.59
Tare (g):	-	122.43
Water content (%):	0.0	44.4

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	-
No.10	-	2	100.0
No.20	0.16	0.85	99.9
No.40	0.24	0.425	99.8
No.60	0.25	0.25	99.8
No.100	0.32	0.15	99.8
No.140	0.36	0.106	99.8
No.200	0.50	0.075	99.7



Gravel (%): 0.0
Sand (%): 0.3
Fines (%): 99.7

Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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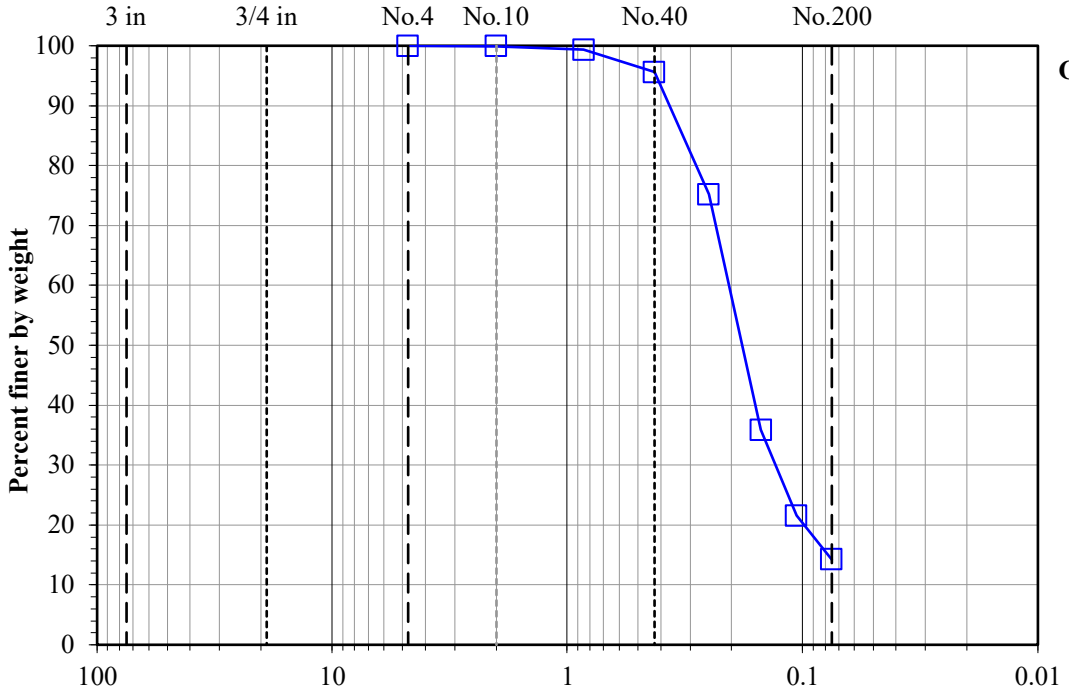
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: FB

Boring No.: B21-OIPS-08
Sample: 15
Depth: 74'
Description: Brown silty sand

	Moist	Dry
Split:	No	
Total sample wt. (g):	223.10	181.54
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	350.22
Dry soil + tare (g):	-	308.66
Tare (g):	-	127.12
Water content (%):	0.0	22.9

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	0.19	2	99.9
No.20	1.24	0.85	99.3
No.40	8.04	0.425	95.6
No.60	45.08	0.25	75.2
No.100	116.42	0.15	35.9
No.140	142.40	0.106	21.6
No.200	155.72	0.075	14.2



Gravel (%): 0.0
Sand (%): 85.8
Fines (%): 14.2

Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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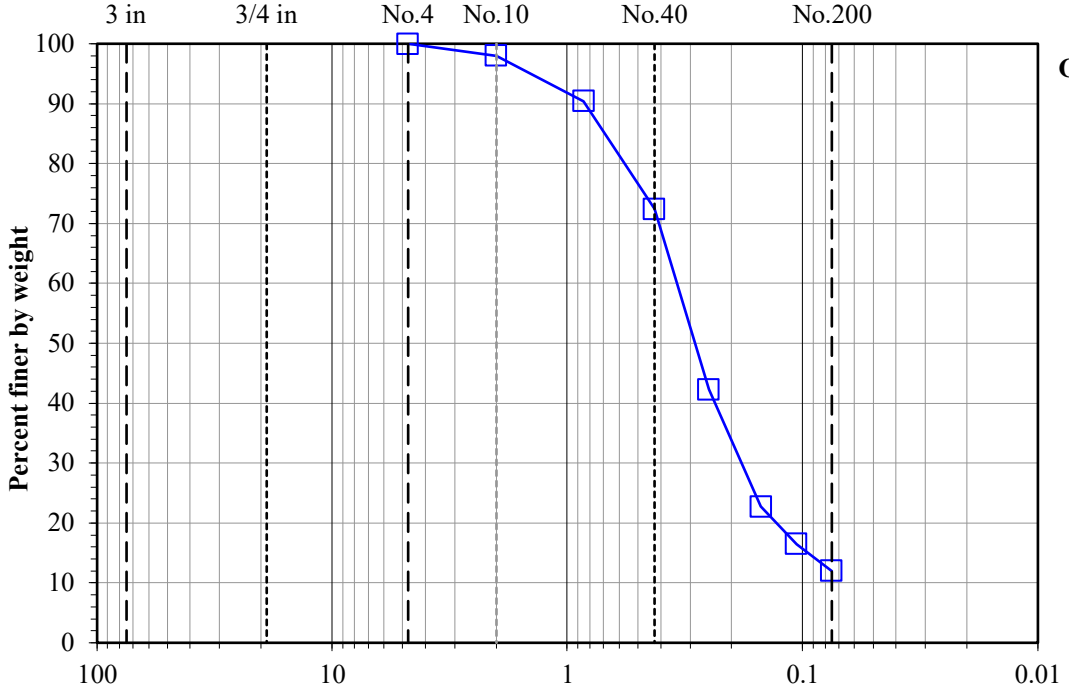
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: RT

Boring No.: B21-OIPS-09
Sample: 4
Depth: 18'
Description: Grey sand with silt

	Moist	Dry
Split:	No	
Total sample wt. (g):	316.75	256.98
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	440.56
Dry soil + tare (g):	-	380.79
Tare (g):	-	123.81
Water content (%):	0.0	23.3

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	100.0
No.10	5.11	2	98.0
No.20	24.63	0.85	90.4
No.40	70.94	0.425	72.4
No.60	148.31	0.25	42.3
No.100	198.63	0.15	22.7
No.140	214.62	0.106	16.5
No.200	226.02	0.075	12.0



Gravel (%): 0.0
Sand (%): 88.0
Fines (%): 12.0

Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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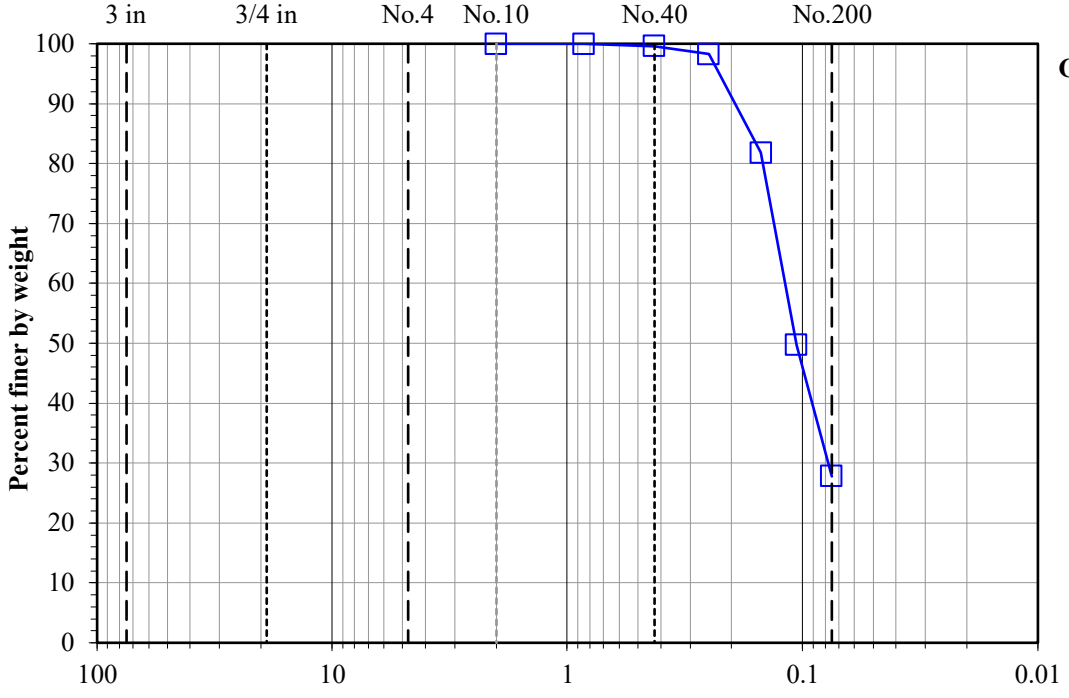
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/14/2021
By: FB

Boring No.: B21-OIPS-09
Sample: 14
Depth: 75'
Description: Brown silty sand

	Moist	Dry
Split:	No	
Total sample wt. (g):	253.72	201.61
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	382.07
Dry soil + tare (g):	-	329.96
Tare (g):	-	128.35
Water content (%):	0.0	25.8

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	-
No.10	-	2	100.0
No.20	0.10	0.85	100.0
No.40	0.83	0.425	99.6
No.60	3.54	0.25	98.2
No.100	36.63	0.15	81.8
No.140	101.41	0.106	49.7
No.200	145.51	0.075	27.8



Gravel (%): 0.0
Sand (%): 72.2
Fines (%): 27.8

Entered by:_____
Reviewed:_____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

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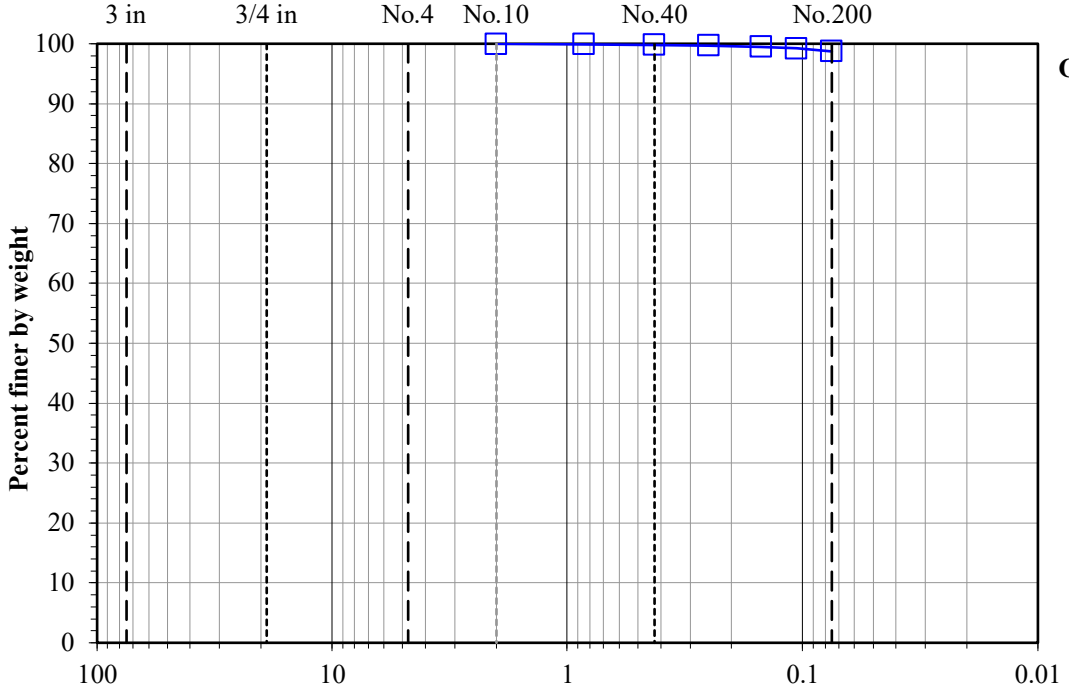
Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: EH

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'
Description: Grey clay

	Moist	Dry
Split:	No	
Total sample wt. (g):	213.13	158.15
	-	
Split fraction:	1.000	

Water content data		
Moist soil + tare (g):	-	341.60
Dry soil + tare (g):	-	286.62
Tare (g):	-	128.47
Water content (%):	0.0	34.8

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
1"	-	25	-
3/4"	-	19	-
3/8"	-	9.5	-
No.4	-	4.75	-
No.10	-	2	100.0
No.20	0.13	0.85	99.9
No.40	0.32	0.425	99.8
No.60	0.48	0.25	99.7
No.100	0.81	0.15	99.5
No.140	1.21	0.106	99.2
No.200	2.02	0.075	98.7



Gravel (%): 0.0
Sand (%): 1.3
Fines (%): 98.7

Entered by:_____
Reviewed:_____

Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[GSDv2.xlsm]21

Amount of Material in Soil Finer than the No. 200 (75µm) Sieve

(ASTM D1140)

© IGES 2010, 2018

Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 12/21/2018
By: BF/JP

Sample Info.	Boring No.	BH18-HP-1	BH18-HP-1	BH18-HP-1	BH18-HP-1	BH18-PC-1	BH18-PC-1	BH18-PC-1	BH18-PC-1
	Sample	3	12A	16	22A	8B	10B	15B	18A
	Depth	20'	53'	69'	98'	45'	55'	80'	95'
	Split	No	No	No	No	No	No	No	No
	Split Sieve*								
	Method	B	B	B	B	B	B	B	B
Specimen soak time (min)		250	170	160	170	180	190	200	190
Moist total sample wt. (g)		152.87	174.86	121.49	125.05	137.58	205.31	138.46	144.95
Moist coarse fraction (g)									
Moist split fraction + tare (g)									
Split fraction tare (g)									
Dry split fraction (g)									
Dry retained No. 200 + tare (g)		190.06	197.53	170.41	185.47	139.37	157.74	162.84	220.67
Wash tare (g)		152.70	122.18	127.14	126.84	129.28	121.55	121.89	212.01
No. 200 Dry wt. retained (g)		37.36	75.35	43.27	58.63	10.09	36.19	40.95	8.66
Split sieve* Dry wt. retained (g)									
Dry total sample wt. (g)		122.55	141.57	104.18	98.16	108.78	172.66	111.12	112.51
Coarse Fraction	Moist soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Split Fraction	Moist soil + tare (g)	305.57	297.04	248.63	251.89	266.86	326.86	260.35	356.96
	Dry soil + tare (g)	275.25	263.75	231.32	225.00	238.06	294.21	233.01	324.52
	Tare (g)	152.70	122.18	127.14	126.84	129.28	121.55	121.89	212.01
	Water content (%)	24.74	23.51	16.62	27.39	26.48	18.91	24.60	28.83
Percent passing split sieve* (%)									
Percent passing No. 200 sieve (%)		**69.5**	**46.8**	**58.5**	**40.3**	**90.7**	**79.0**	**63.1**	**92.3**

Entered by:_____
Reviewed:_____

Amount of Material in Soil Finer than the No. 200 (75µm) Sieve

(ASTM D1140)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: BF/JP/RT/HB

Sample Info.	Boring No.	BH19-BR-9	BH19-BR-9	BH19-BR-9	BH19-ES-1	BH19-ES-1	BH19-ES-1	BH19-ES-1	BH19-ES-1
	Sample	4B	7	9B	3	5	8B	13B	14B
	Depth	16'	38'	48'	13'	17'	24'	44'	52'
	Split	No	No	No	No	No	No	No	No
	Split Sieve*								
	Method	B	B	B	B	B	B	B	B
Specimen soak time (min)		360	380	420	370	390	150	350	330
Moist total sample wt. (g)		140.43	197.15	204.75	163.77	184.13	129.34	200.98	206.54
Moist coarse fraction (g)									
Moist split fraction + tare (g)									
Split fraction tare (g)									
Dry split fraction (g)									
Dry retained No. 200 + tare (g)		208.77	141.11	198.81	236.31	207.80	151.49	255.30	200.53
Wash tare (g)		172.20	127.16	140.56	211.93	123.84	128.65	124.77	122.48
No. 200 Dry wt. retained (g)		36.57	13.95	58.25	24.38	83.96	22.84	130.53	78.05
Split sieve* Dry wt. retained (g)									
Dry total sample wt. (g)		95.49	149.46	153.94	107.68	142.83	97.34	166.67	164.50
Coarse Fraction	Moist soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Split Fraction	Moist soil + tare (g)	312.63	324.31	345.31	375.70	307.97	257.99	325.75	329.02
	Dry soil + tare (g)	267.69	276.62	294.50	319.61	266.67	225.99	291.44	286.98
	Tare (g)	172.20	127.16	140.56	211.93	123.84	128.65	124.77	122.48
	Water content (%)	47.06	31.91	33.01	52.09	28.91	32.87	20.59	25.56
Percent passing split sieve* (%)									
Percent passing No. 200 sieve (%)		**61.7**	**90.7**	**62.2**	**77.4**	**41.2**	**76.5**	**21.7**	**52.6**

Entered by:_____
Reviewed:_____

Amount of Material in Soil Finer than the No. 200 (75µm) Sieve

(ASTM D1140)

© IGES 2010, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: RT/EZ/HB/JDF

Sample Info.	Boring No.	BH19-ES-2	BH19-ES-2	BH19-ES-2	BH19-ES-2	BH19-ES-2	BH19-ES-2	BH19-ES-2	
	Sample	1	2B	3B	6	8B	13B	25A	
	Depth	9'	11'	13'	20'	26'	51'	110'	
	Split	No	No	No	No	No	No	No	
	Split Sieve*								
	Method	B	B	B	B	B	B	B	
Specimen soak time (min)		430	160	120	400	430	310	150	
Moist total sample wt. (g)		209.61	222.69	224.66	114.25	211.75	206.77	215.24	
Moist coarse fraction (g)									
Moist split fraction + tare (g)									
Split fraction tare (g)									
Dry split fraction (g)									
Dry retained No. 200 + tare (g)		238.00	148.88	197.91	128.77	250.82	227.99	140.35	
Wash tare (g)		127.69	127.92	151.75	127.59	153.66	139.75	124.99	
No. 200 Dry wt. retained (g)		110.31	20.96	46.16	1.18	97.16	88.24	15.36	
Split sieve* Dry wt. retained (g)									
Dry total sample wt. (g)		166.86	136.11	158.20	82.93	156.34	163.85	166.30	
Coarse Fraction	Moist soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Split Fraction	Moist soil + tare (g)	337.30	350.61	376.41	241.84	365.41	346.52	340.23	
	Dry soil + tare (g)	294.55	264.03	309.95	210.52	310.00	303.60	291.29	
	Tare (g)	127.69	127.92	151.75	127.59	153.66	139.75	124.99	
	Water content (%)	25.62	63.61	42.01	37.77	35.44	26.19	29.43	
Percent passing split sieve* (%)									
Percent passing No. 200 sieve (%)		**33.9**	**84.6**	**70.8**	**98.6**	**37.9**	**46.1**	**90.8**	

Entered by:_____
Reviewed:_____

Amount of Material in Soil Finer than the No. 200 (75µm) Sieve

(ASTM D1140)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: RT/KB/BRR/FB

Sample Info.	Boring No.	B21-IS-01	B21-IS-02	B21-IS-02	B21-IS-04	B21-IS-05	B21-IS-05	B21-IS-06	B21-OIPS-01
	Sample	2B	3A	5	1	2	4B	4	2
	Depth	10'	8'	16'	6'	10'	15'	14'	6'
	Split	No	No	No	No	No	No	No	No
	Split Sieve*								
	Method	B	B	B	B	B	B	B	B
Specimen soak time (min)		90	150	420	400	170	430	170	150
Moist total sample wt. (g)		305.18	115.96	565.81	326.65	371.02	66.77	448.45	236.08
Moist coarse fraction (g)									
Moist split fraction + tare (g)									
Split fraction tare (g)									
Dry split fraction (g)									
Dry retained No. 200 + tare (g)		173.31	229.31	229.68	206.28	141.91	143.81	236.05	227.30
Wash tare (g)		127.25	208.43	128.65	127.92	126.65	127.68	126.63	181.18
No. 200 Dry wt. retained (g)		46.06	20.88	101.03	78.36	15.26	16.13	109.42	46.12
Split sieve* Dry wt. retained (g)									
Dry total sample wt. (g)		216.63	81.63	420.88	251.06	235.41	49.92	336.36	184.16
Coarse Fraction	Moist soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Split Fraction	Moist soil + tare (g)	432.43	324.39	694.46	454.57	497.67	194.45	575.08	417.26
	Dry soil + tare (g)	343.88	290.06	549.53	378.98	362.06	177.60	462.99	365.34
	Tare (g)	127.25	208.43	128.65	127.92	126.65	127.68	126.63	181.18
	Water content (%)	40.88	42.06	34.43	30.11	57.61	33.75	33.32	28.19
Percent passing split sieve* (%)									
Percent passing No. 200 sieve (%)		**78.7**	**74.4**	**76.0**	**68.8**	**93.5**	**67.7**	**67.5**	**75.0**

Entered by:_____
Reviewed:_____

Amount of Material in Soil Finer than the No. 200 (75µm) Sieve

(ASTM D1140)

© IGES 2010, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: FB/RT

Sample Info.	Boring No.	B21-OIPS-01	B21-OIPS-02	B21-OIPS-02	B21-OIPS-02	B21-OIPS-03	B21-OIPS-05	B21-OIPS-07	B21-OIPS-07
	Sample	4B	3	4A	6	3	5B	3B	4
	Depth	20'	14'	18'	30'	15'	21'	12'	14'
	Split	No	No	No	No	No	No	No	No
	Split Sieve*								
	Method	B	B	B	B	B	B	B	B
Specimen soak time (min)		160	310	400	460	410	140	510	520
Moist total sample wt. (g)		314.39	288.46	240.50	188.16	254.20	200.51	257.72	357.42
Moist coarse fraction (g)									
Moist split fraction + tare (g)									
Split fraction tare (g)									
Dry split fraction (g)									
Dry retained No. 200 + tare (g)		260.04	157.51	171.02	124.17	142.27	204.90	175.79	259.53
Wash tare (g)		127.37	128.23	126.90	122.16	119.14	127.22	123.61	126.82
No. 200 Dry wt. retained (g)		132.67	29.28	44.12	2.01	23.13	77.68	52.18	132.71
Split sieve* Dry wt. retained (g)									
Dry total sample wt. (g)		239.11	211.76	182.50	121.21	172.52	148.48	192.80	275.49
Coarse Fraction	Moist soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Split Fraction	Moist soil + tare (g)	441.76	416.69	367.40	310.32	373.34	327.73	381.33	484.24
	Dry soil + tare (g)	366.48	339.99	309.40	243.37	291.66	275.70	316.41	402.31
	Tare (g)	127.37	128.23	126.90	122.16	119.14	127.22	123.61	126.82
	Water content (%)	31.48	36.22	31.78	55.23	47.35	35.04	33.67	29.74
Percent passing split sieve* (%)									
Percent passing No. 200 sieve (%)		**44.5**	**86.2**	**75.8**	**98.3**	**86.6**	**47.7**	**72.9**	**51.8**

Entered by:_____
Reviewed:_____

Amount of Material in Soil Finer than the No. 200 (75µm) Sieve

(ASTM D1140)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/3/2021
By: FB

Sample Info.	Boring No.	B21-OIPS-08	B21-OIPS-09	B21-OIPS-09					
	Sample	3	8B	10					
	Depth	12'	45'	55'					
	Split	No	No	No					
	Split Sieve*								
	Method	B	B	B					
Specimen soak time (min)		540	1490	1510					
Moist total sample wt. (g)		325.75	228.36	226.11					
Moist coarse fraction (g)									
Moist split fraction + tare (g)									
Split fraction tare (g)									
Dry split fraction (g)									
Dry retained No. 200 + tare (g)		262.55	174.92	155.79					
Wash tare (g)		129.04	121.12	126.69					
No. 200 Dry wt. retained (g)		133.51	53.80	29.10					
Split sieve* Dry wt. retained (g)									
Dry total sample wt. (g)		246.72	185.56	168.67					
Coarse Fraction	Moist soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Split Fraction	Moist soil + tare (g)	454.79	349.48	352.80					
	Dry soil + tare (g)	375.76	306.68	295.36					
	Tare (g)	129.04	121.12	126.69					
	Water content (%)	32.03	23.07	34.05					
Percent passing split sieve* (%)									
Percent passing No. 200 sieve (%)		**45.9**	**71.0**	**82.7**					

Entered by:_____
Reviewed:_____

Consolidation Test Results

One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 7/31/2019
By: EH

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

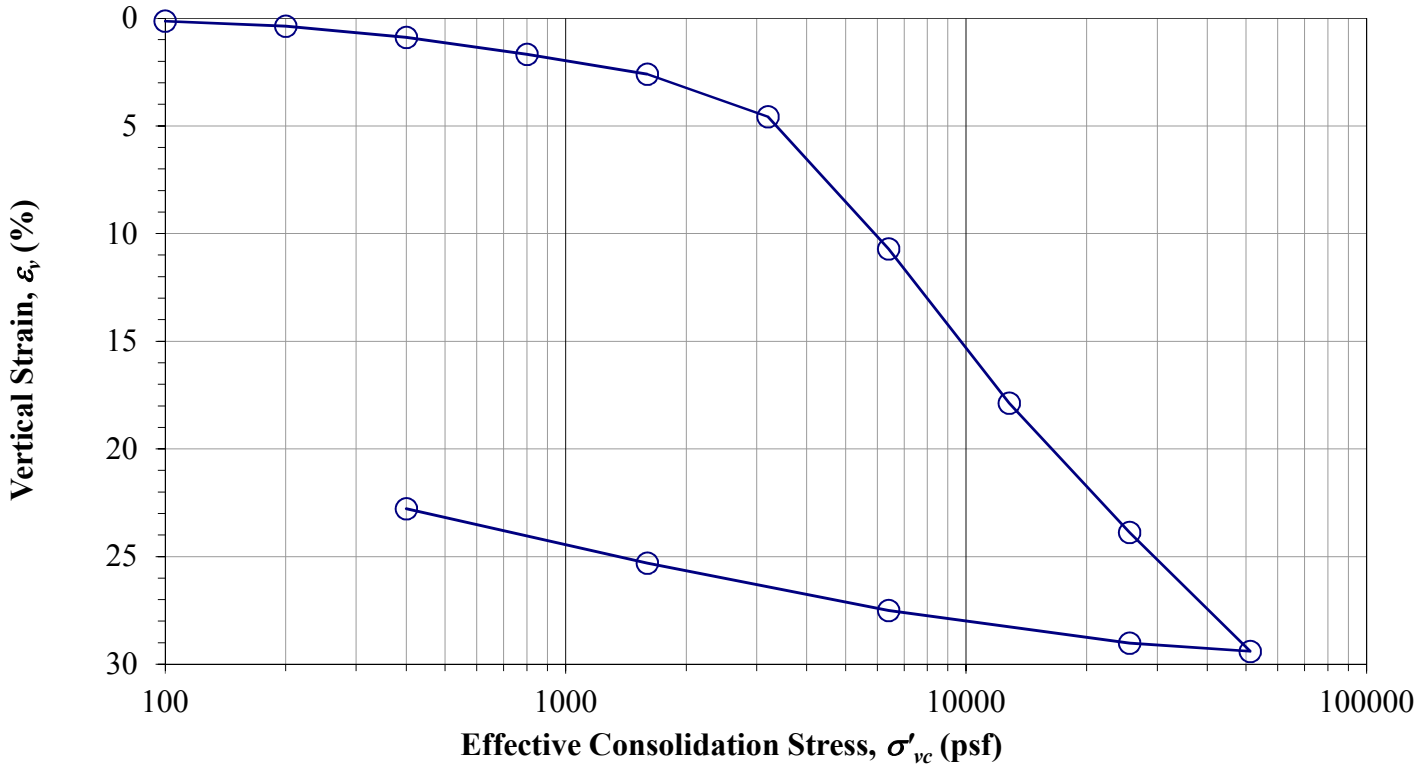
Test method:	B	
Inundation stress (psf), timing:	Seating	Beginning
Specific gravity, G_s	2.85	Assumed

Water type used for inundation: Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.919	0.710
Sample diameter, D (in.)	2.413	2.413
Wt. rings + wet soil (g)	161.90	146.37
Wt. rings/tare (g)	44.99	44.99
Total unit wt., γ (pcf)	106.0	119.00
Wet soil + tare (g)	340.67	222.94
Dry soil + tare (g)	263.05	196.56
Tare (g)	127.03	123.70
Water content, ω (%)	57.1	36.2
Dry unit wt., γ_d (pcf)	67.5	87.4
Saturation, S	0.99	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9190	1.6369
100	0.0013	0.14	0.9177	1.6333
200	0.0034	0.37	0.9156	1.6271
400	0.0082	0.89	0.9108	1.6133
800	0.0155	1.68	0.9035	1.5925
1600	0.0238	2.59	0.8952	1.5685
3200	0.0421	4.58	0.8769	1.5162
6400	0.0985	10.72	0.8205	1.3543
12800	0.1642	17.87	0.7548	1.1658
25600	0.2194	23.87	0.6996	1.0074
51200	0.2702	29.40	0.6488	0.8616
25600	0.2667	29.02	0.6523	0.8717
6400	0.2527	27.50	0.6663	0.9118
1600	0.2326	25.31	0.6864	0.9695
400	0.2093	22.77	0.7097	1.0364



Entered: _____
Reviewed: _____

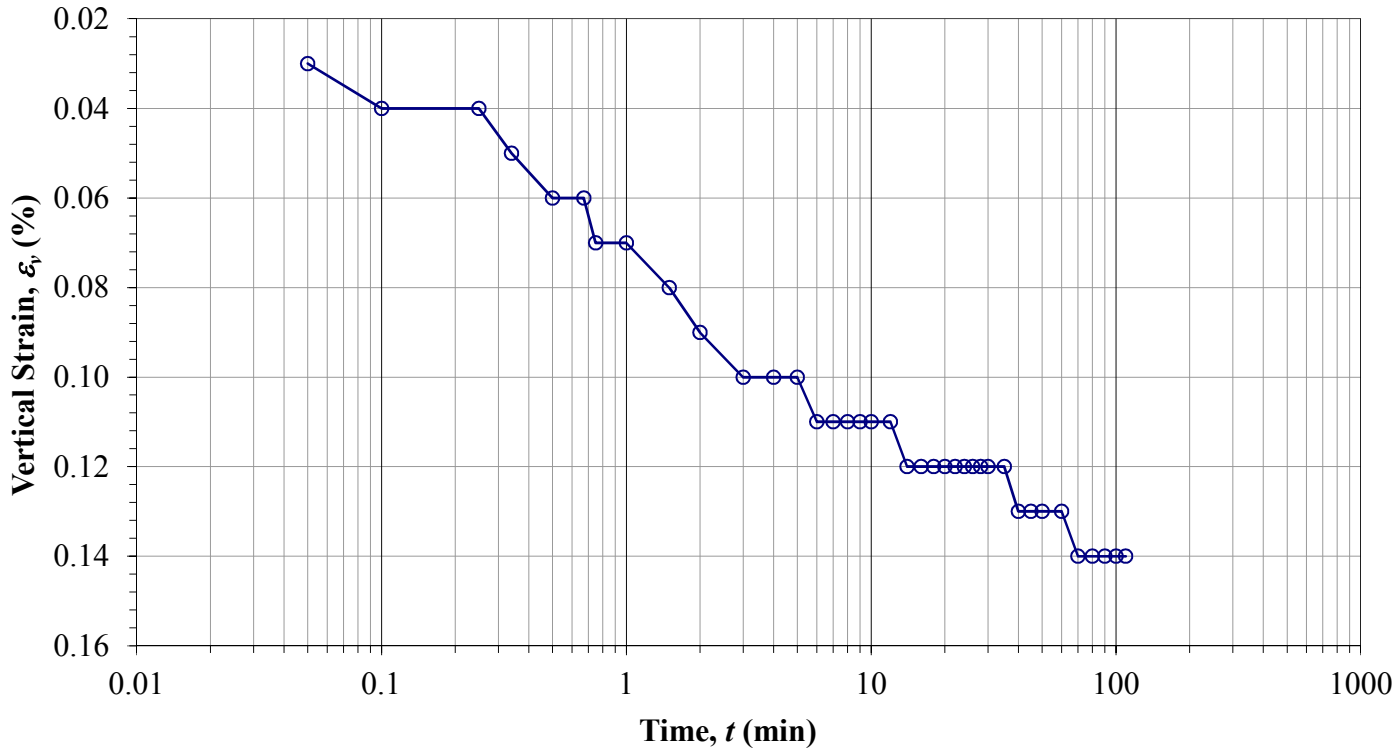
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'

Constant Load Step: 1 of 14
Stress: 100 psf





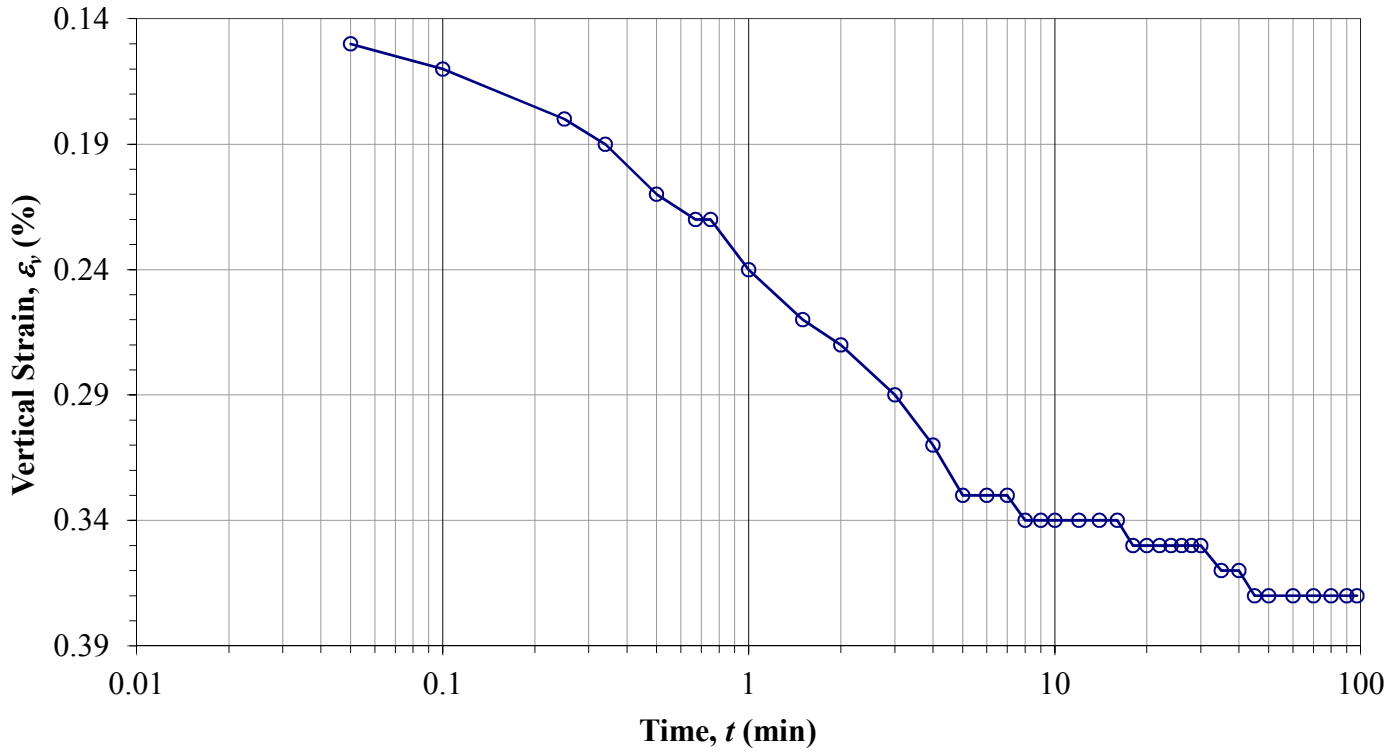
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

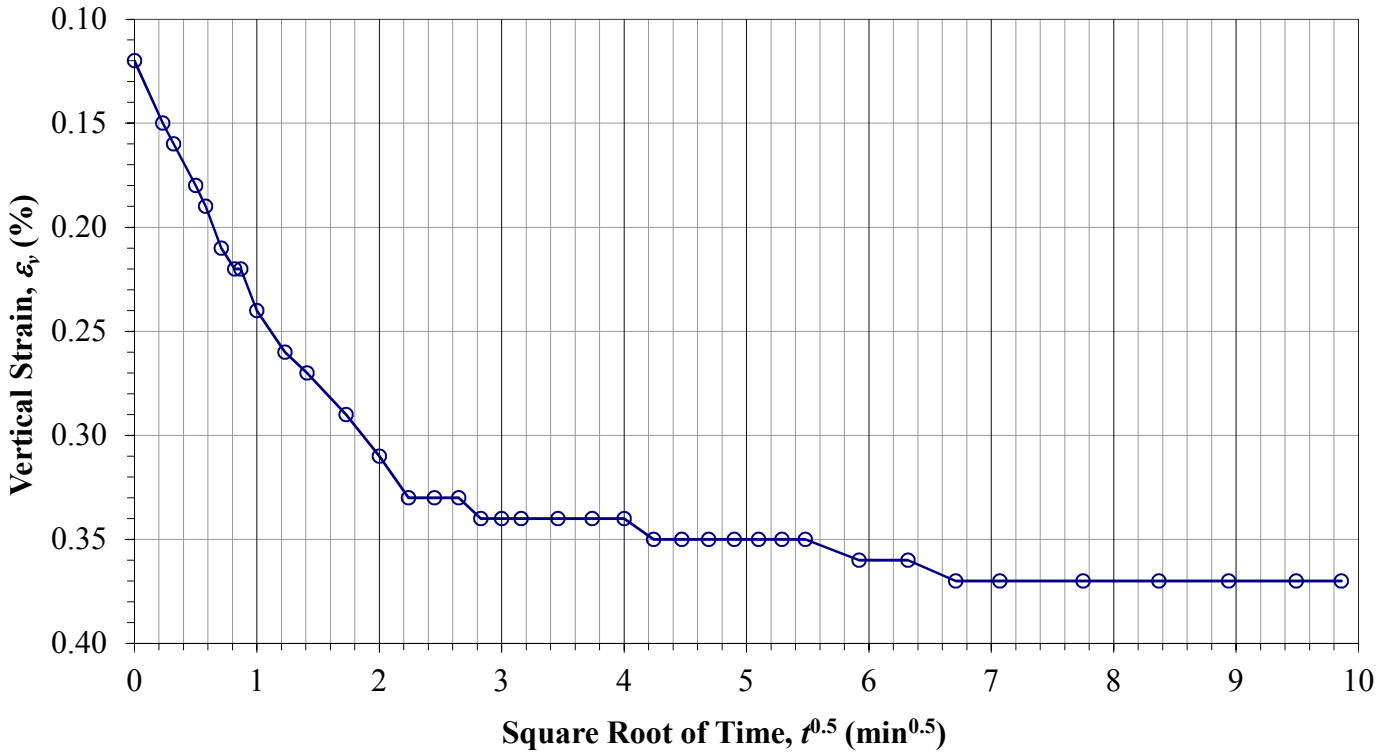
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

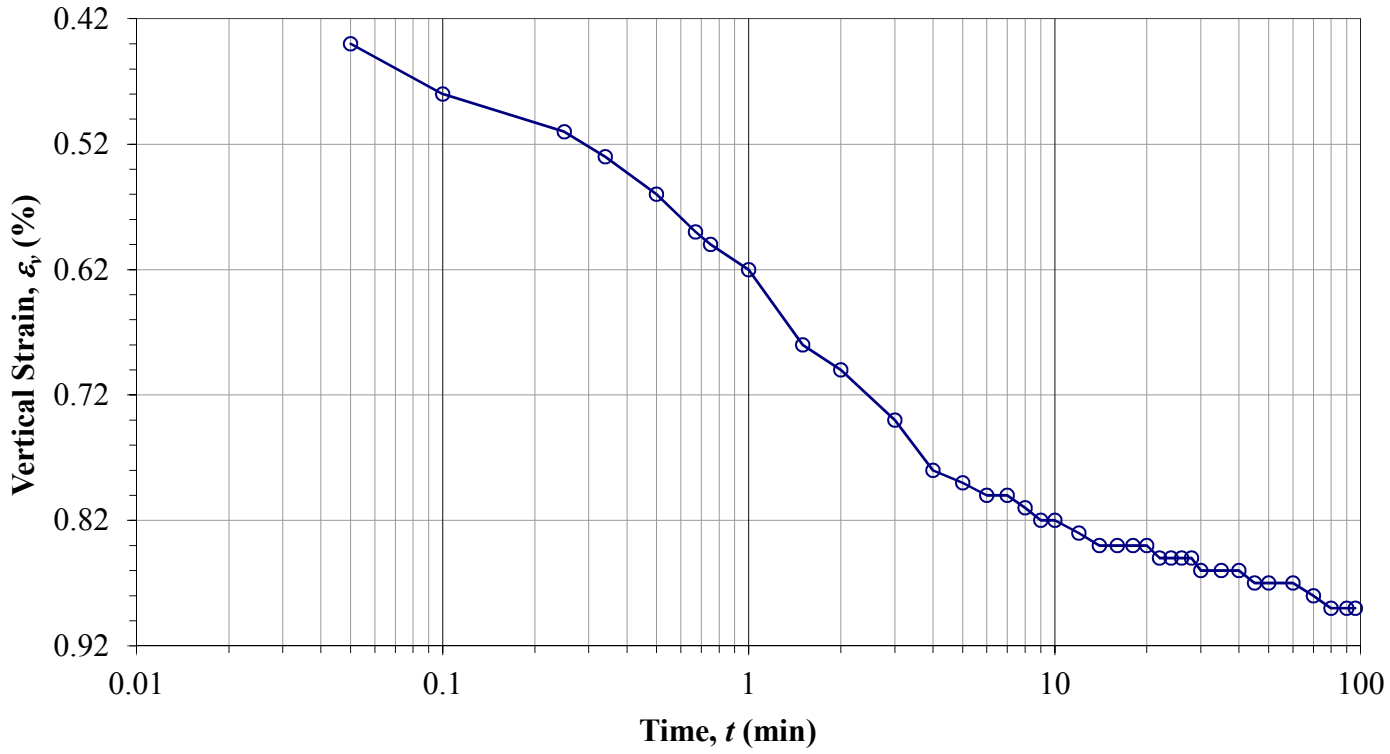
(ASTM D2435)

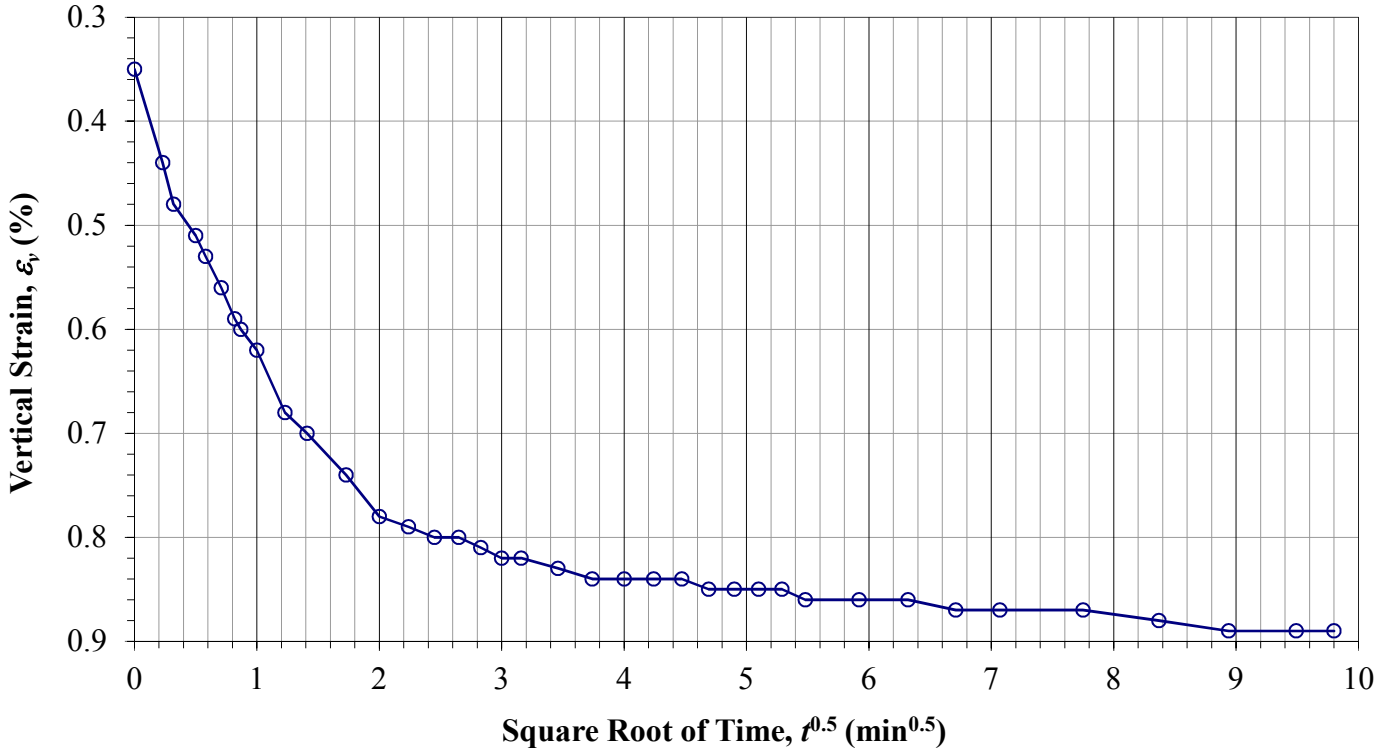
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'

Constant Load Step: 3 of 14
Stress: 400 psf





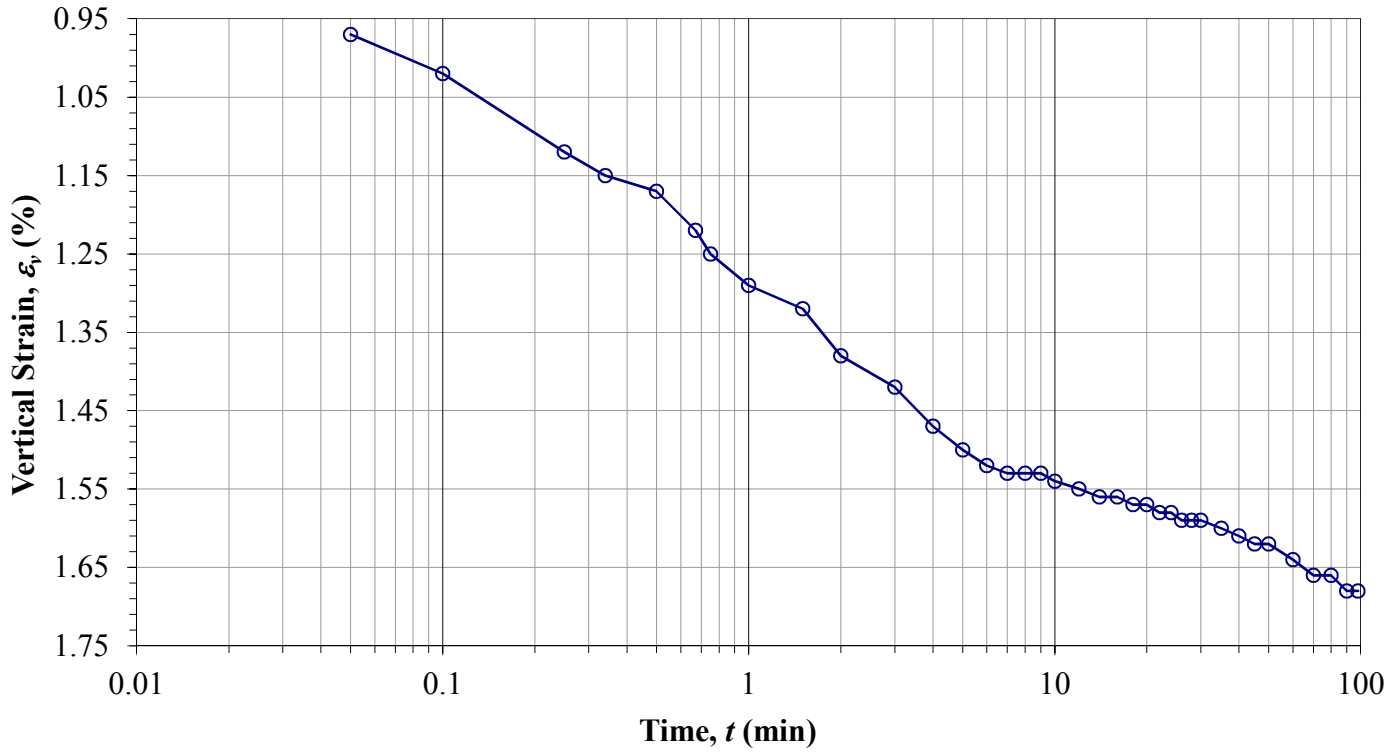
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

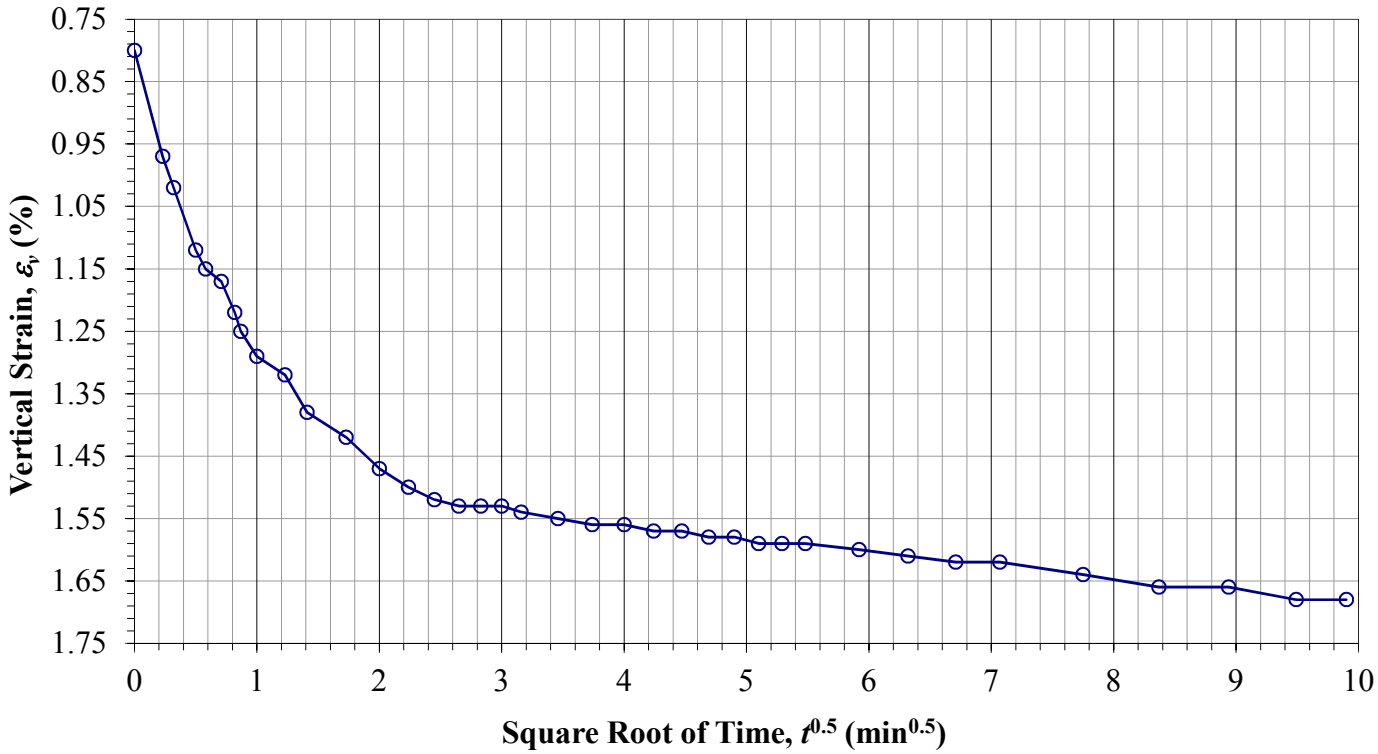
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'

Constant Load Step: 4 of 14
Stress: 800 psf



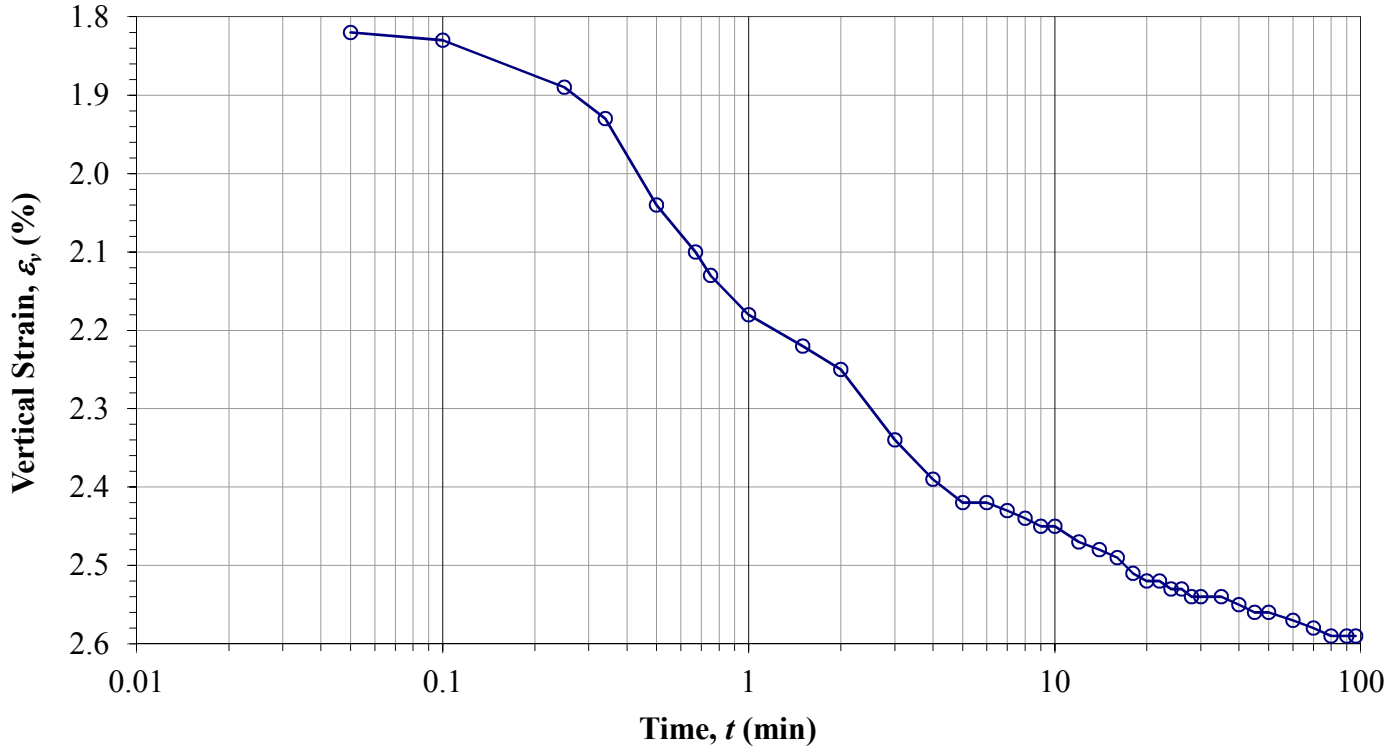


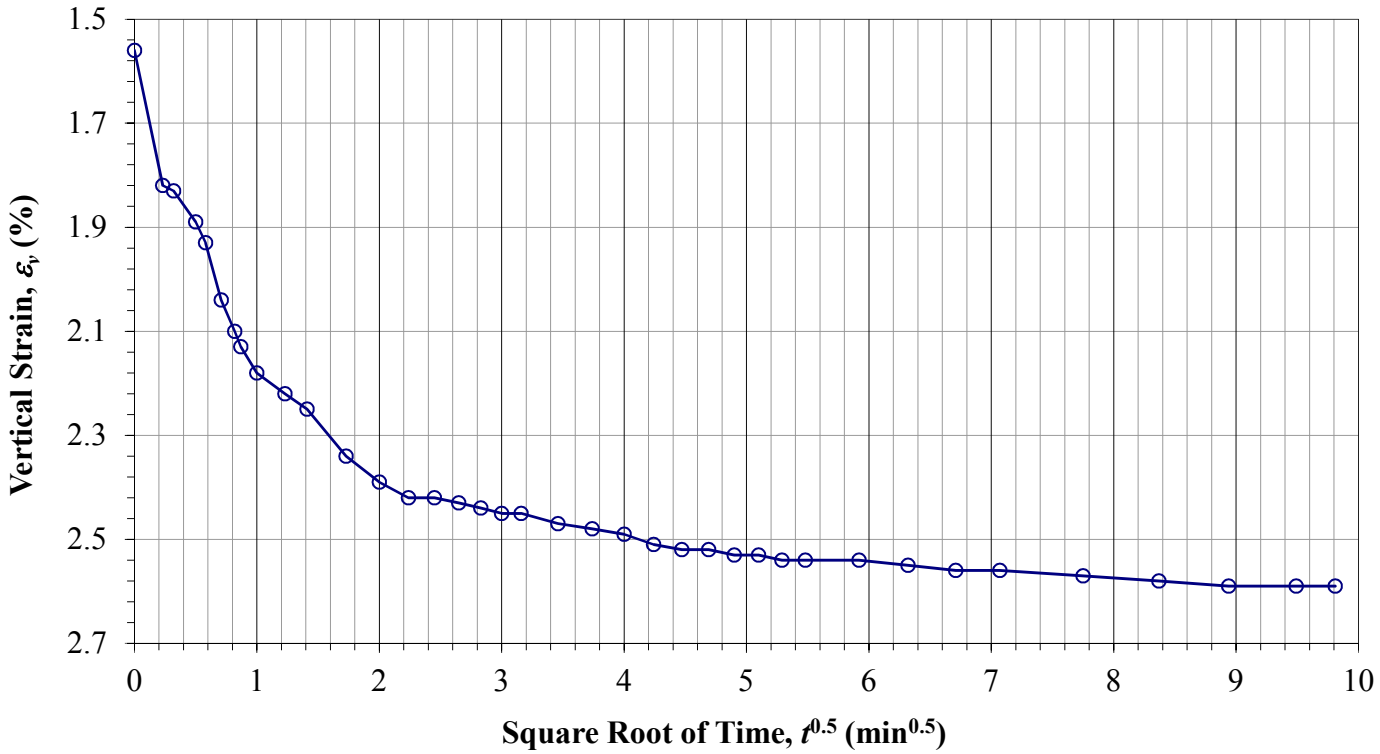
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 10
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 5 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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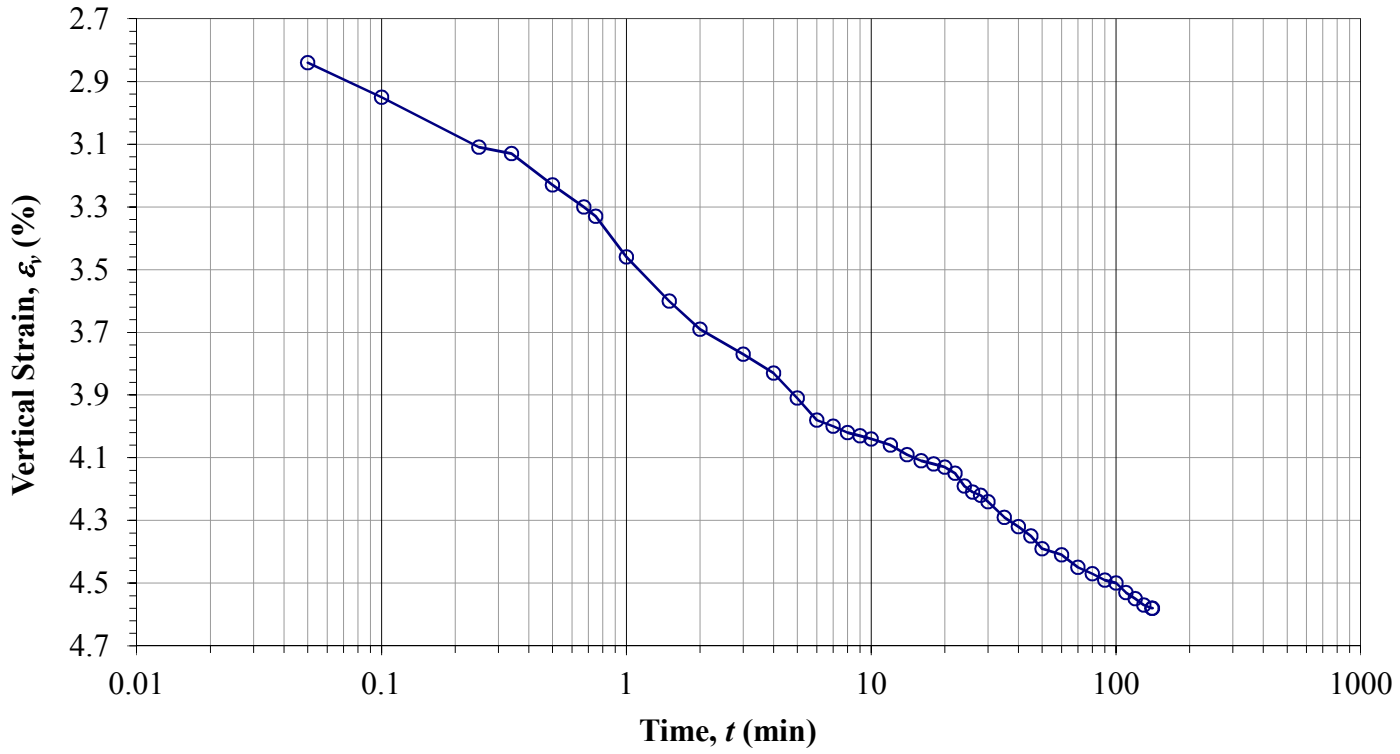
Project: AECOM **Boring No.:** BH19-ES-1

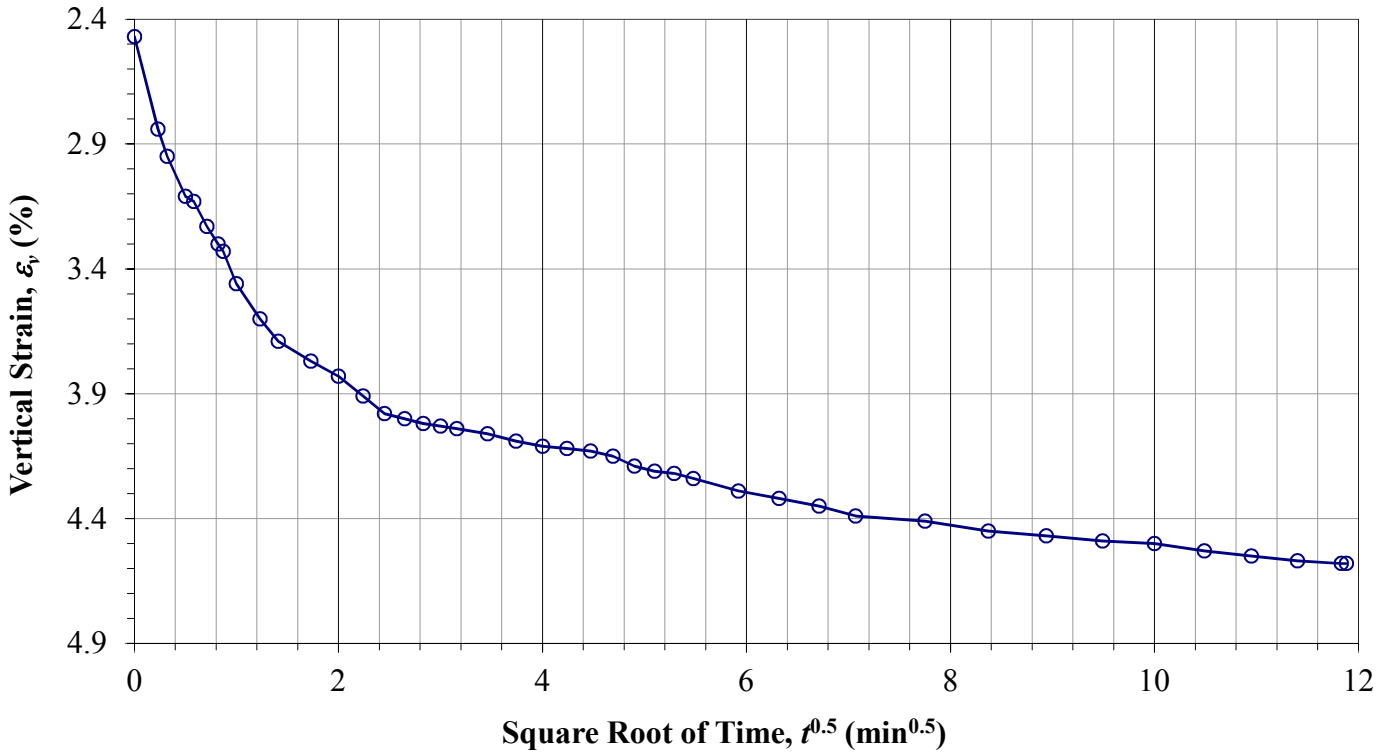
No: 00100-015, 3G2 (XIII) **Sample:** 10

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 6 of 14

Stress: 3200 psf





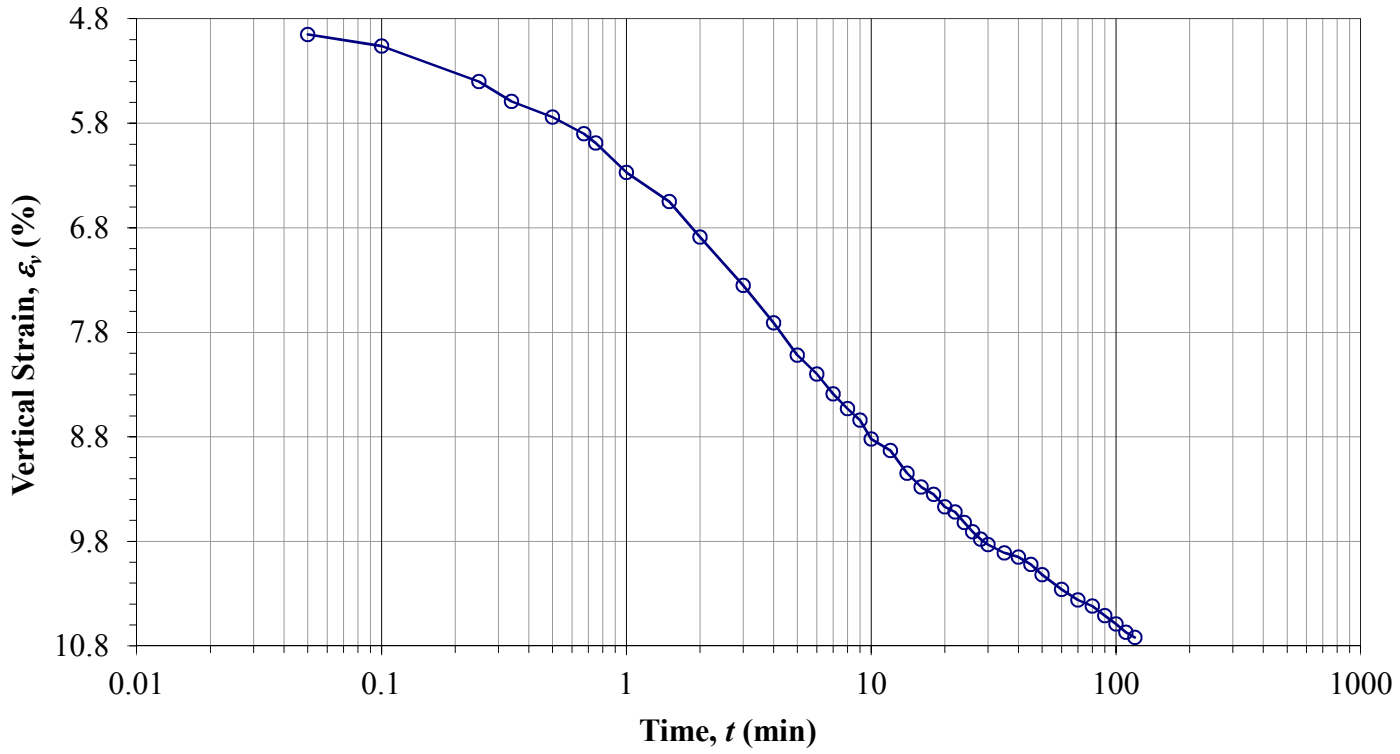
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

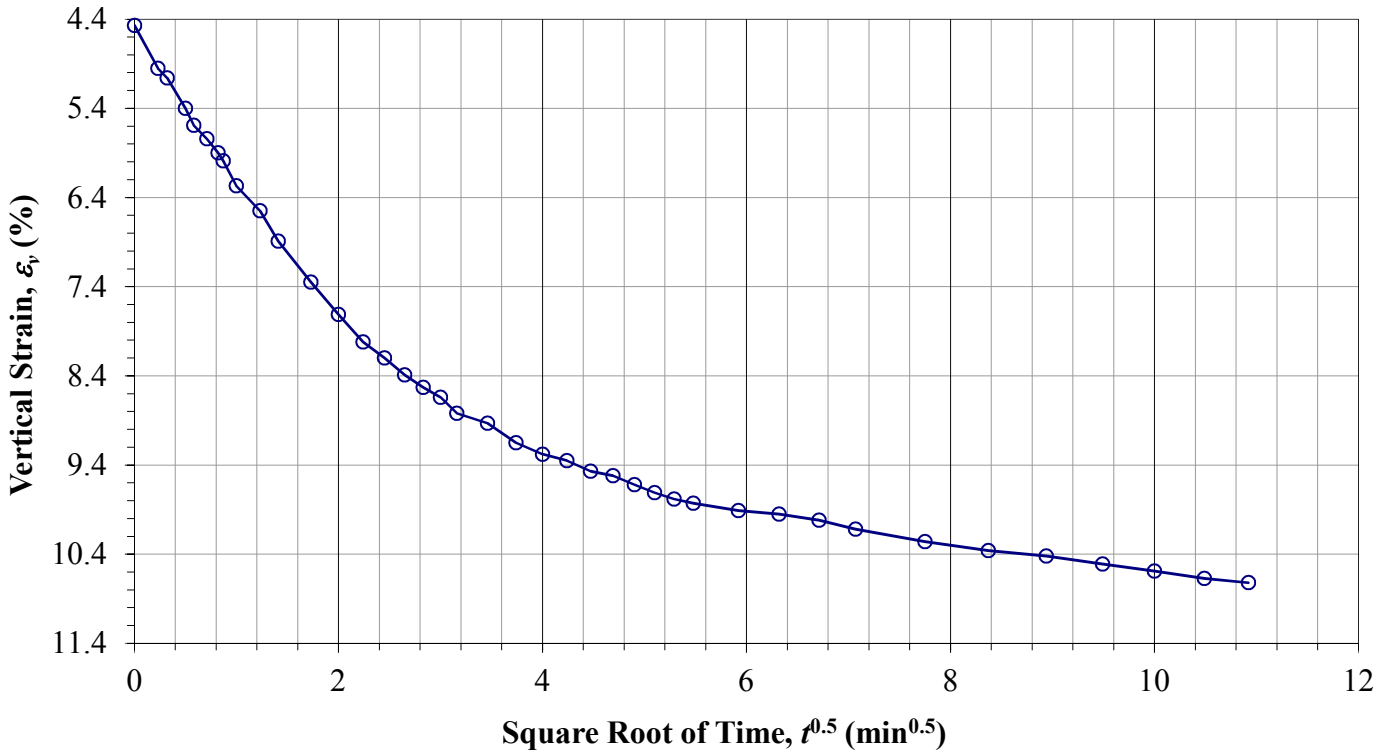
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'

Constant Load Step: 7 of 14
Stress: 6400 psf





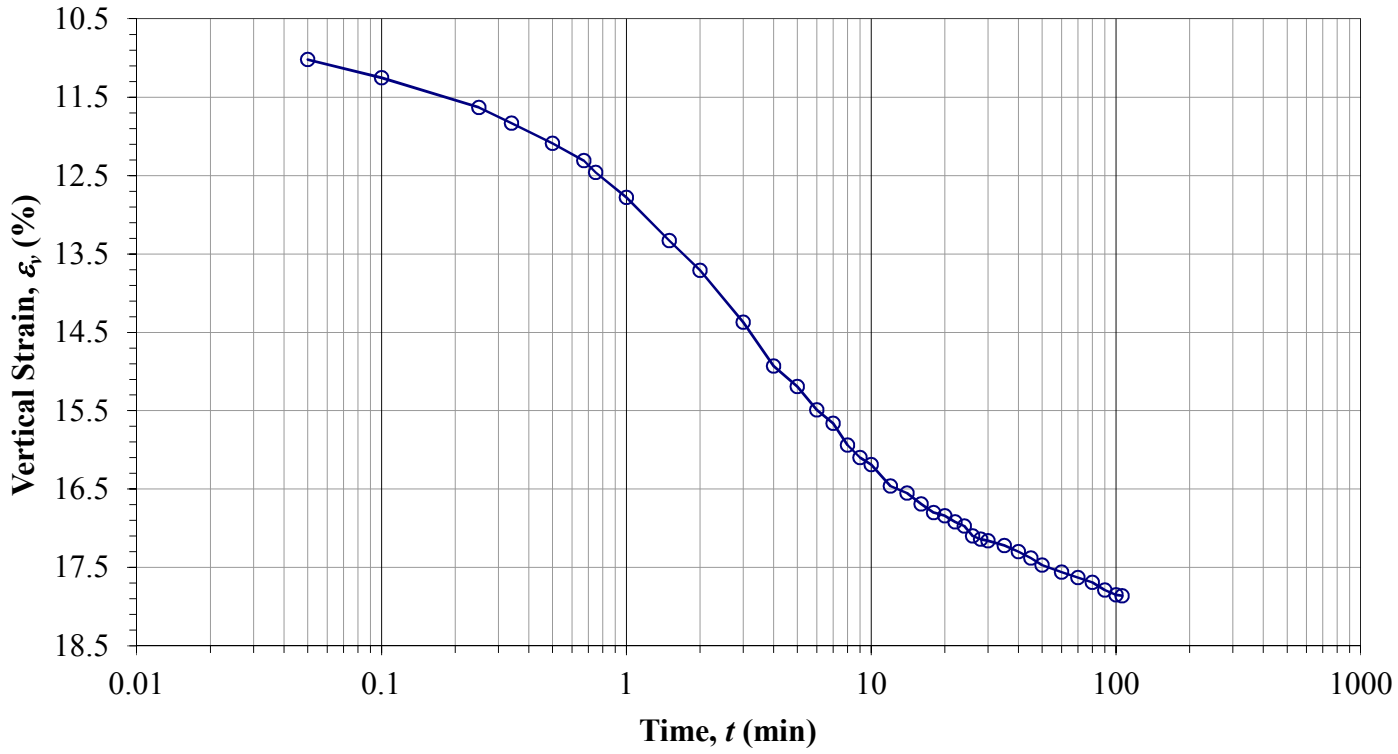
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

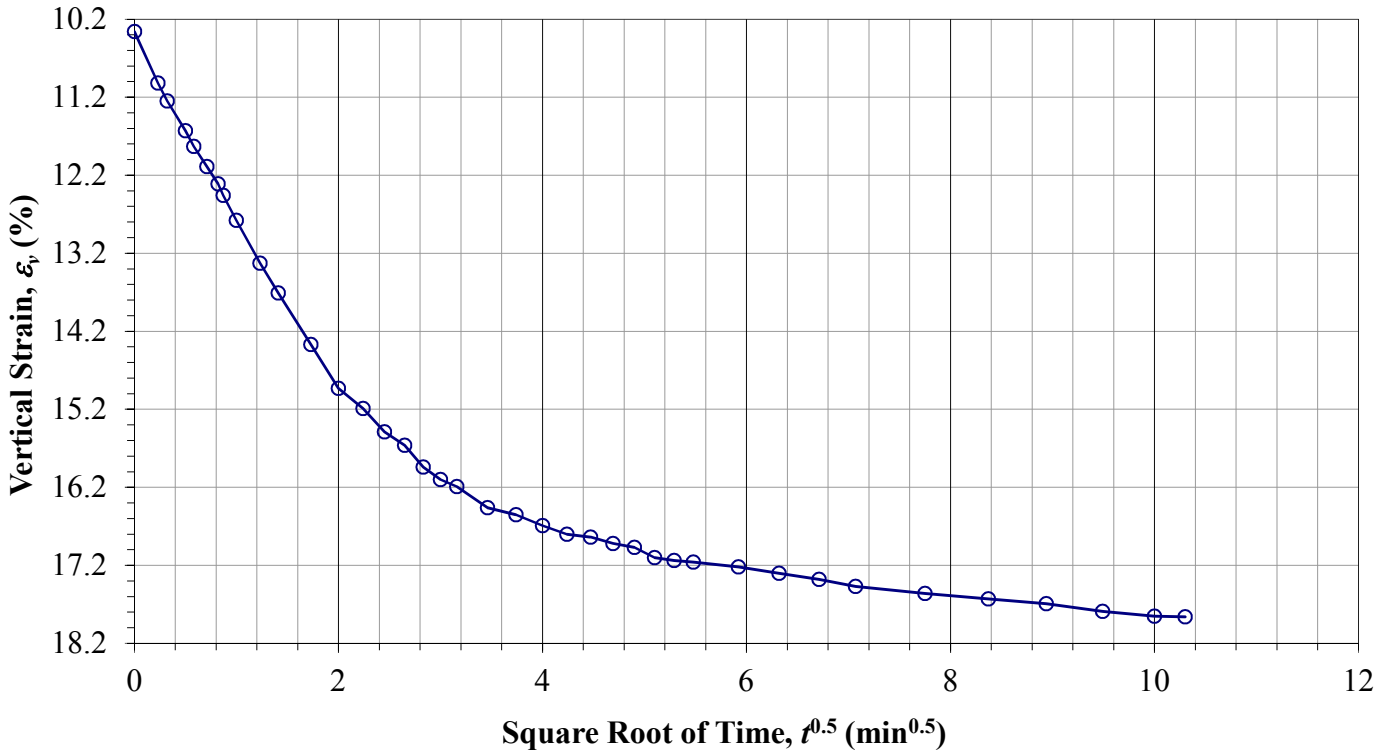
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'

Constant Load Step: 8 of 14
Stress: 12800 psf





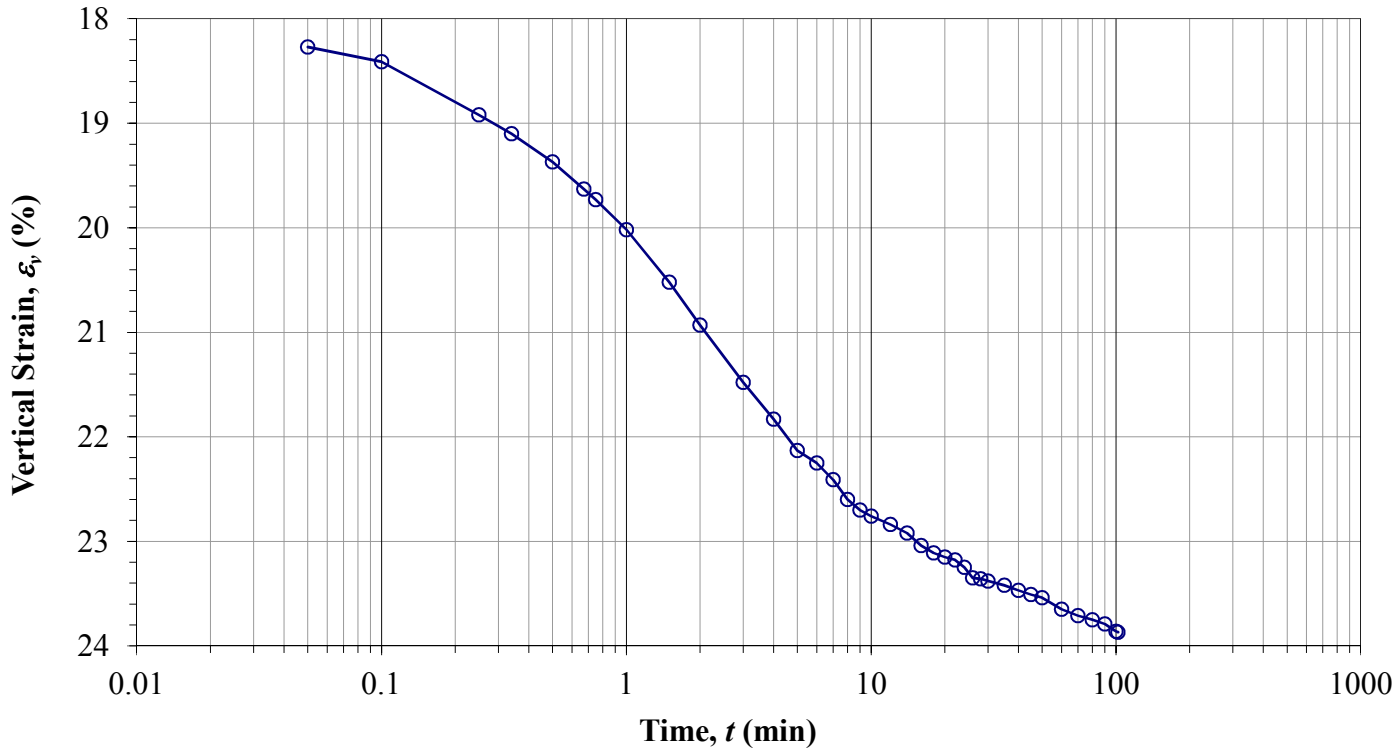
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

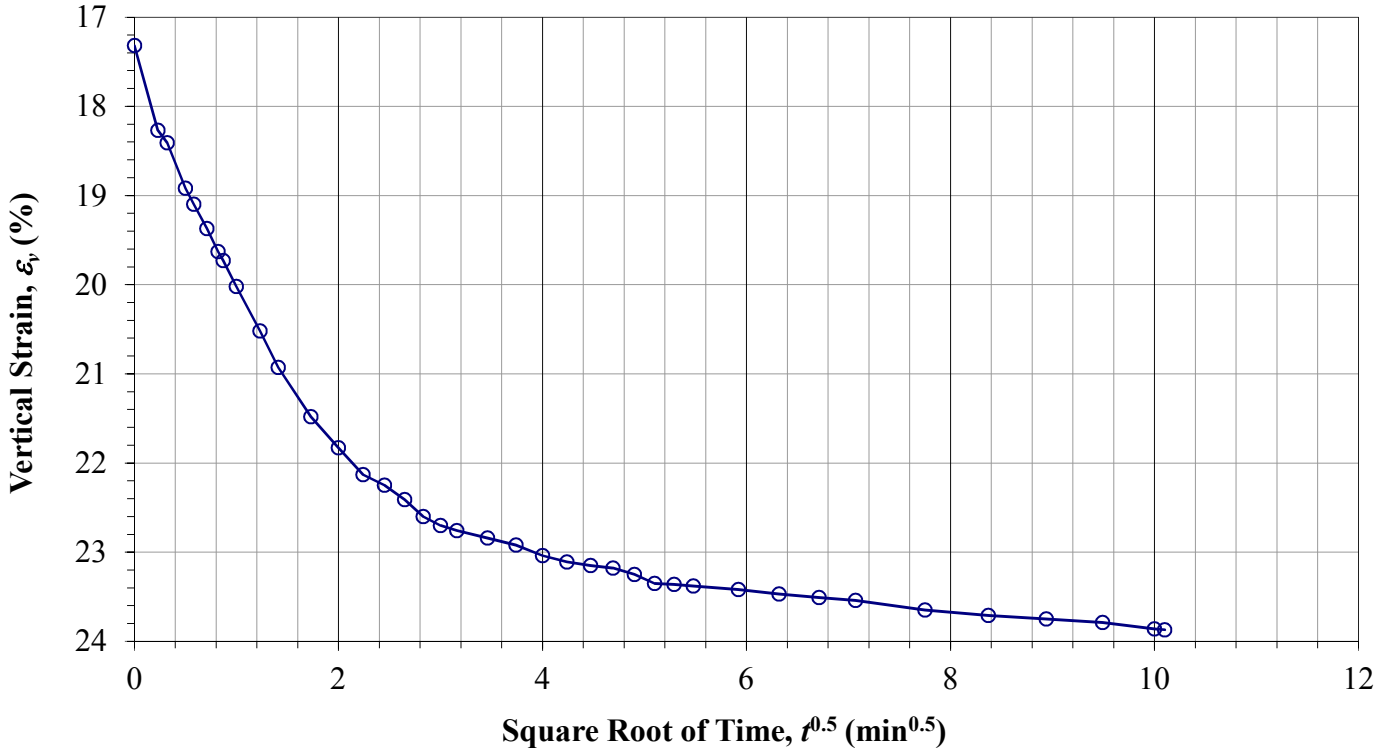
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'

Constant Load Step: 9 of 14
Stress: 25600 psf





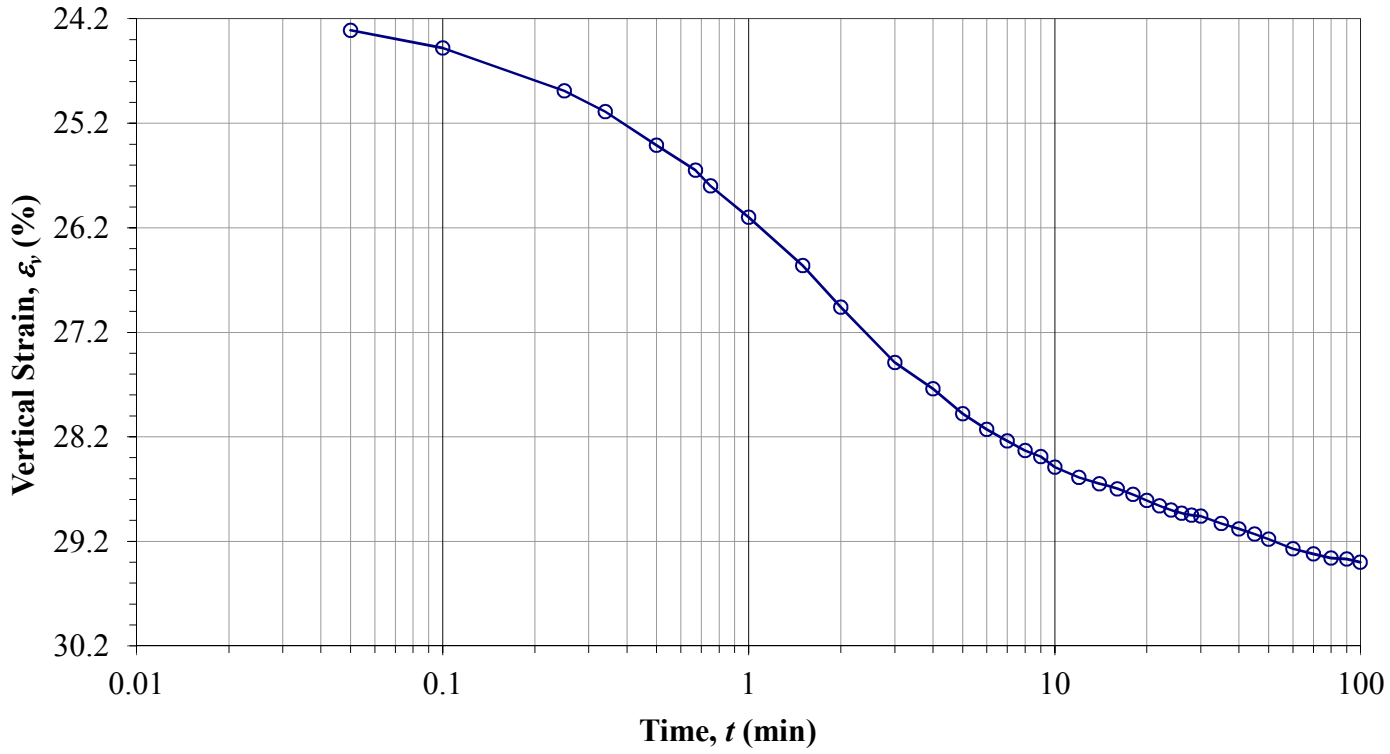
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

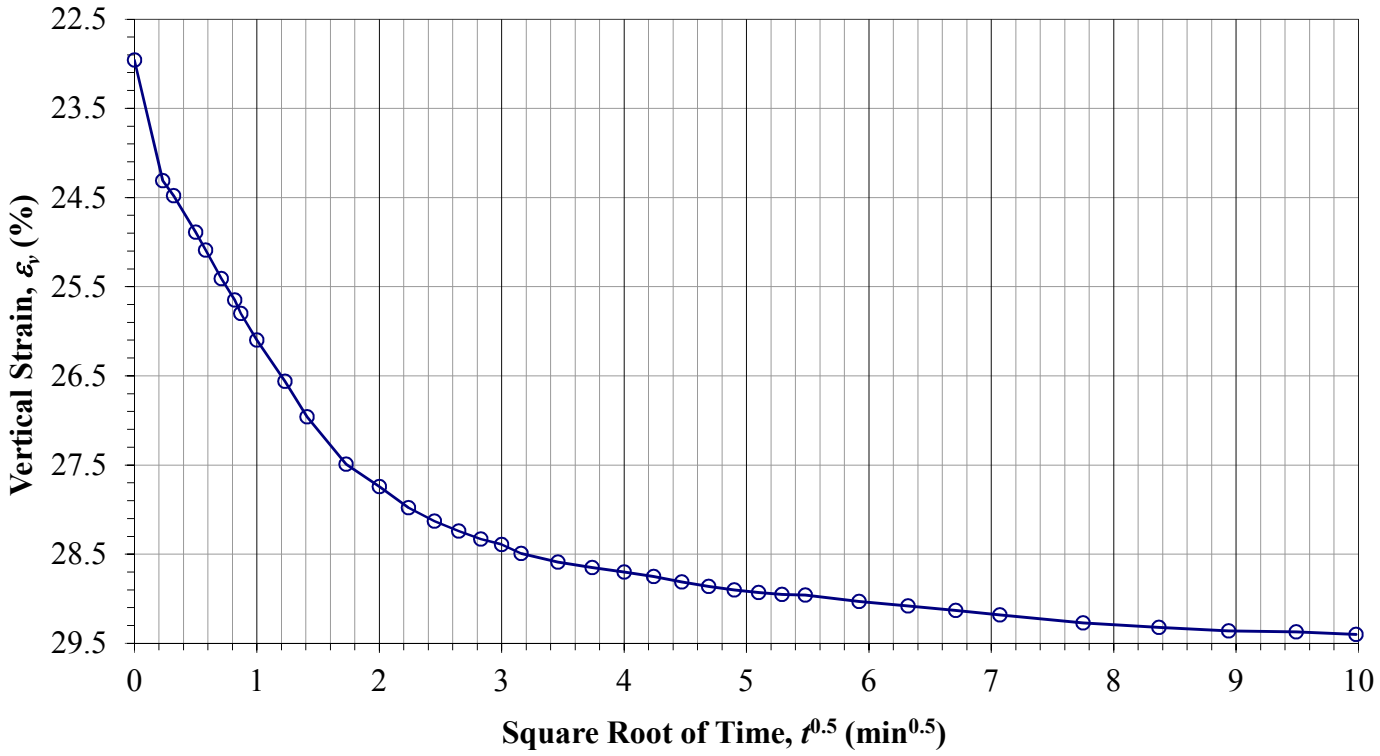
© IGES 2011, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'

Constant Load Step: 10 of 14
Stress: 51200 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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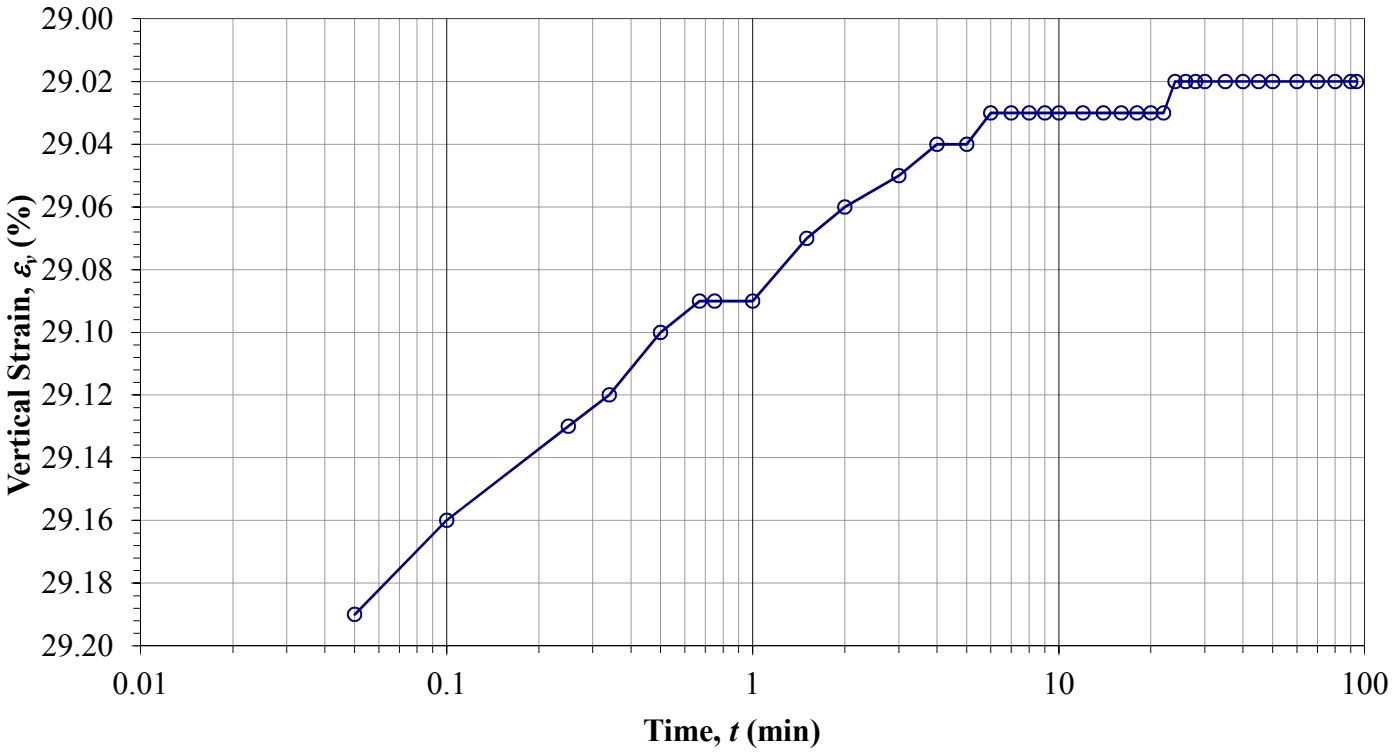
Project: AECOM **Boring No.:** BH19-ES-1

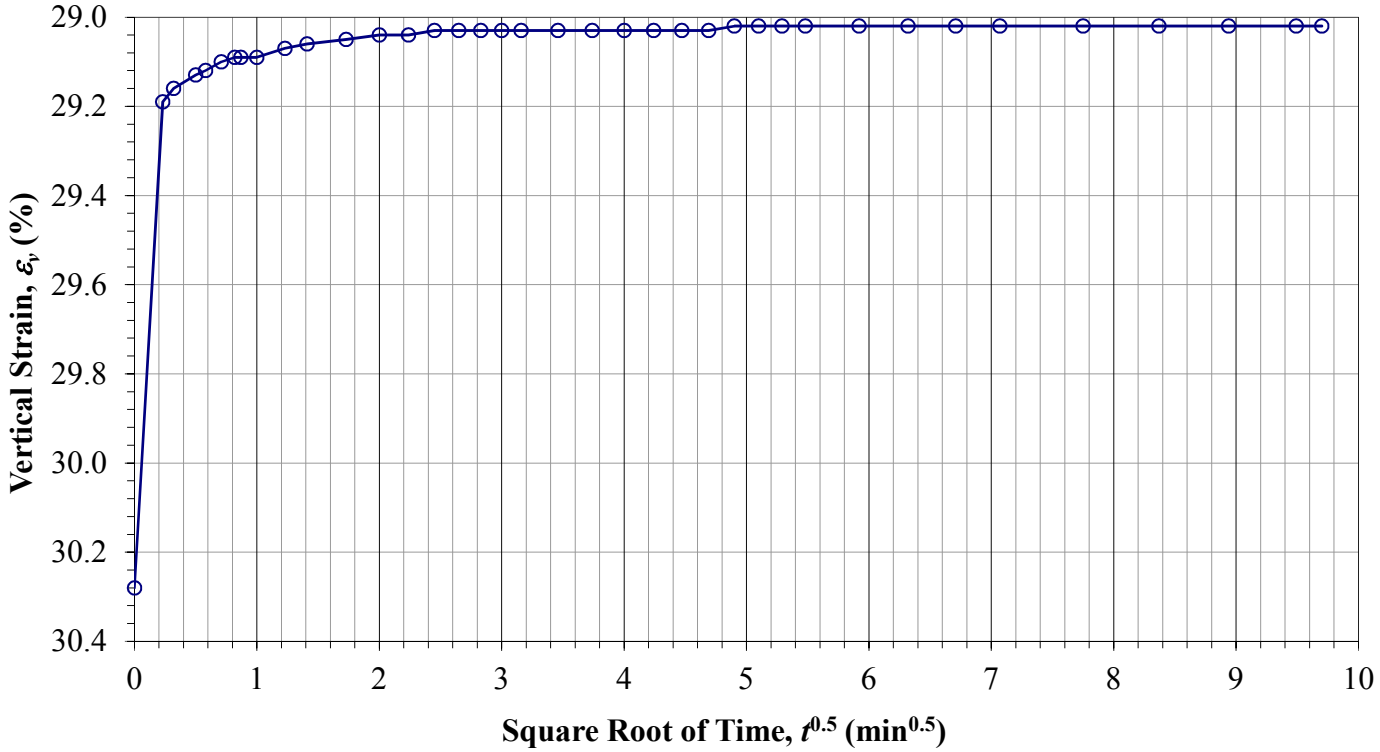
No: 00100-015, 3G2 (XIII) **Sample:** 10

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 11 of 14

Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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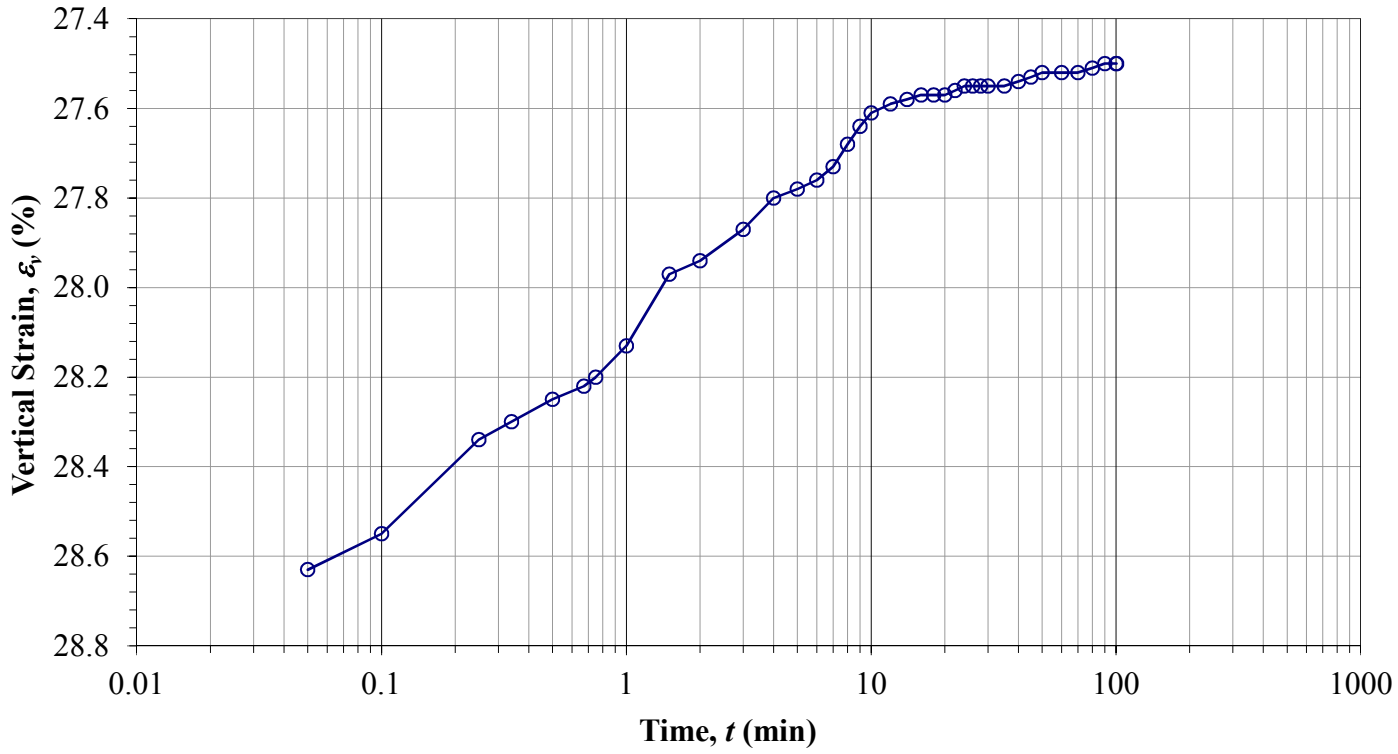
Project: AECOM **Boring No.:** BH19-ES-1

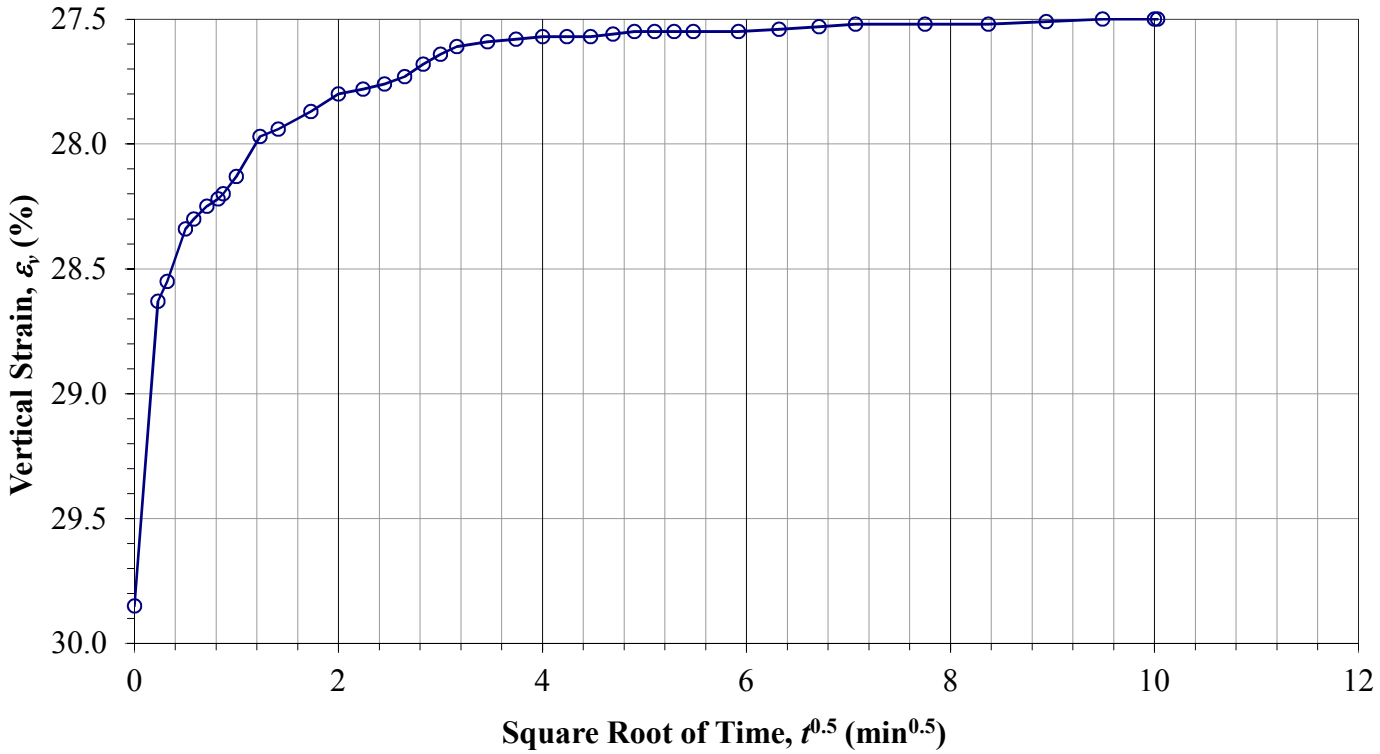
No: 00100-015, 3G2 (XIII) **Sample:** 10

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 12 of 14

Stress: 6400 psf





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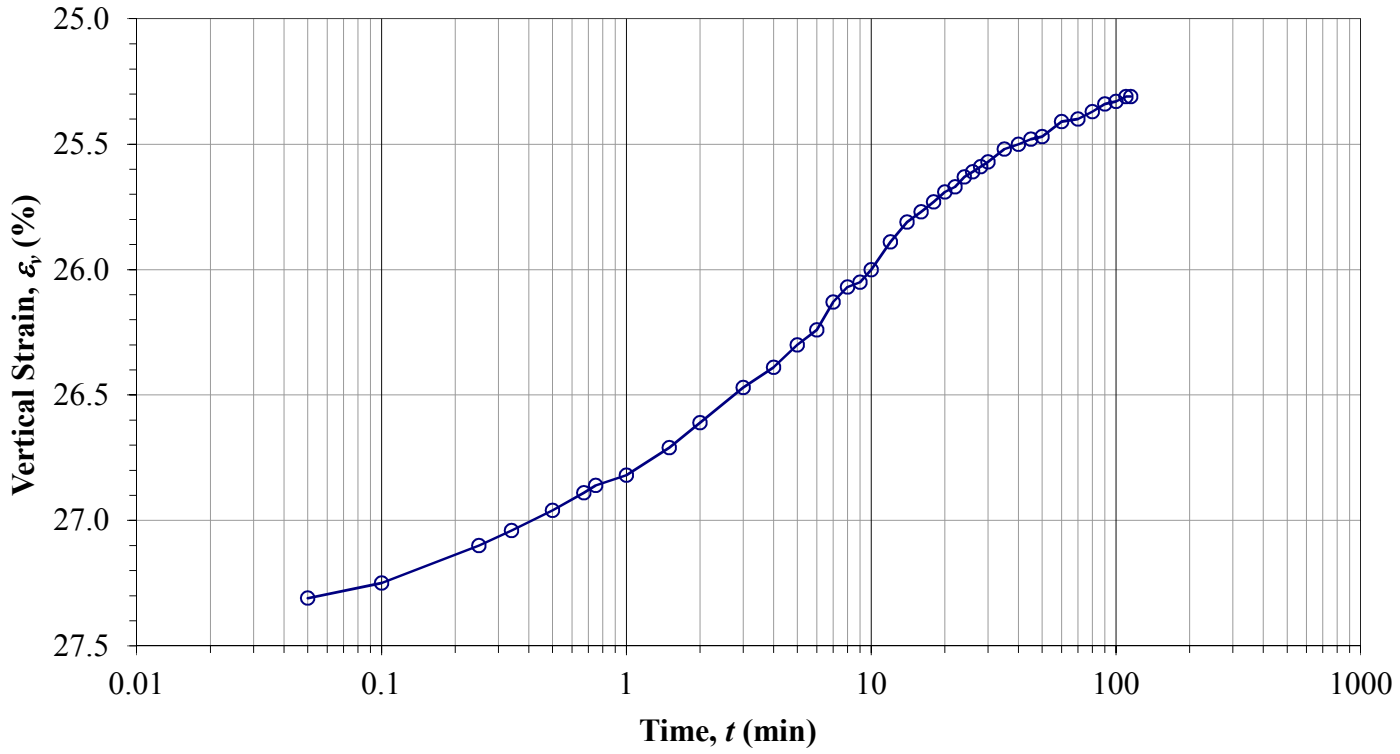
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

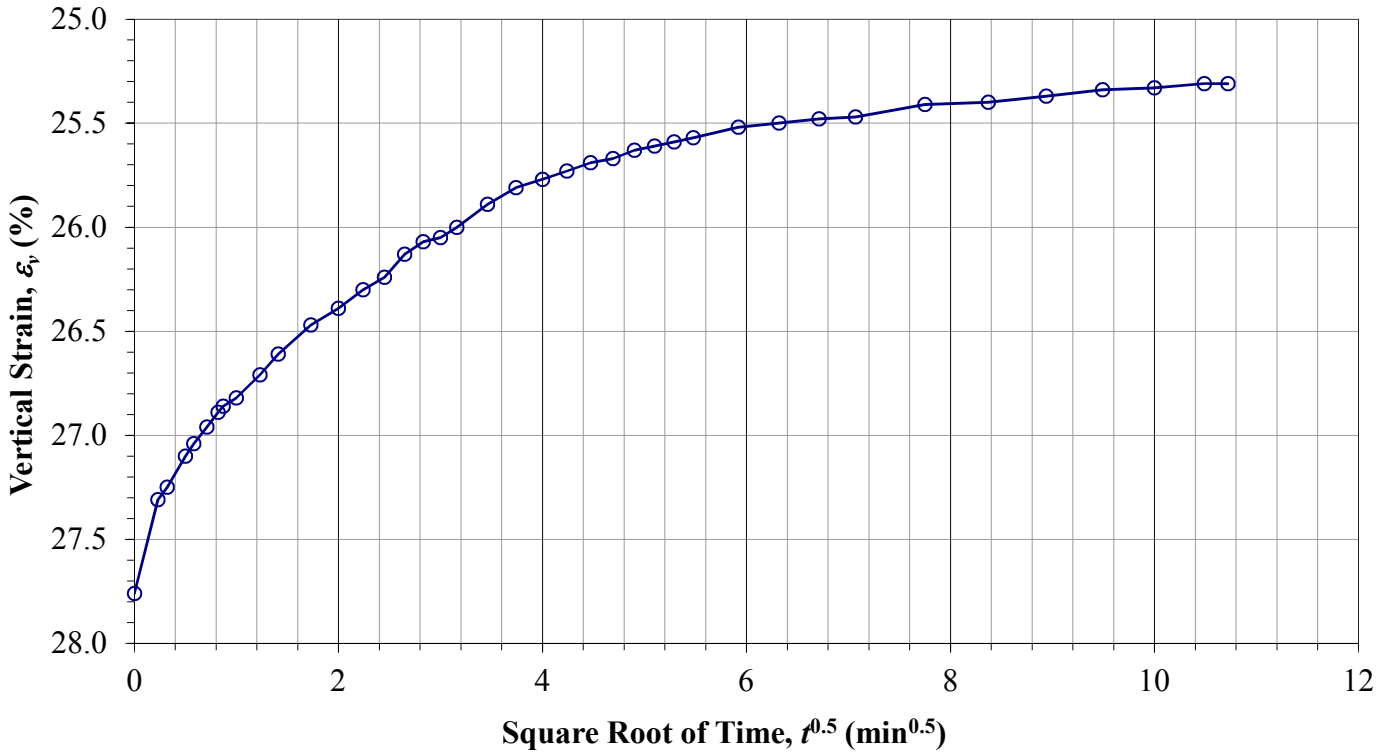
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 10
Depth: 35'

Constant Load Step: 13 of 14
Stress: 1600 psf



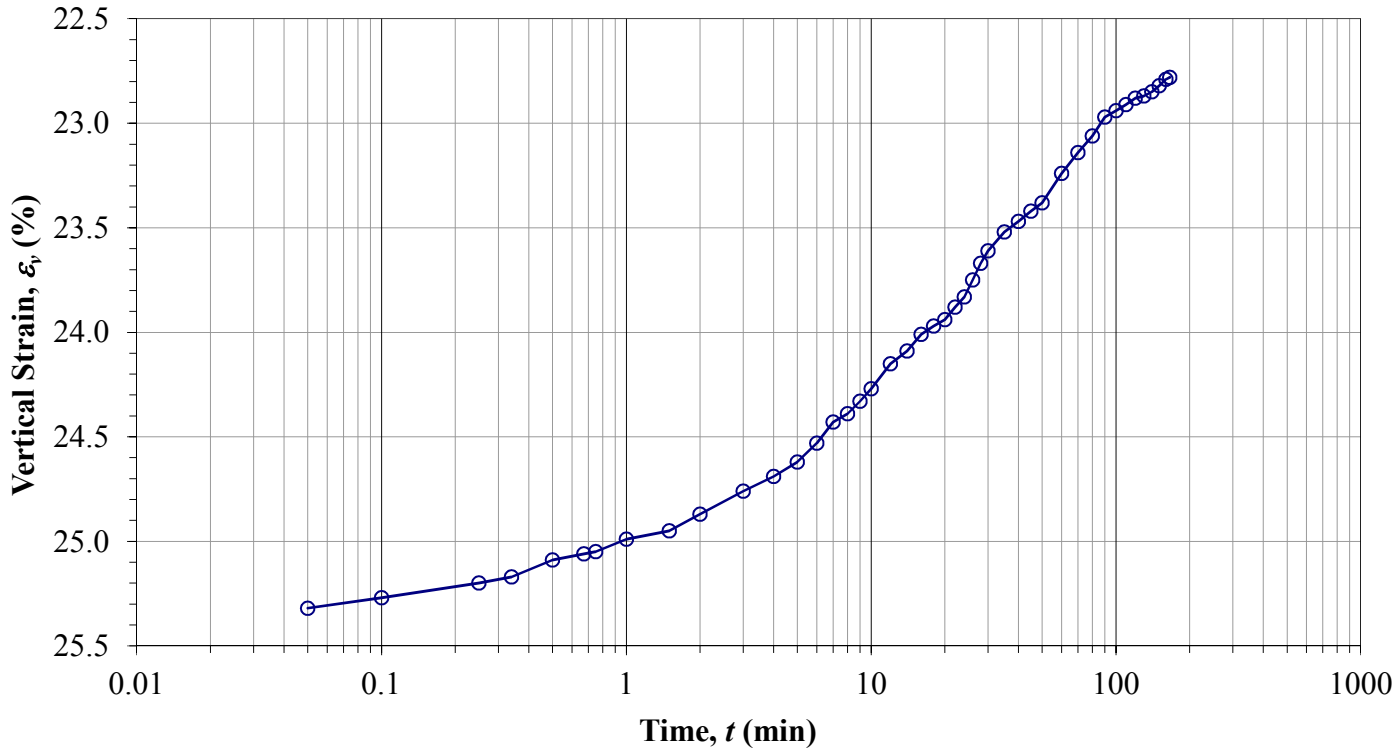


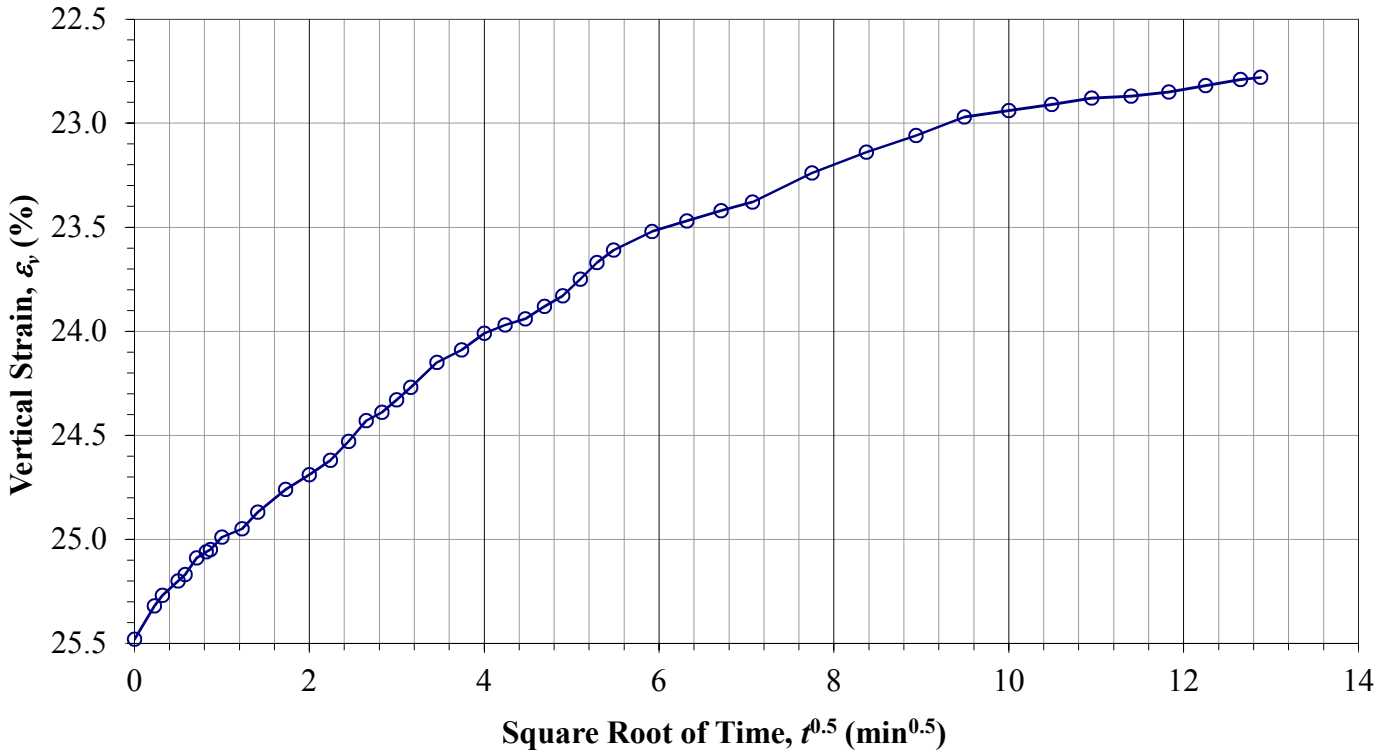
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 10
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: EH

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

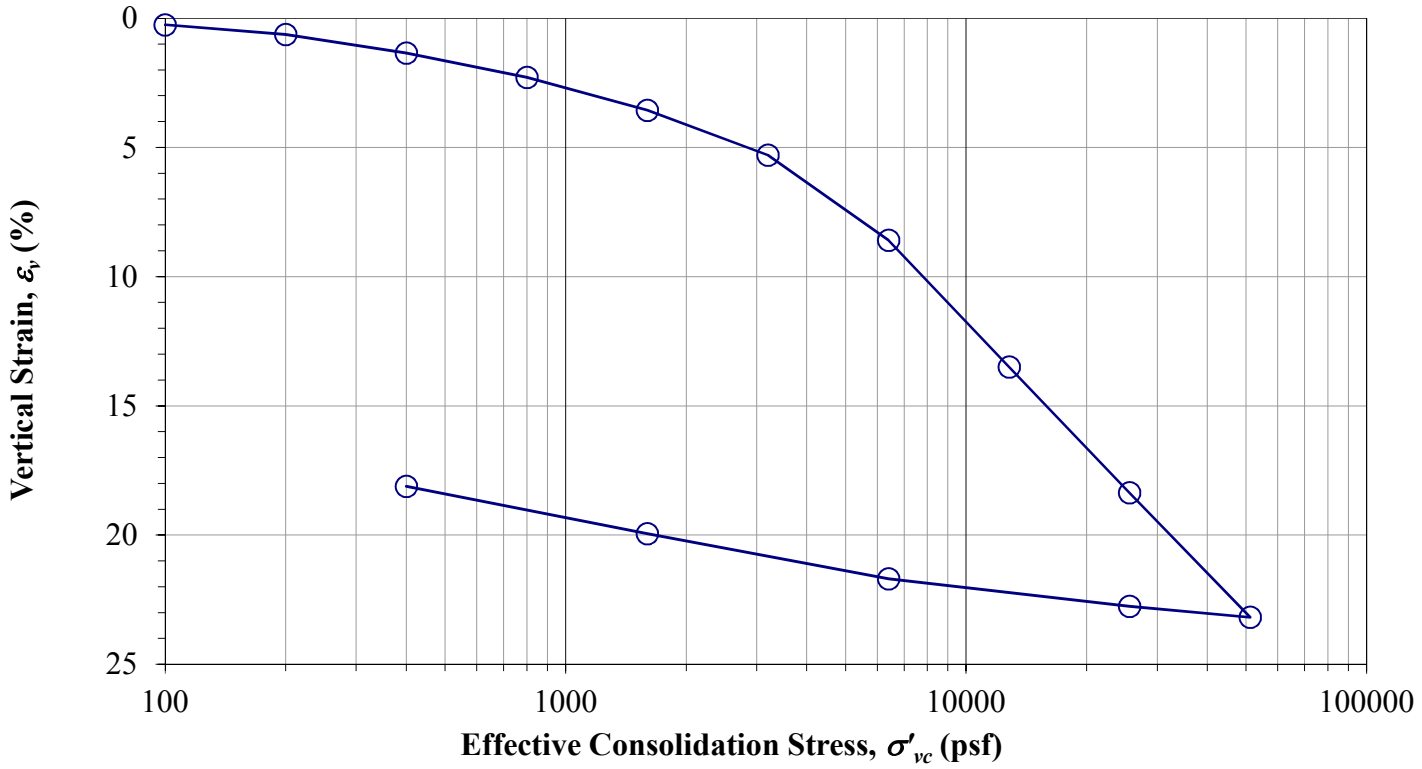
Test method:	B	
Inundation stress (psf), timing:	Seating	Beginning
Specific gravity, G_s	2.75	Assumed

Water type used for inundation: Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.920	0.753
Sample diameter, D (in.)	2.408	2.408
Wt. rings + wet soil (g)	175.28	166.58
Wt. rings/tare (g)	45.66	45.66
Total unit wt., γ (pcf)	117.9	134.25
Wet soil + tare (g)	321.19	246.87
Dry soil + tare (g)	268.14	222.70
Tare (g)	114.71	128.06
Water content, ω (%)	34.6	25.5
Dry unit wt., γ_d (pcf)	87.6	106.9
Saturation, S	0.99	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9200	0.9603
100	0.0024	0.26	0.9176	0.9553
200	0.0058	0.63	0.9142	0.9479
400	0.0123	1.34	0.9077	0.9340
800	0.0210	2.29	0.8990	0.9155
1600	0.0328	3.57	0.8872	0.8904
3200	0.0488	5.30	0.8712	0.8564
6400	0.0791	8.59	0.8409	0.7918
12800	0.1242	13.50	0.7958	0.6957
25600	0.1689	18.36	0.7511	0.6004
51200	0.2133	23.18	0.7067	0.5058
25600	0.2094	22.76	0.7106	0.5141
6400	0.1996	21.70	0.7204	0.5350
1600	0.1835	19.95	0.7365	0.5693
400	0.1666	18.11	0.7534	0.6053



Entered: _____
Reviewed: _____

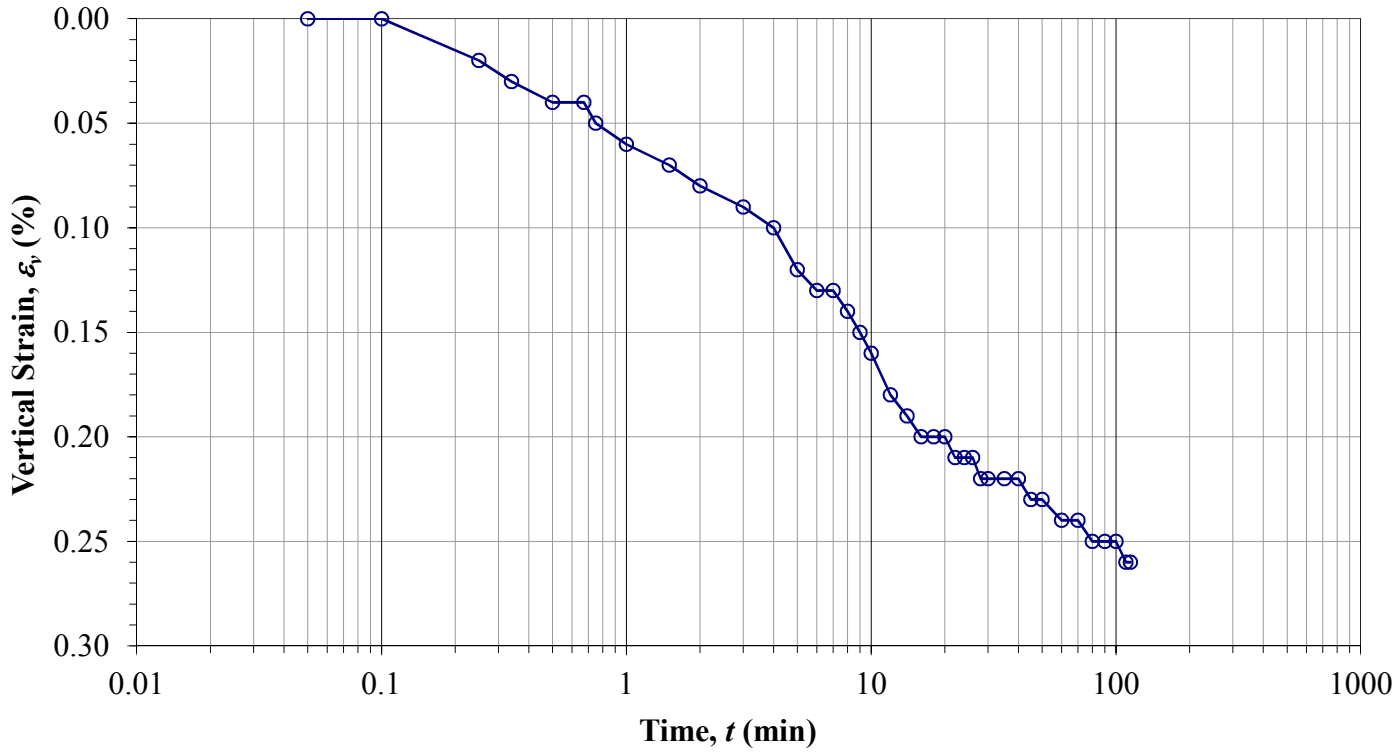
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

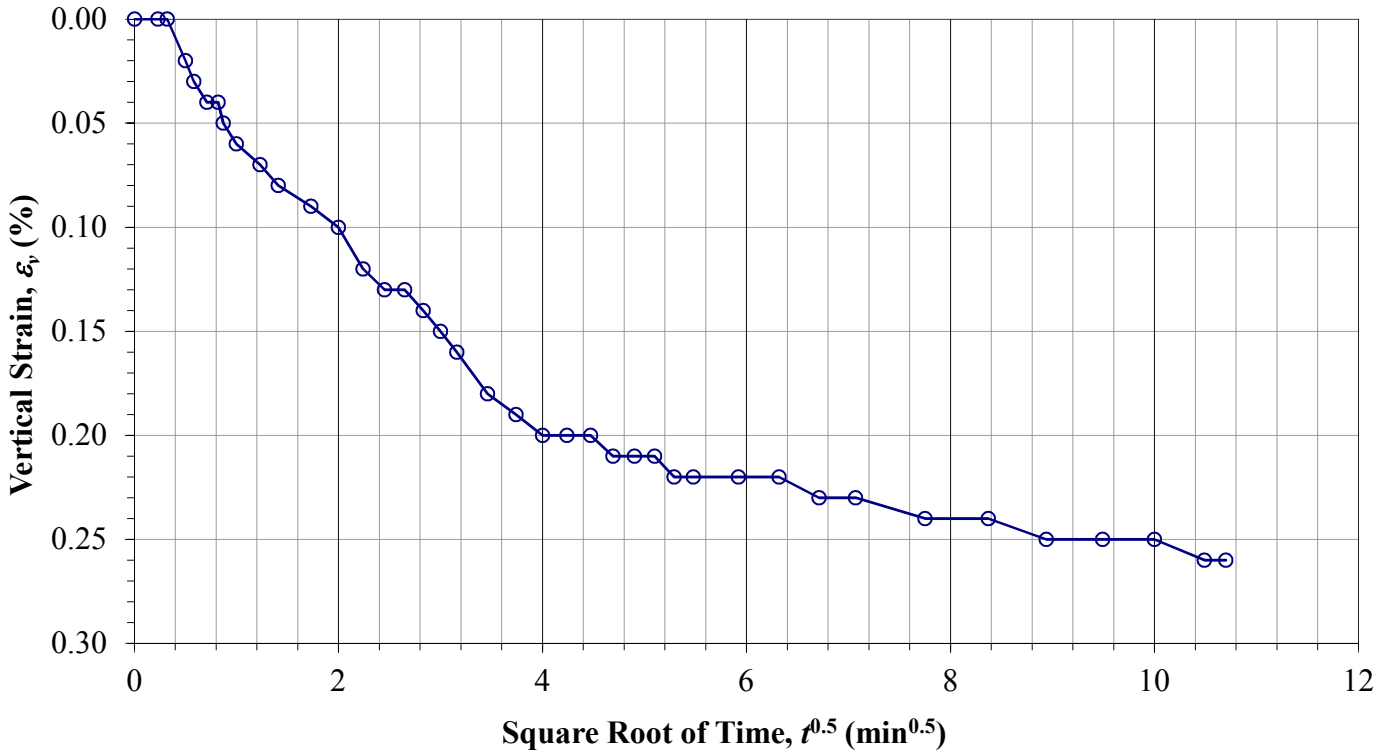
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'

Constant Load Step: 1 of 14
Stress: 100 psf





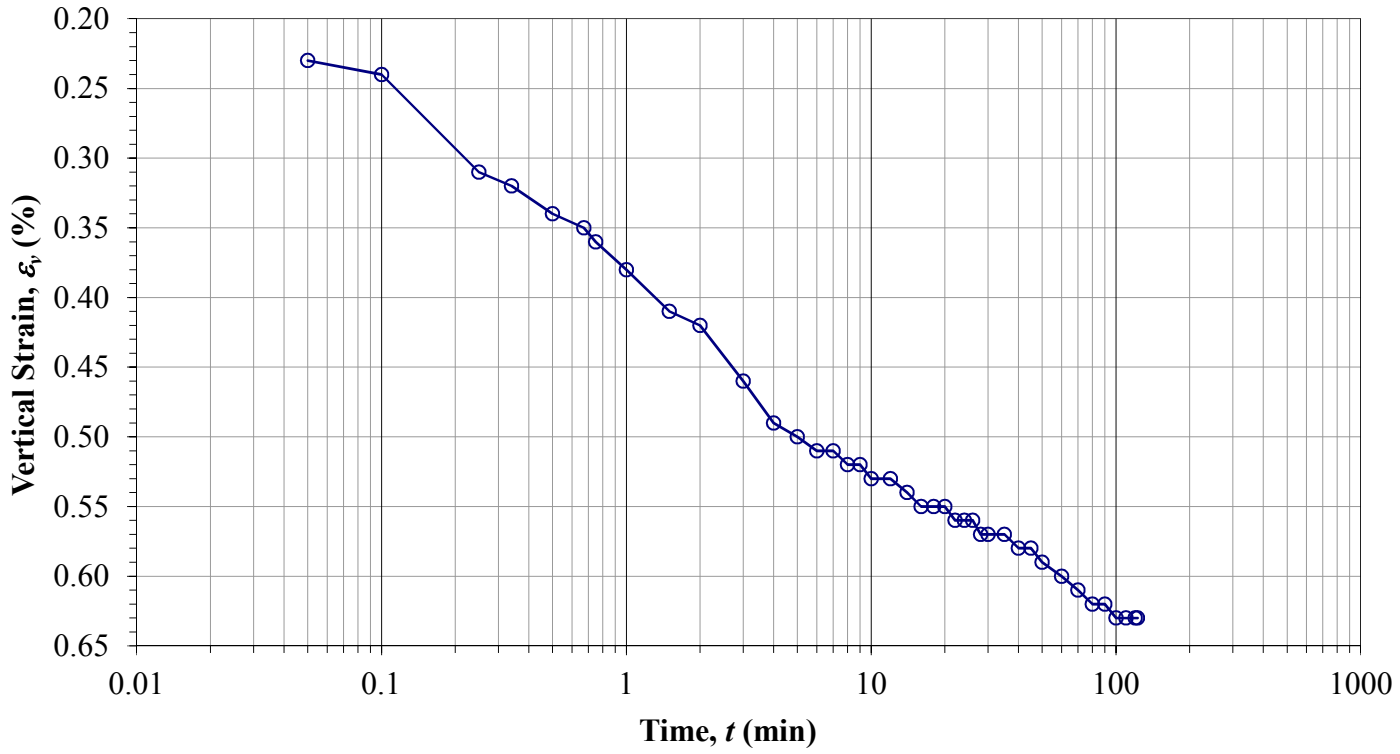
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

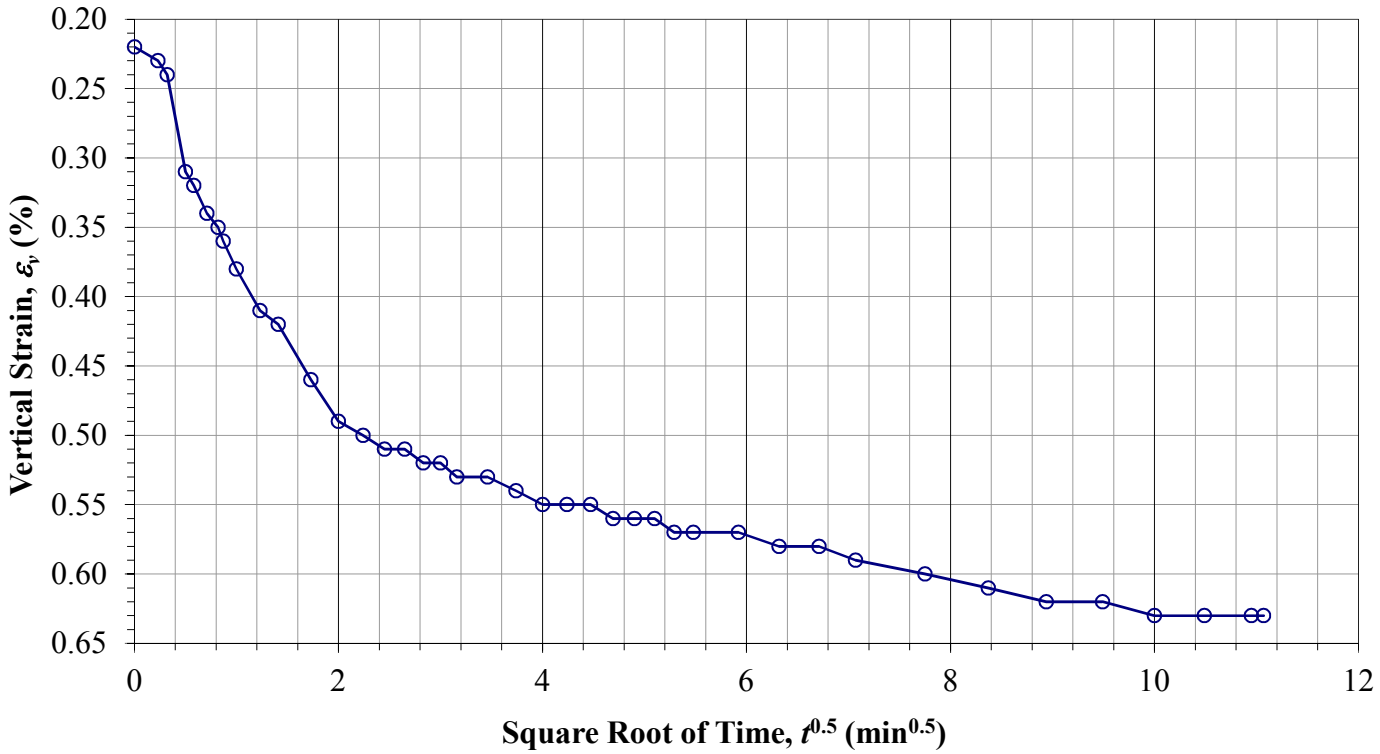
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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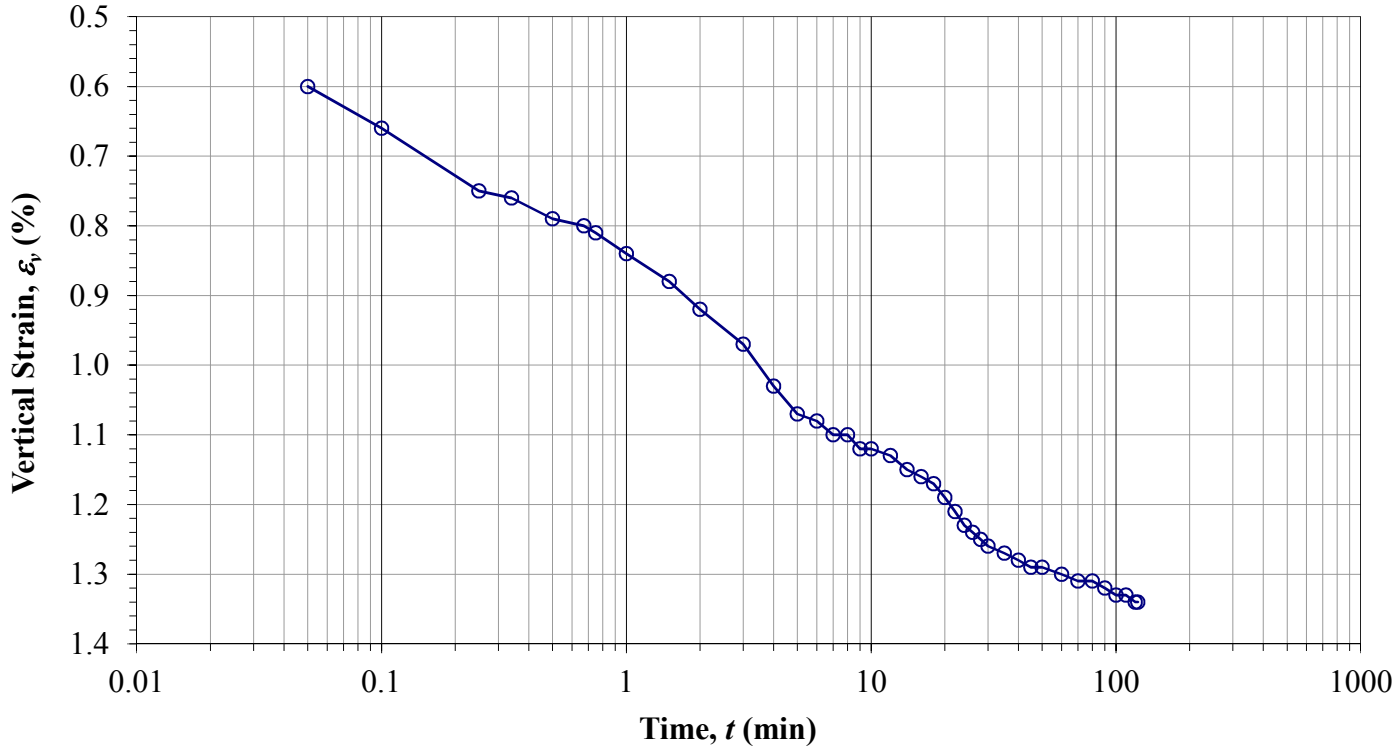
Project: AECOM **Boring No.:** BH19-ES-1

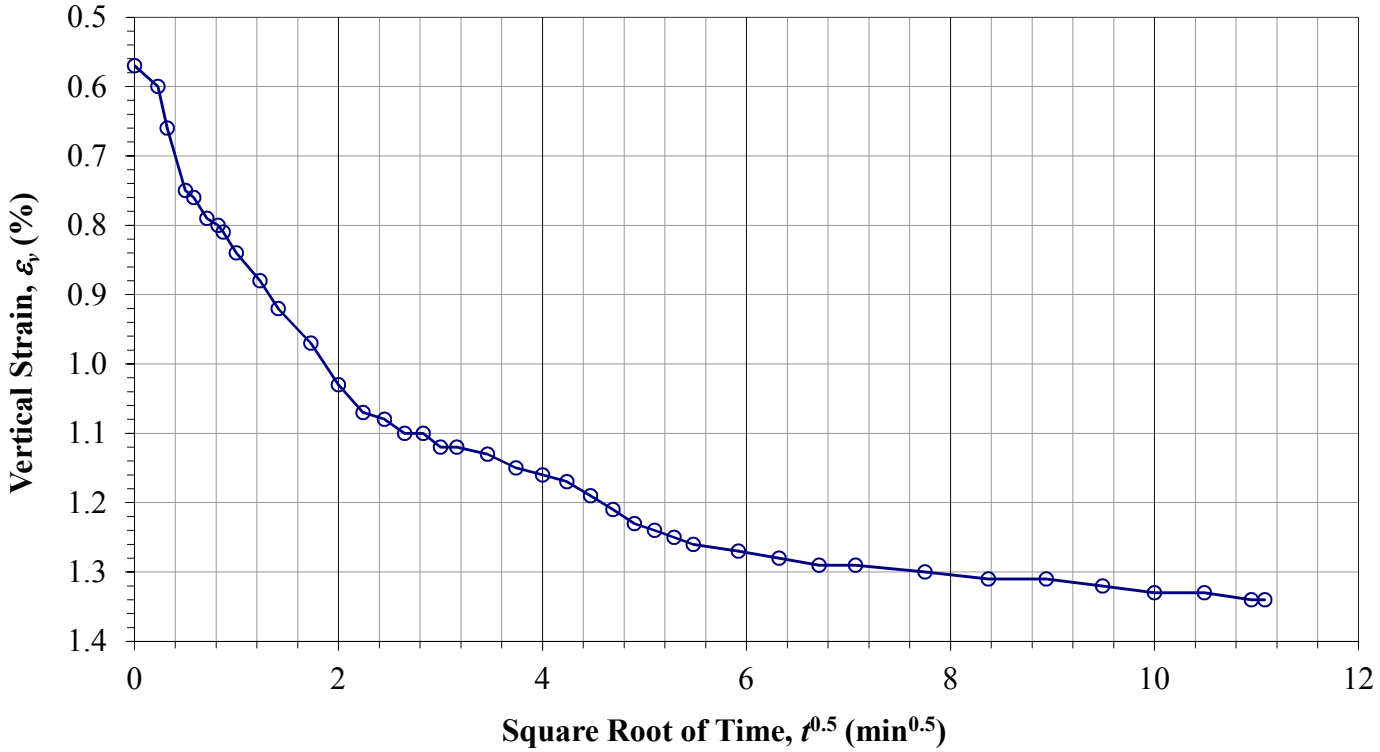
No: 00100-015, 3G2 (XIII) **Sample:** 21

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 85'

Constant Load Step: 3 of 14

Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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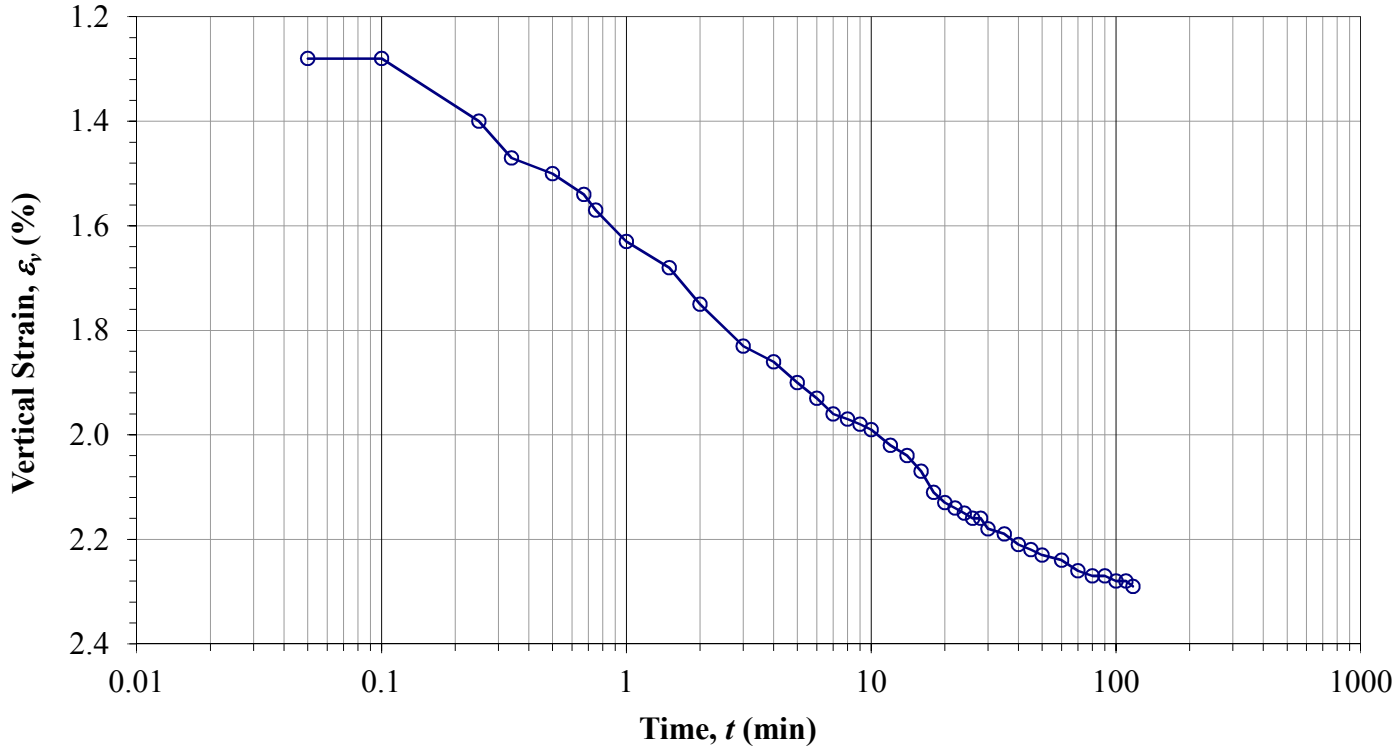
Project: AECOM **Boring No.:** BH19-ES-1

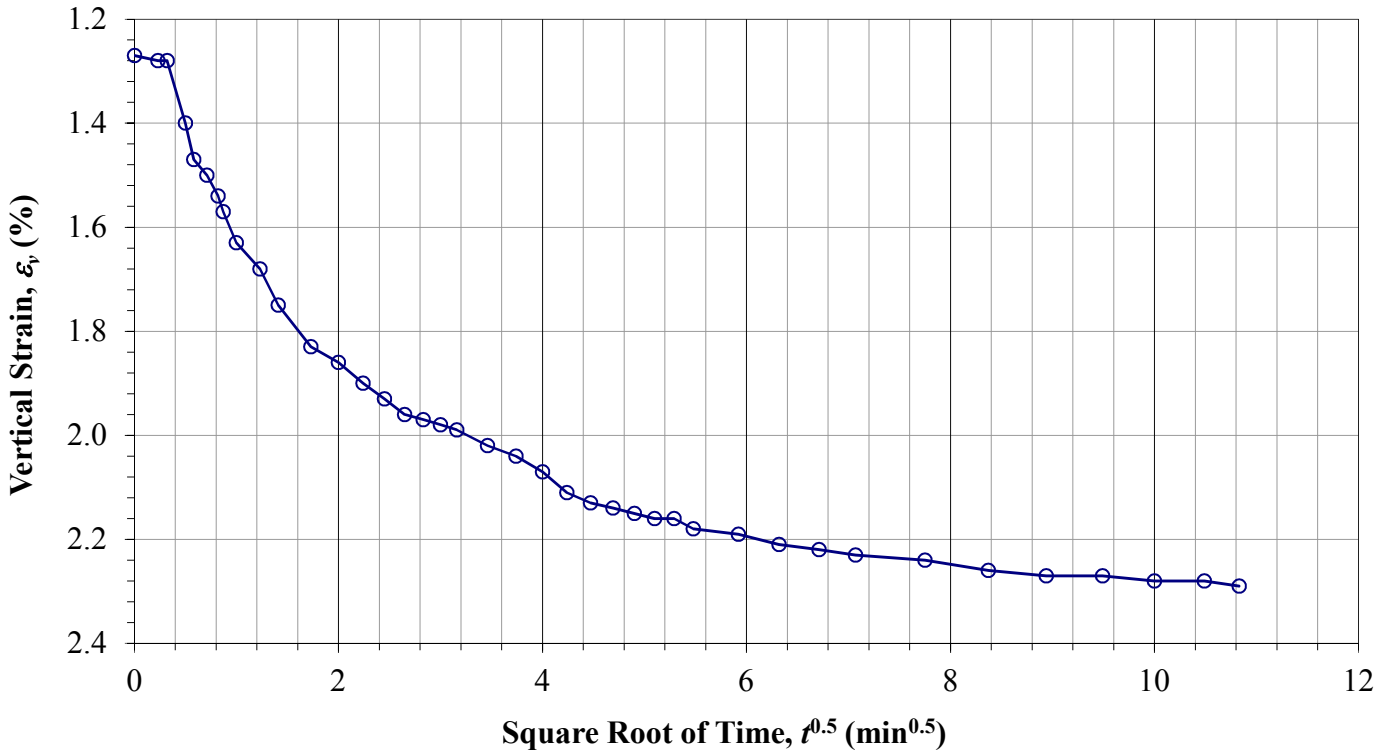
No: 00100-015, 3G2 (XIII) **Sample:** 21

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 85'

Constant Load Step: 4 of 14

Stress: 800 psf





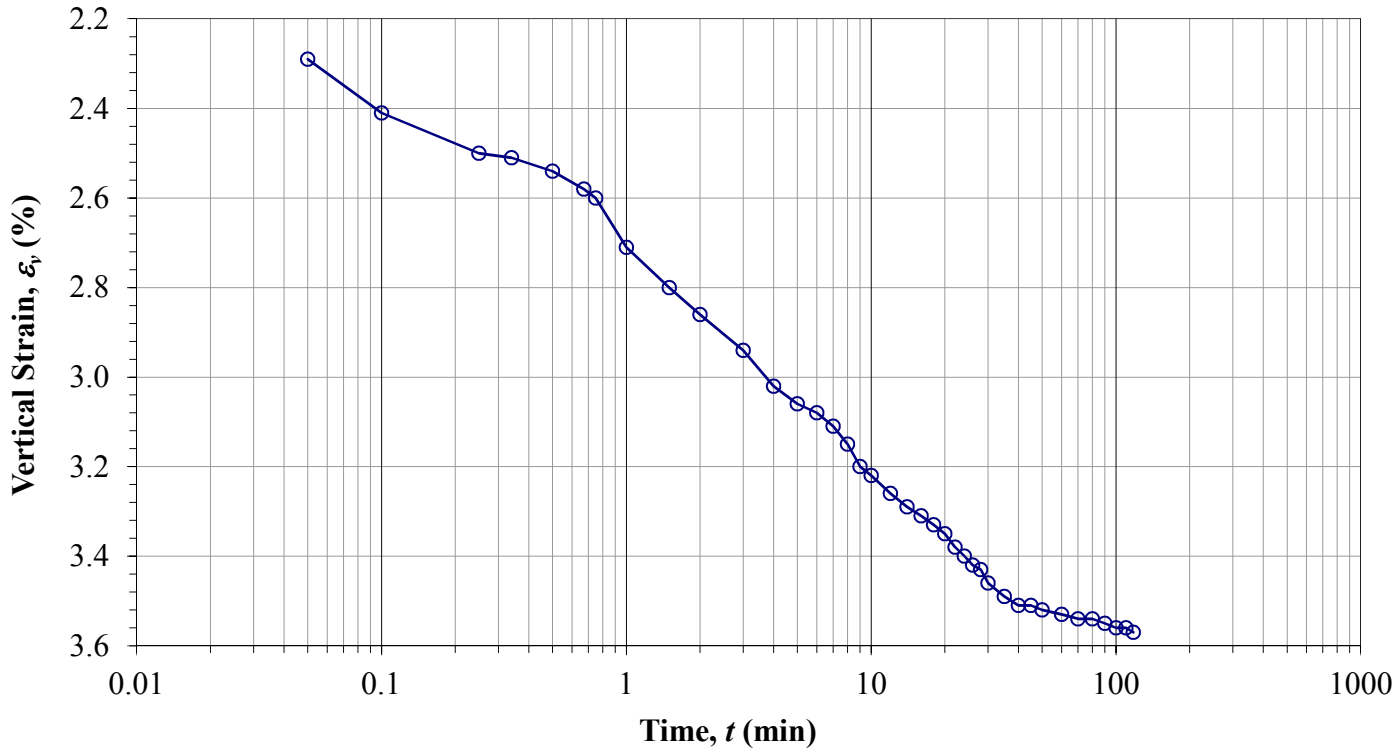
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

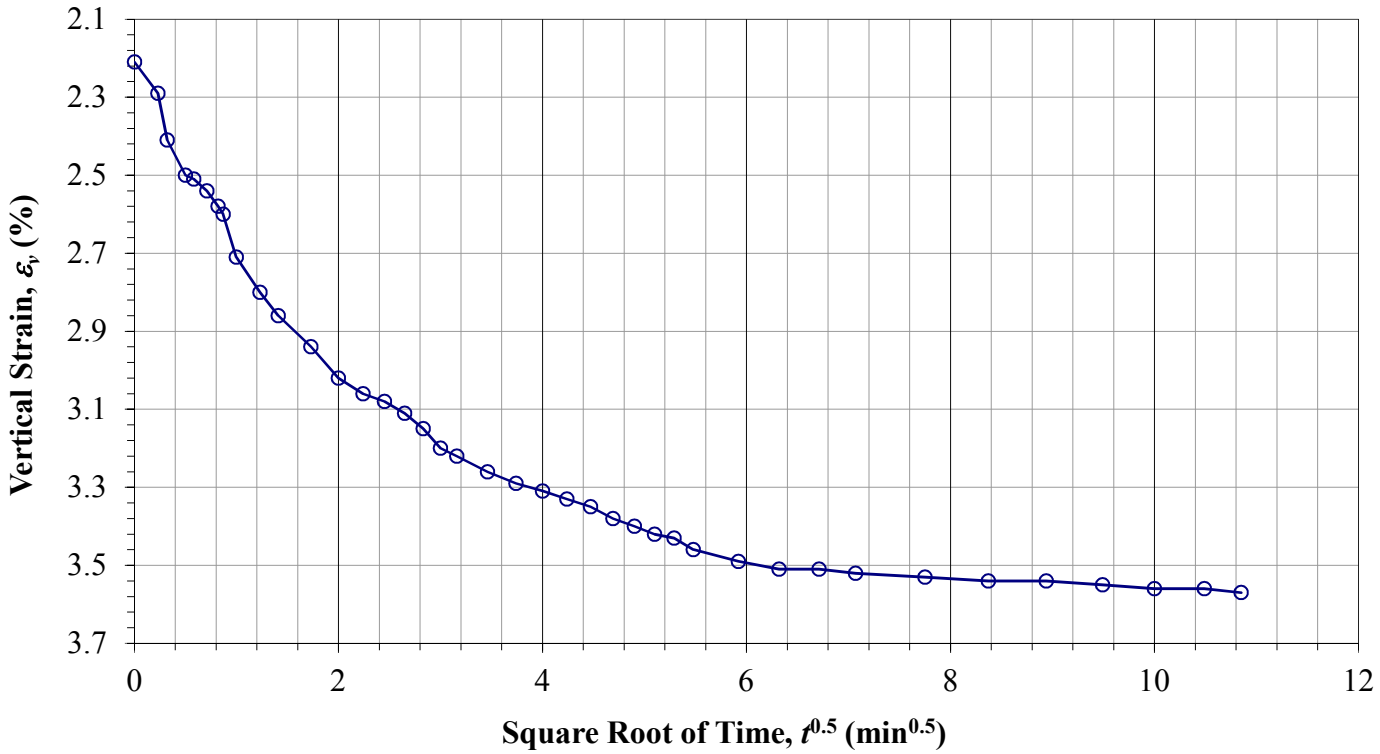
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'

Constant Load Step: 5 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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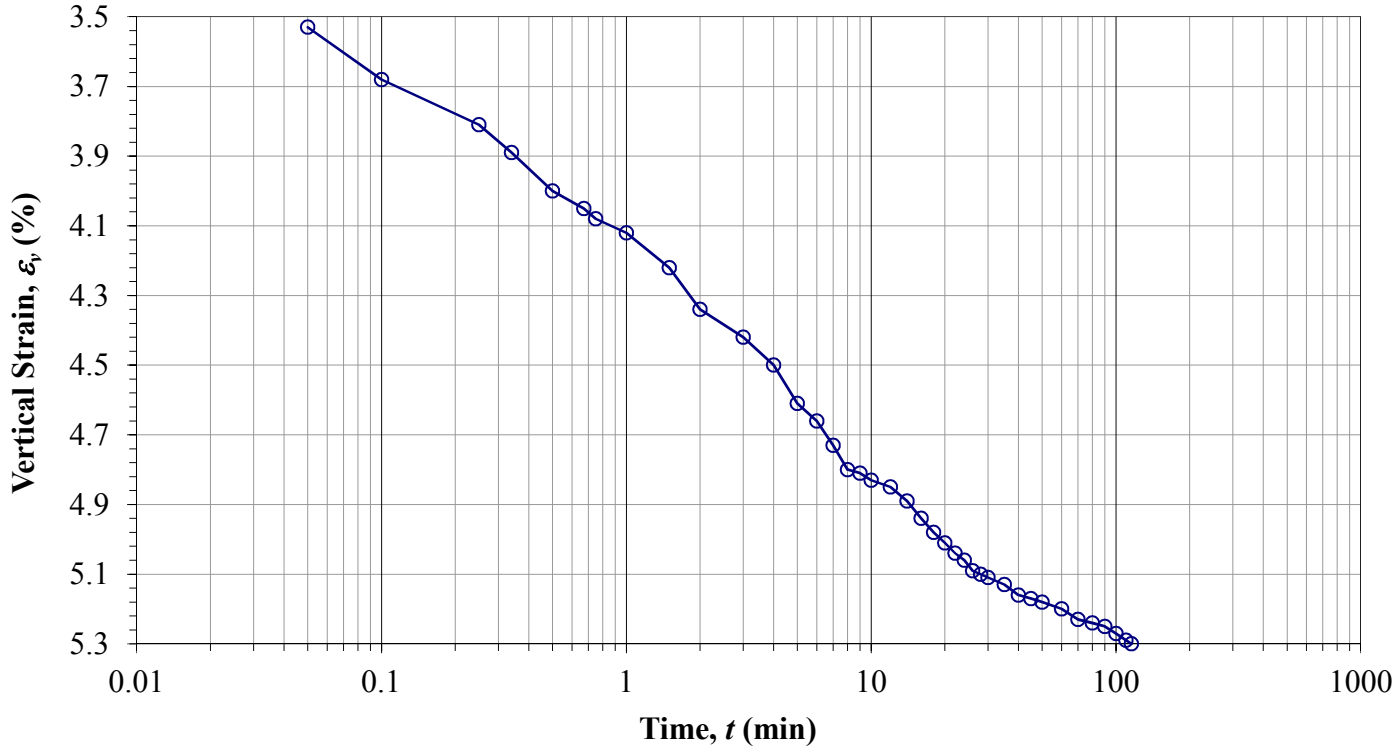
Project: AECOM **Boring No.:** BH19-ES-1

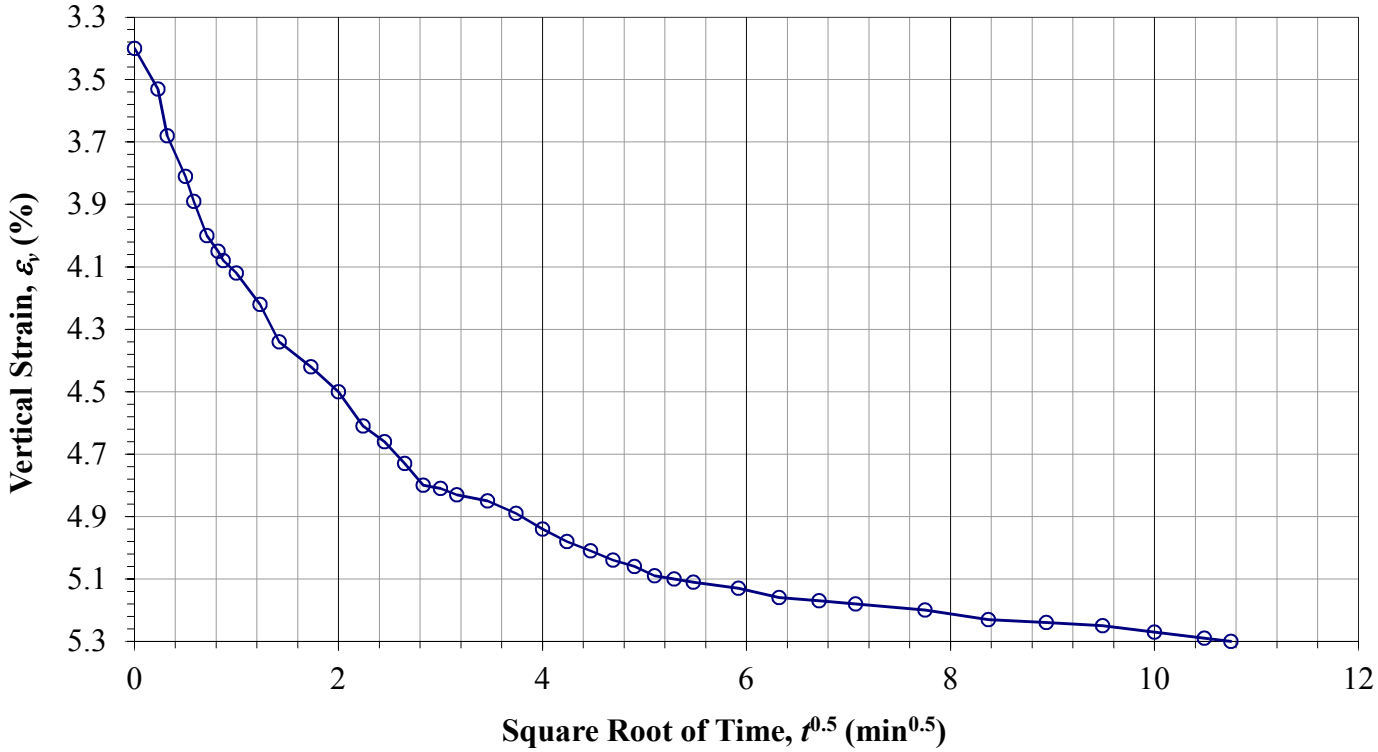
No: 00100-015, 3G2 (XIII) **Sample:** 21

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 85'

Constant Load Step: 6 of 14

Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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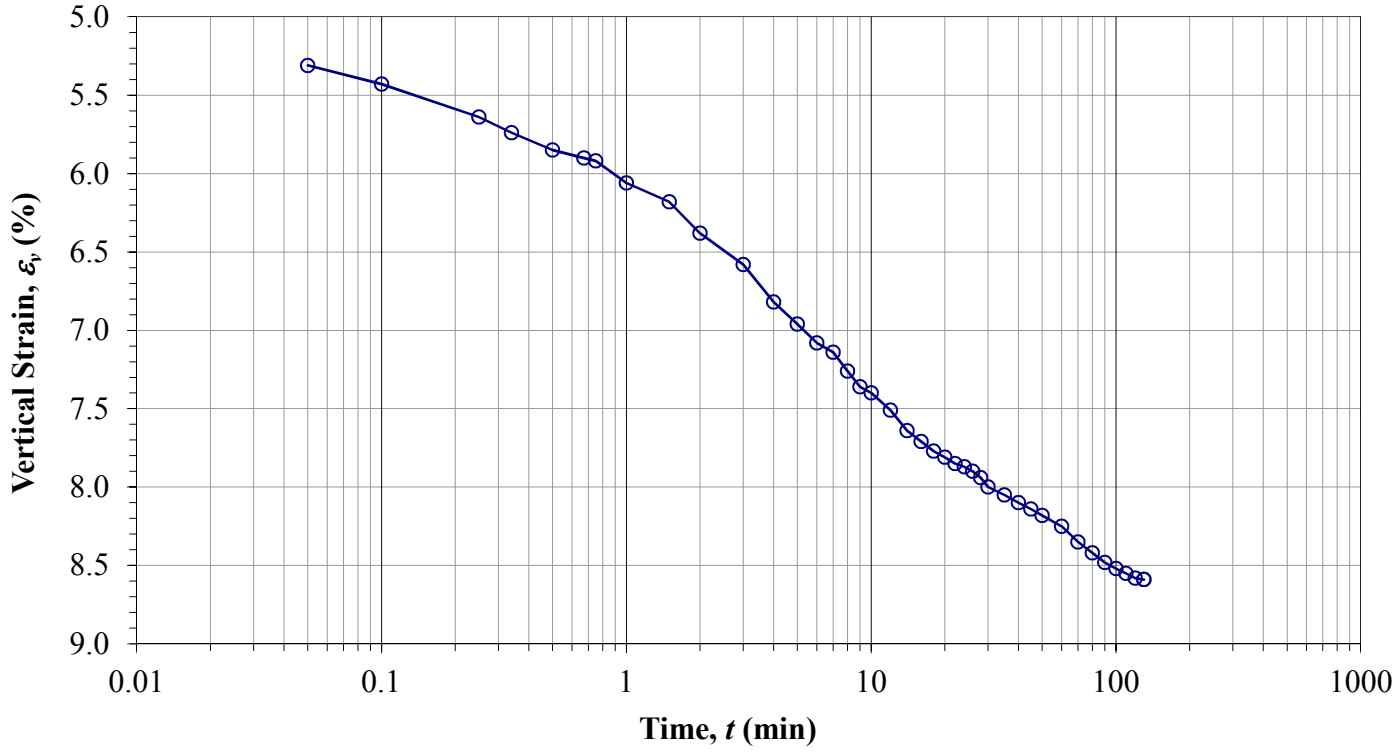
Project: AECOM **Boring No.:** BH19-ES-1

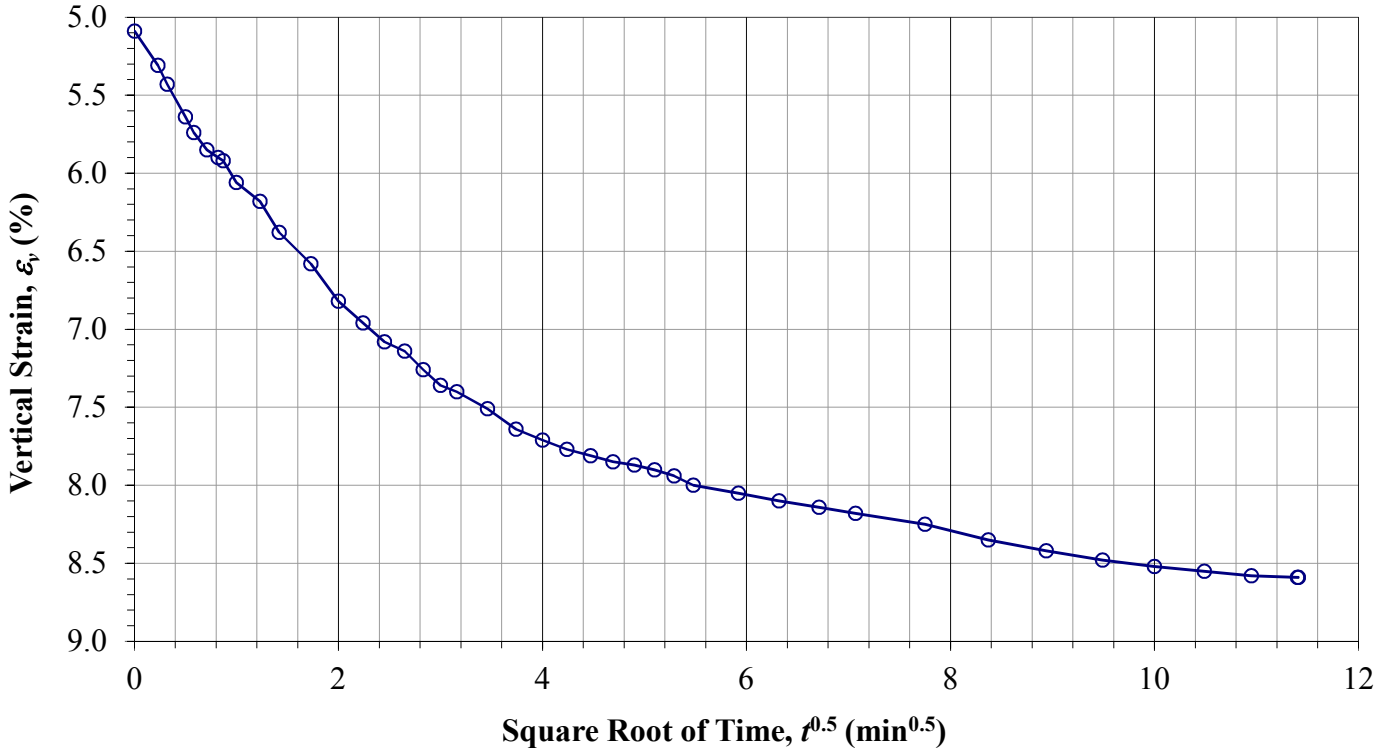
No: 00100-015, 3G2 (XIII) **Sample:** 21

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 85'

Constant Load Step: 7 of 14

Stress: 6400 psf





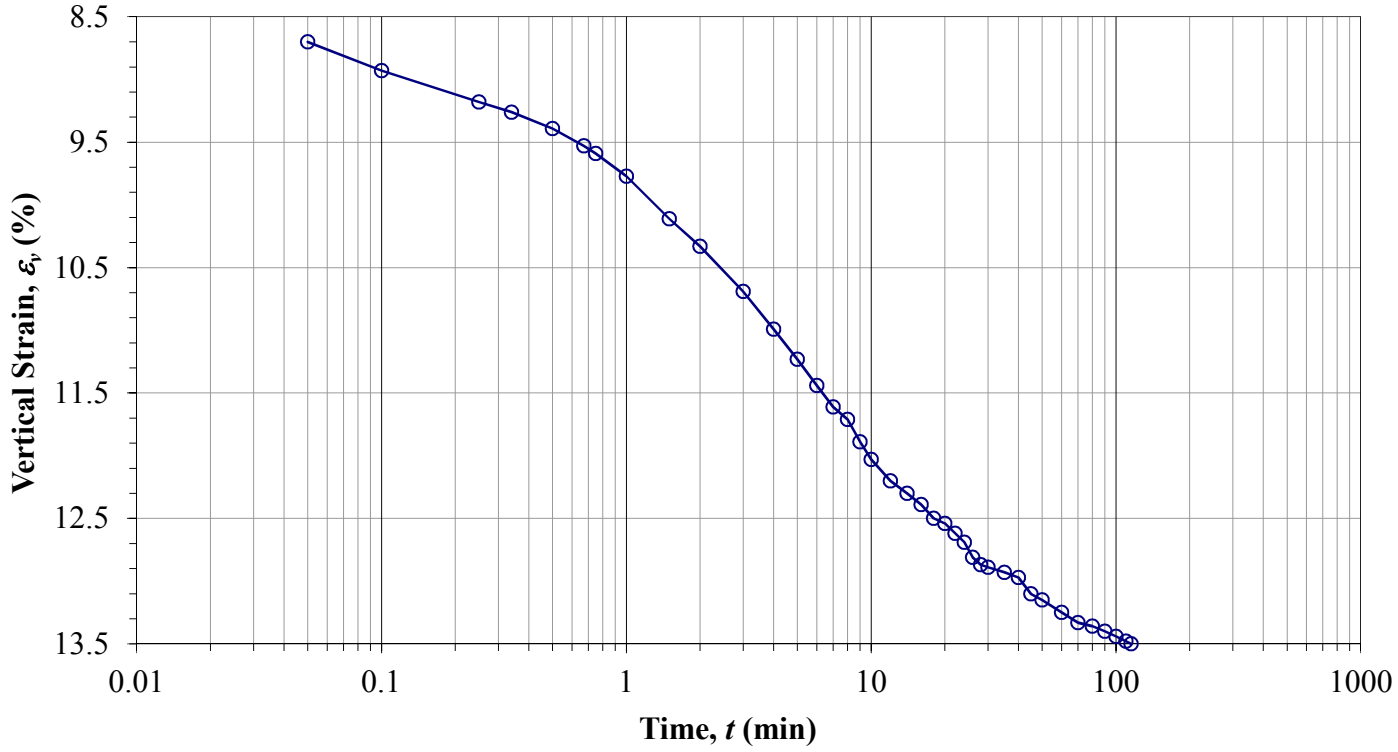
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

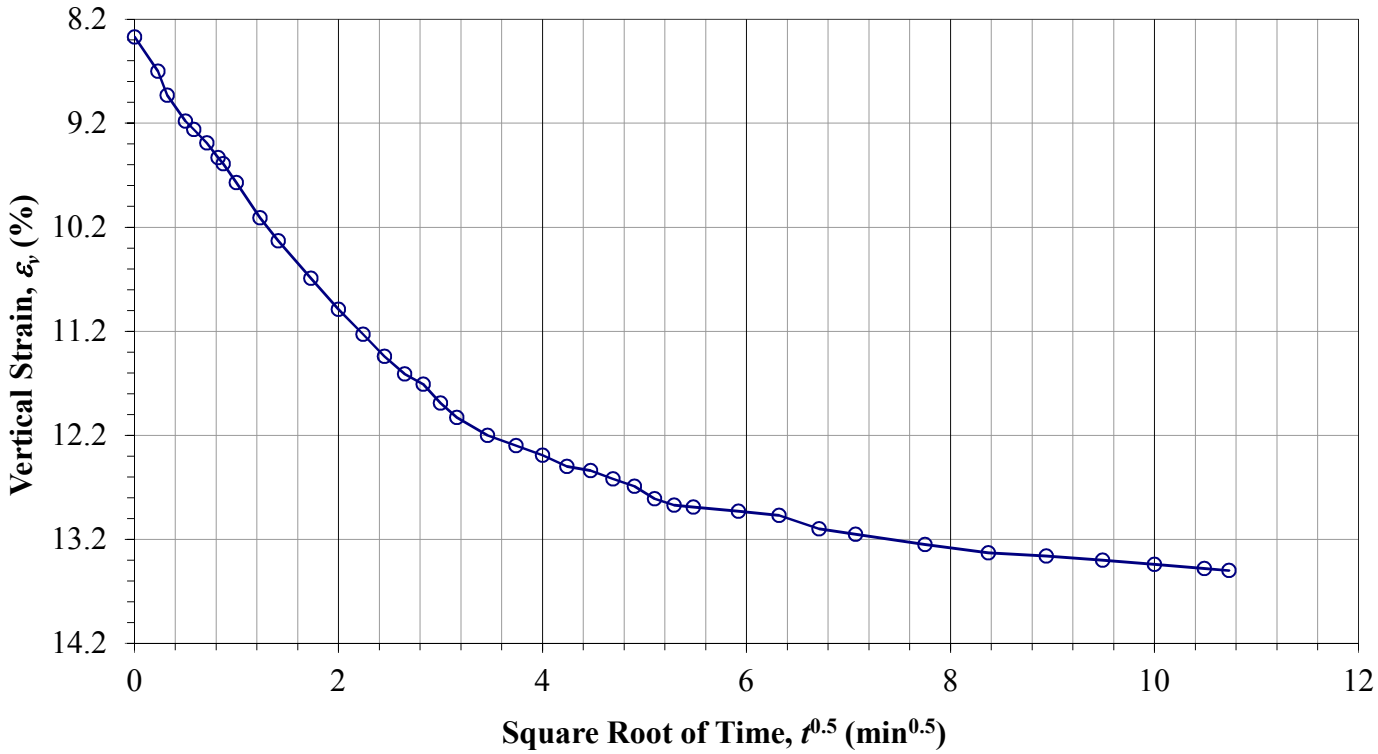
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'

Constant Load Step: 8 of 14
Stress: 12800 psf





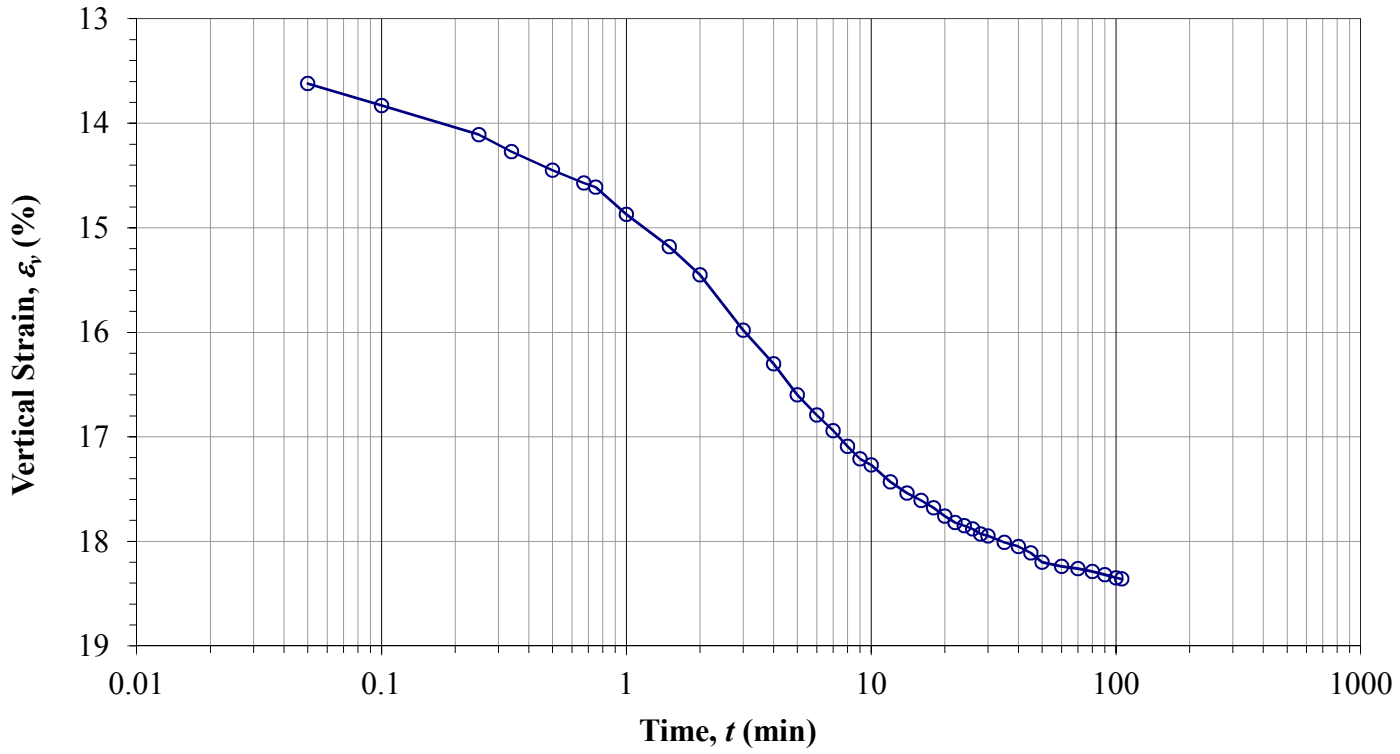
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

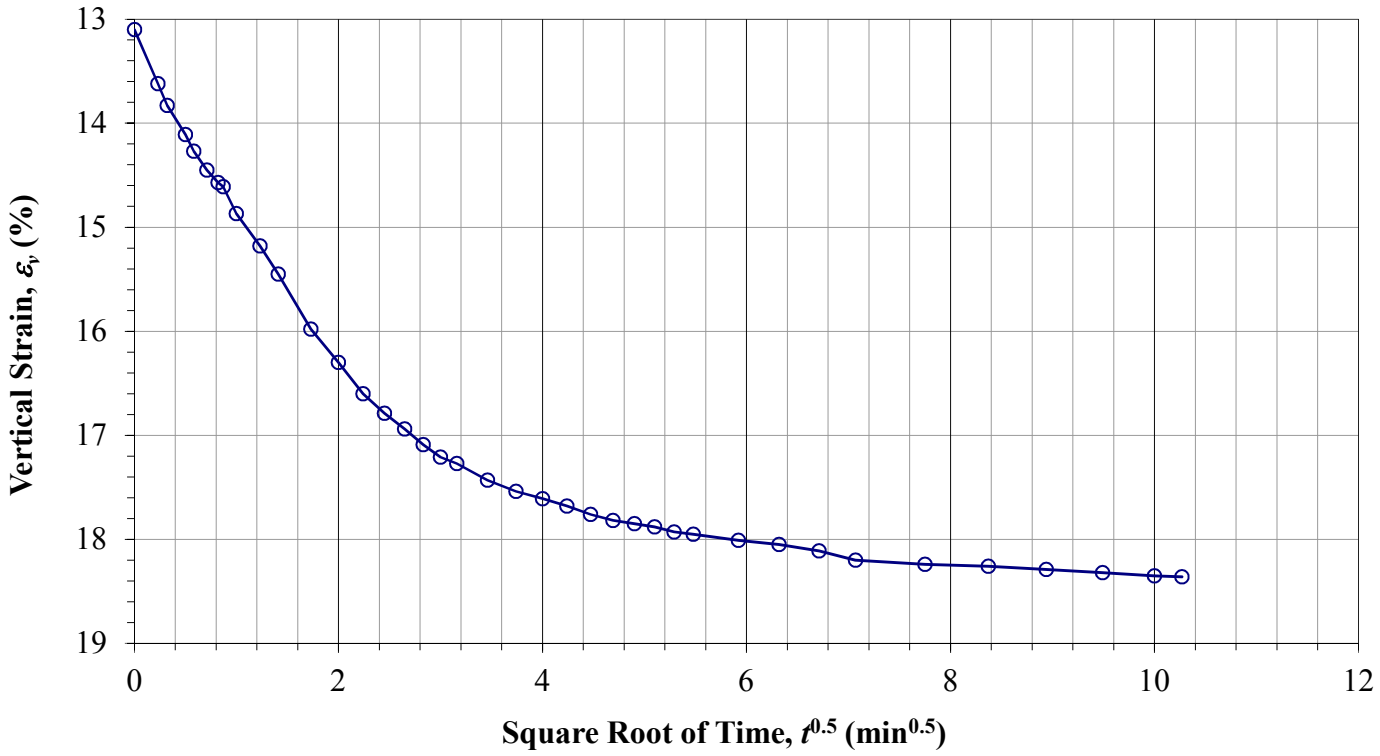
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'

Constant Load Step: 9 of 14
Stress: 25600 psf





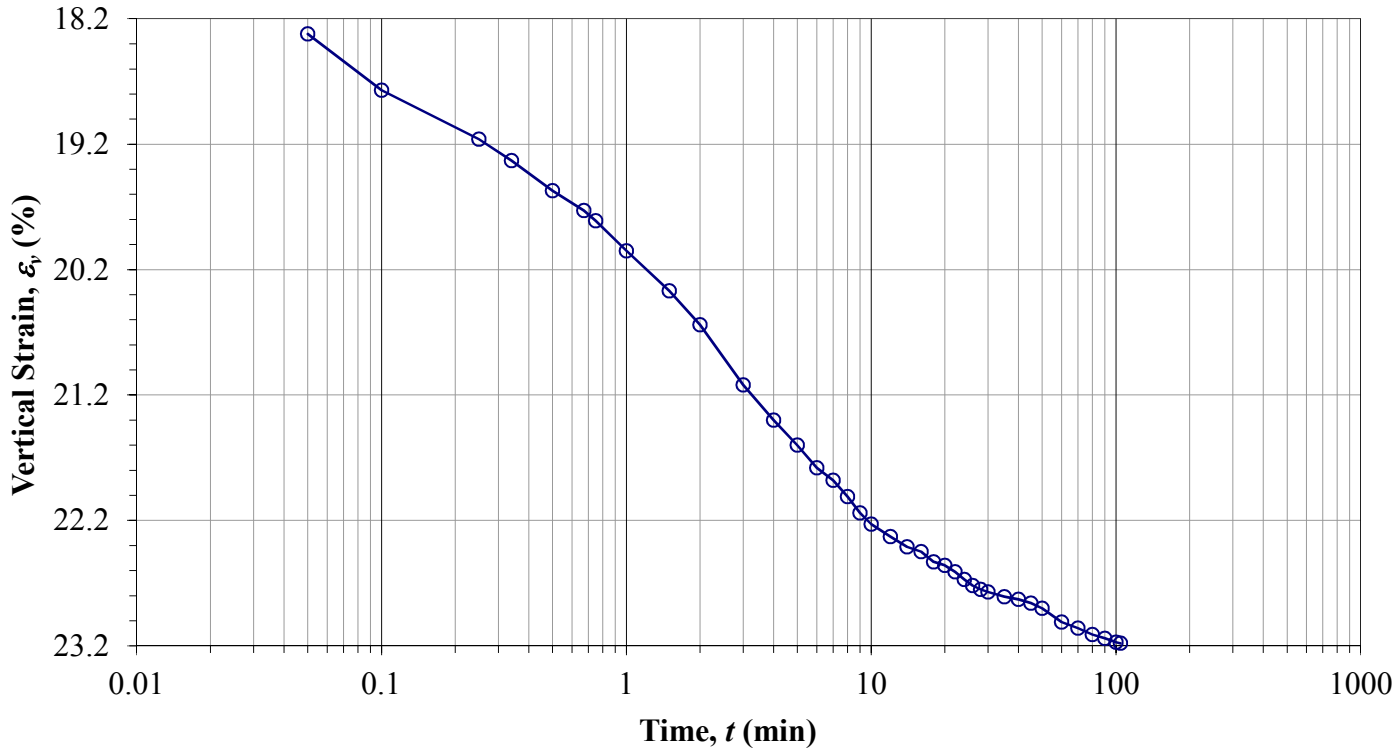
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

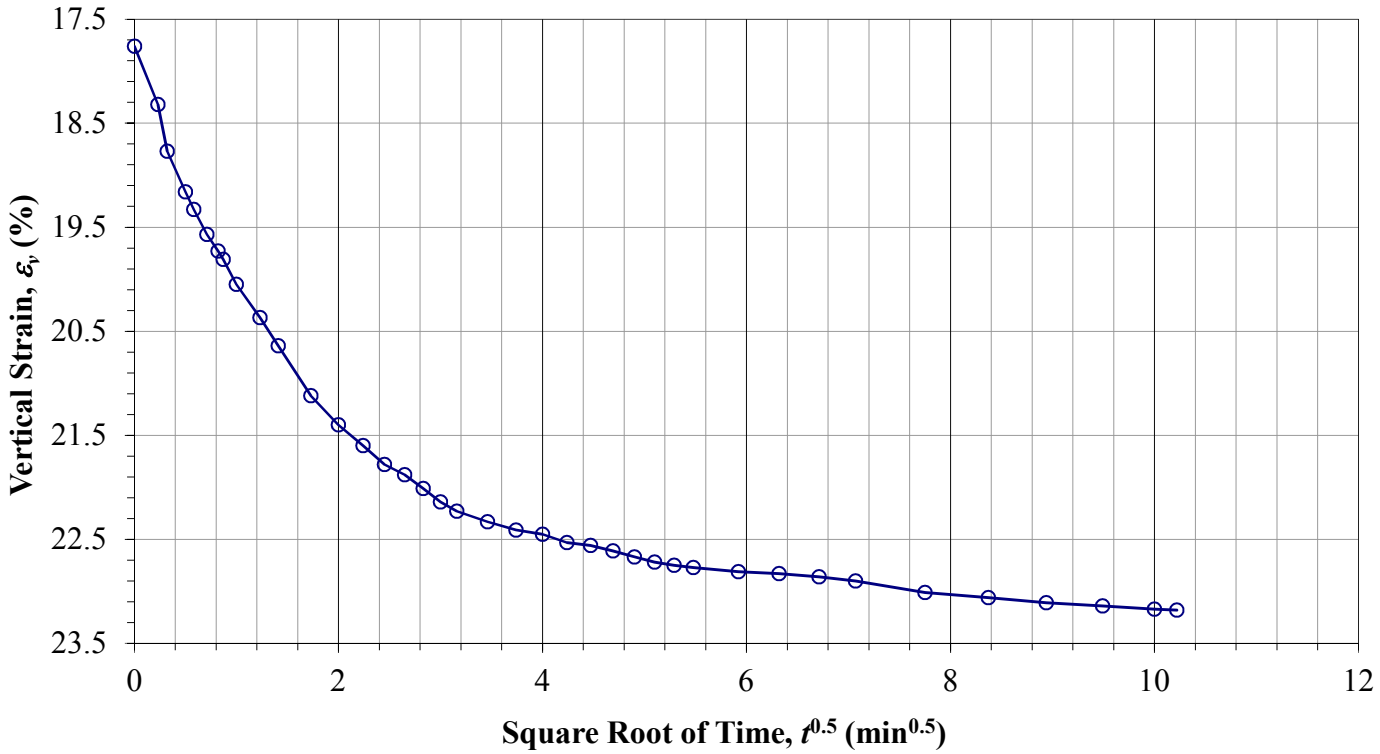
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'

Constant Load Step: 10 of 14
Stress: 51200 psf



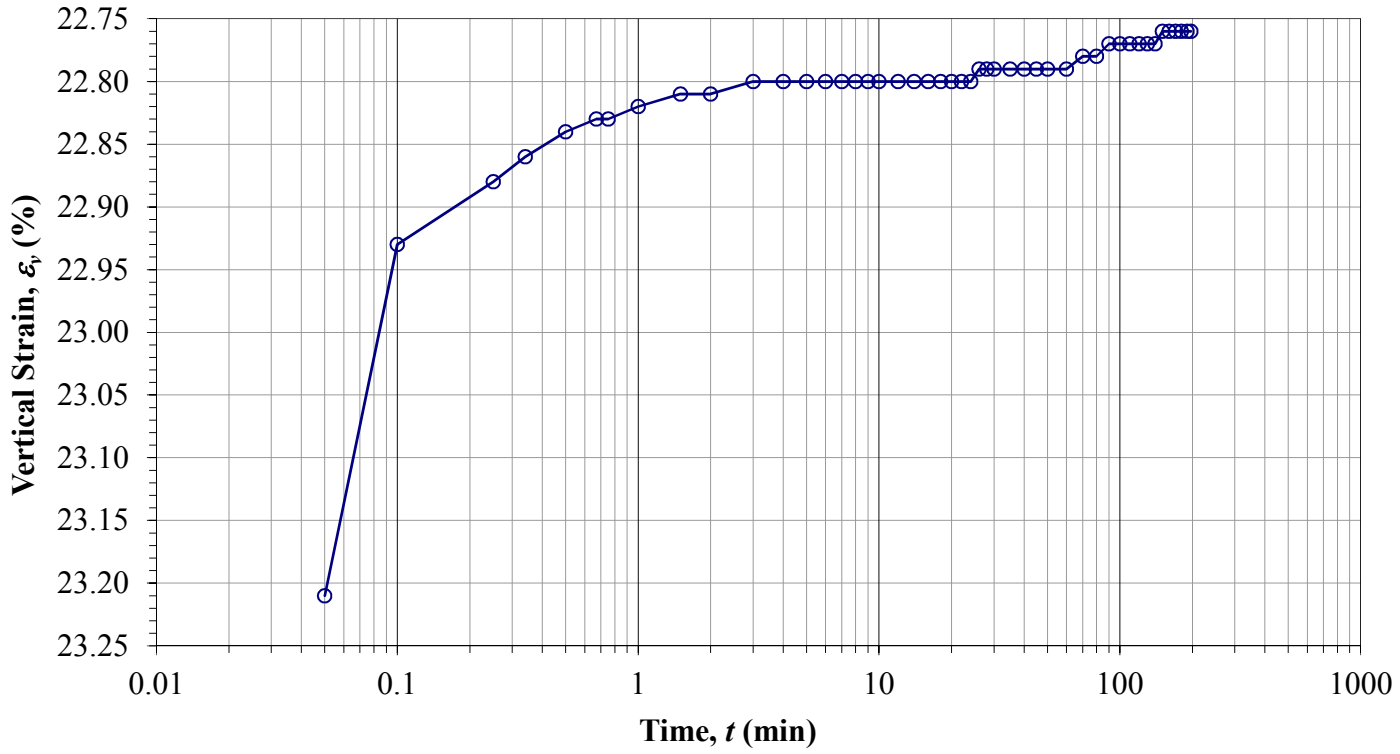


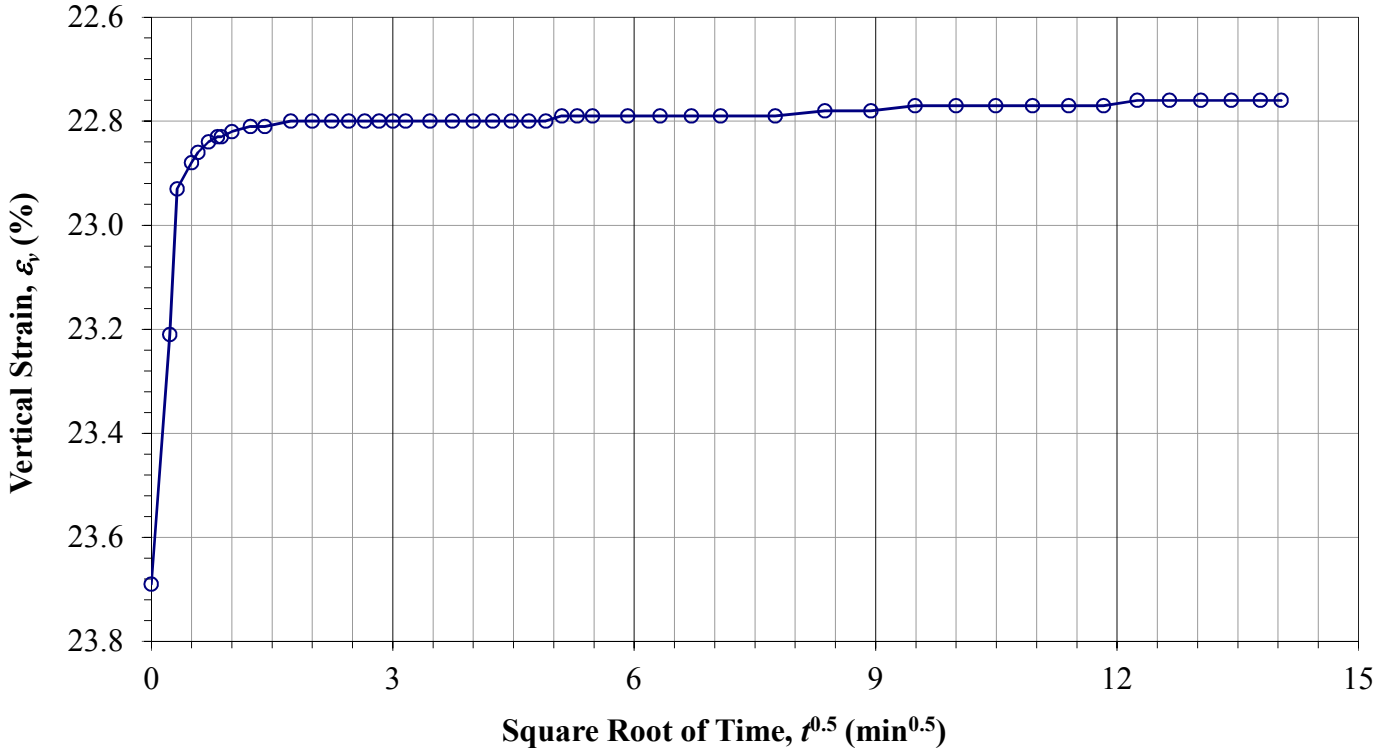
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 21
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 85'

Constant Load Step: 11 of 14
Stress: 25600 psf





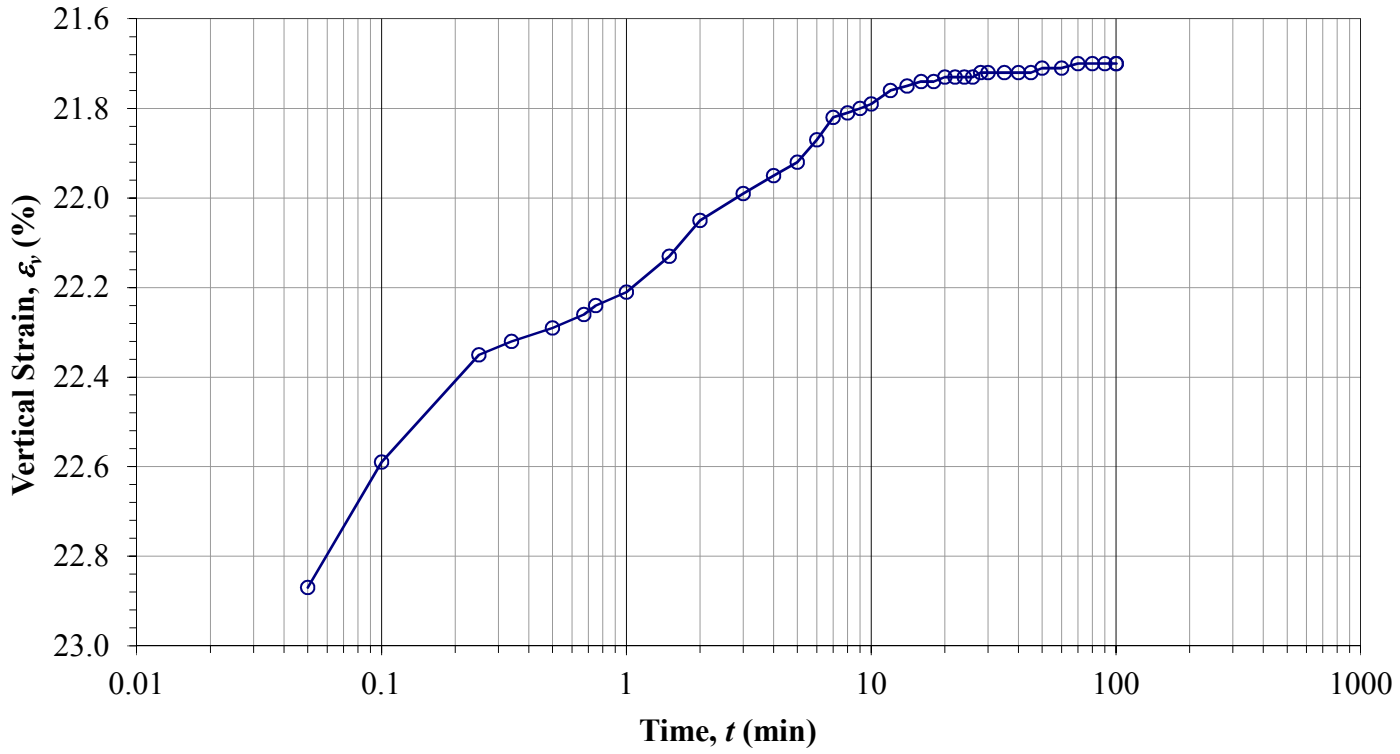
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

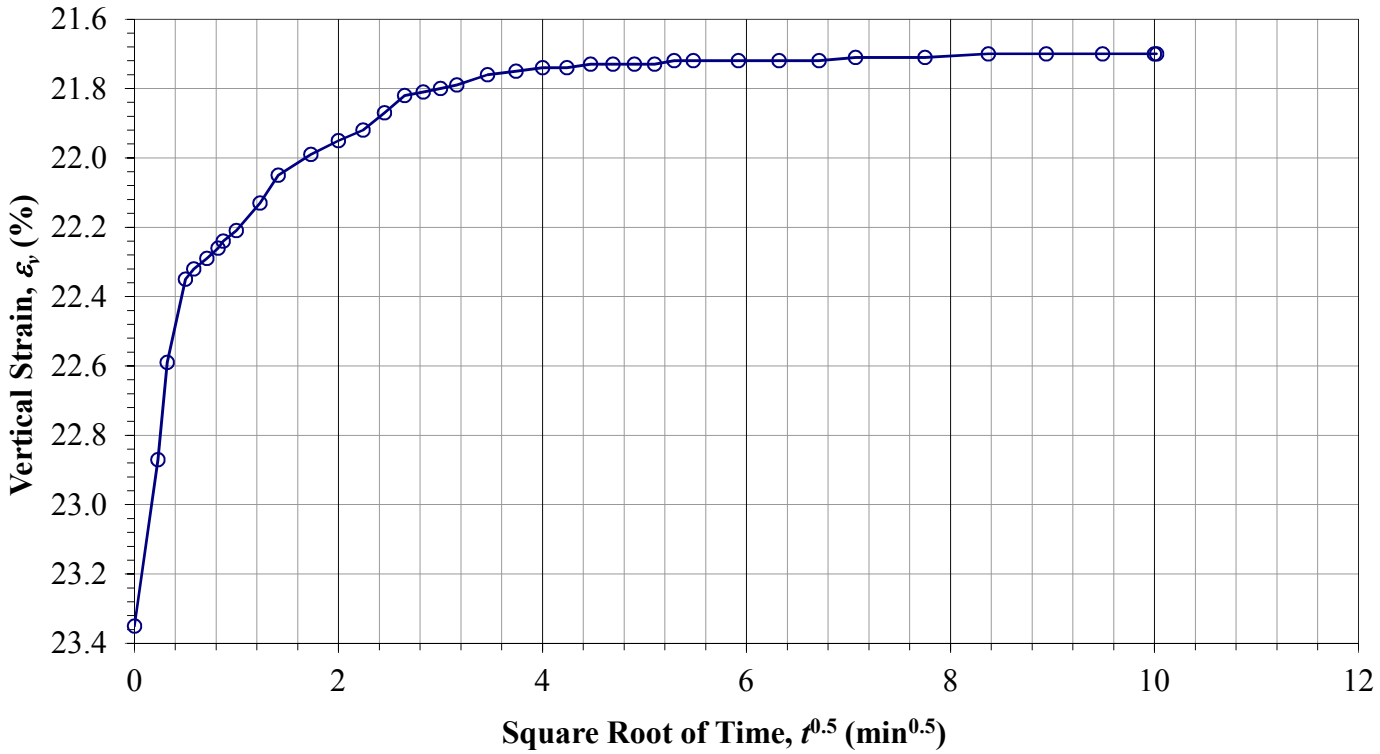
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'

Constant Load Step: 12 of 14
Stress: 6400 psf





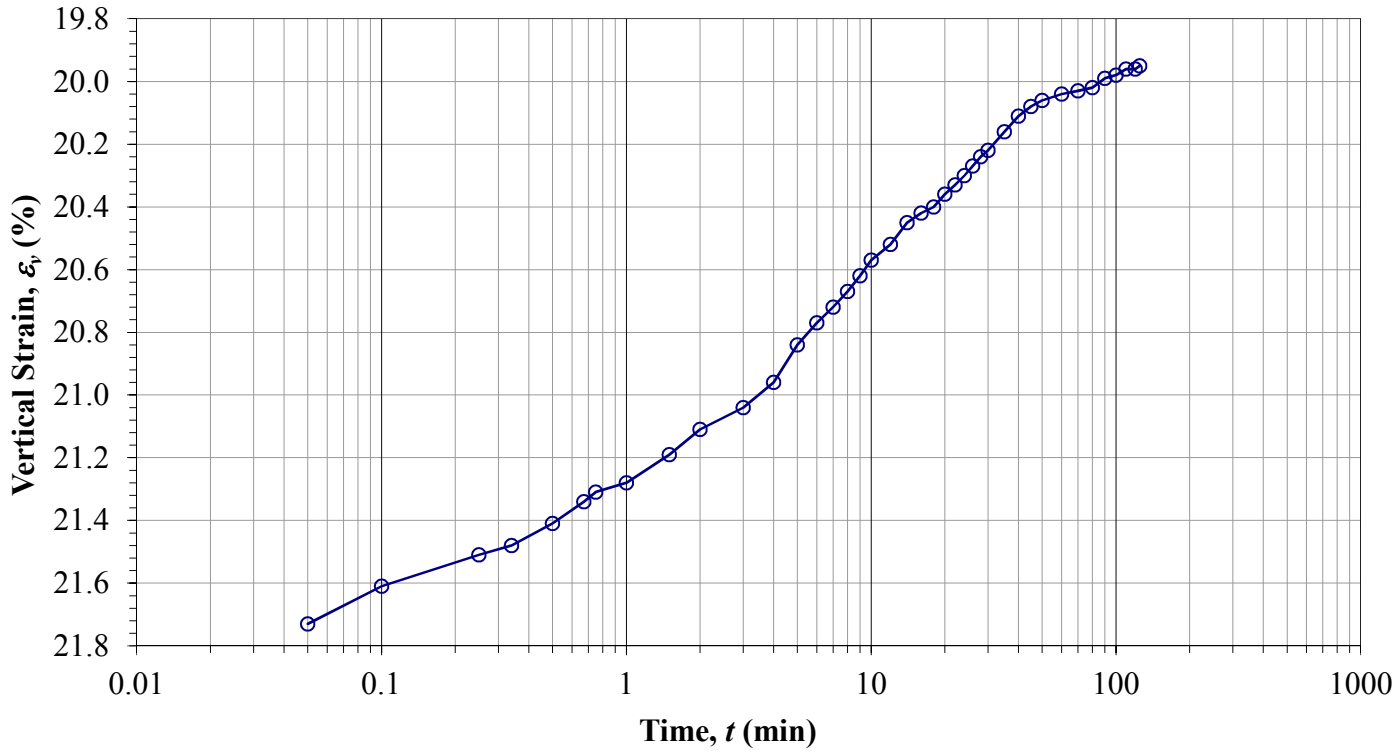
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

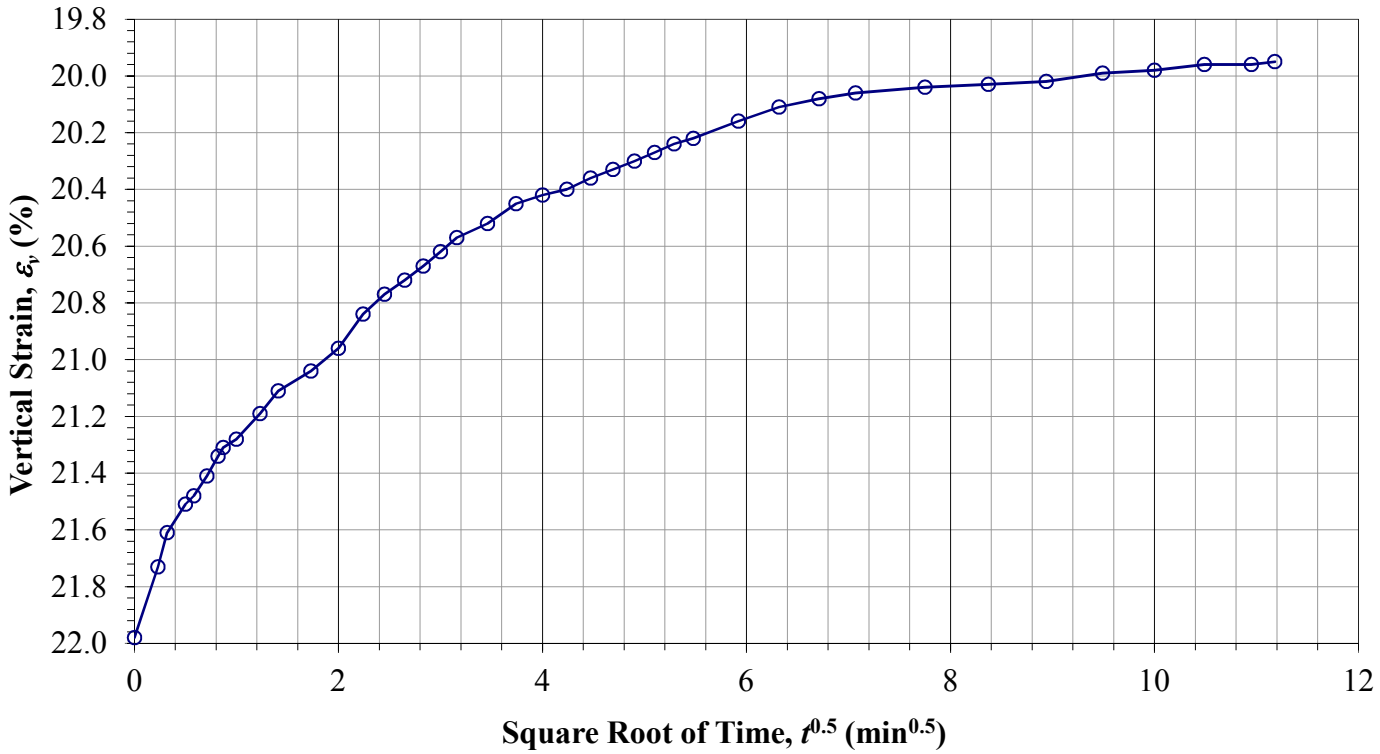
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'

Constant Load Step: 13 of 14
Stress: 1600 psf





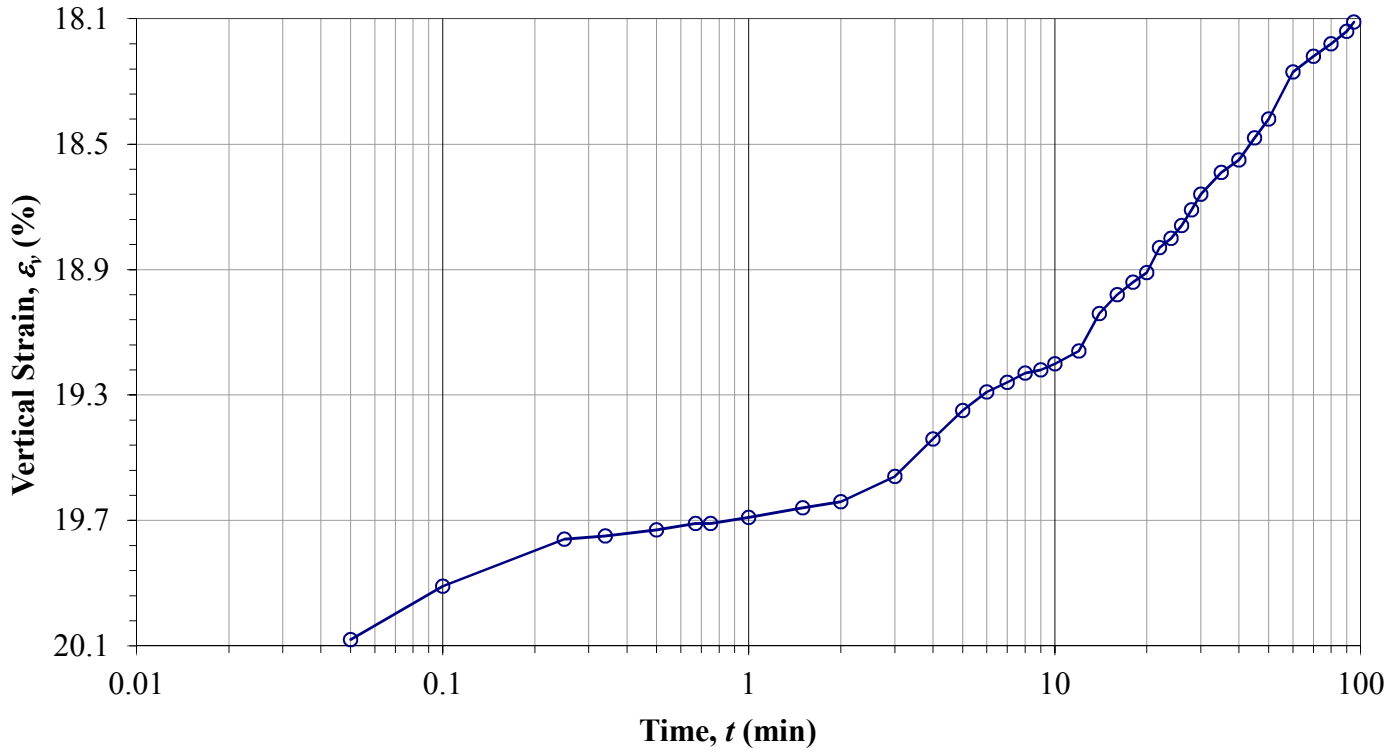
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

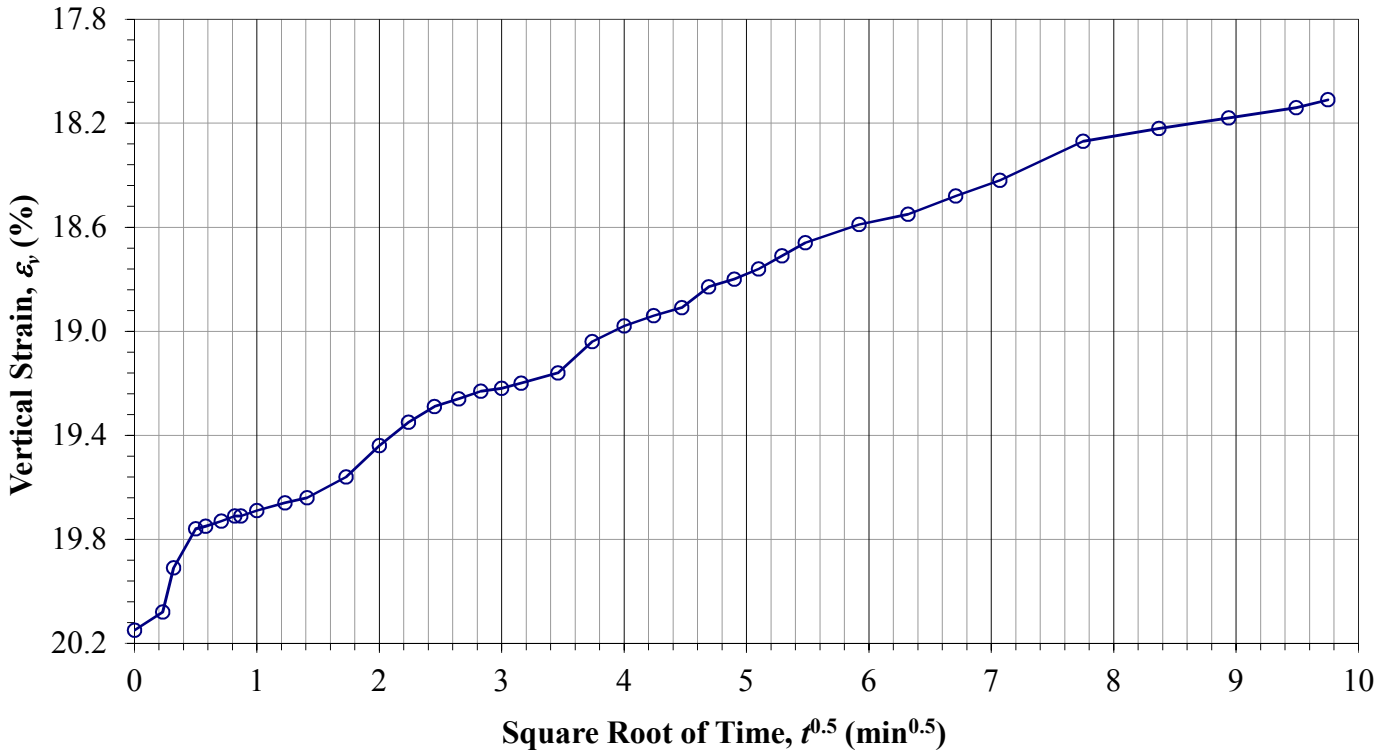
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 21
Depth: 85'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: JDF

Boring No.: BH19-ES-1
Sample: 24
Depth: 100'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

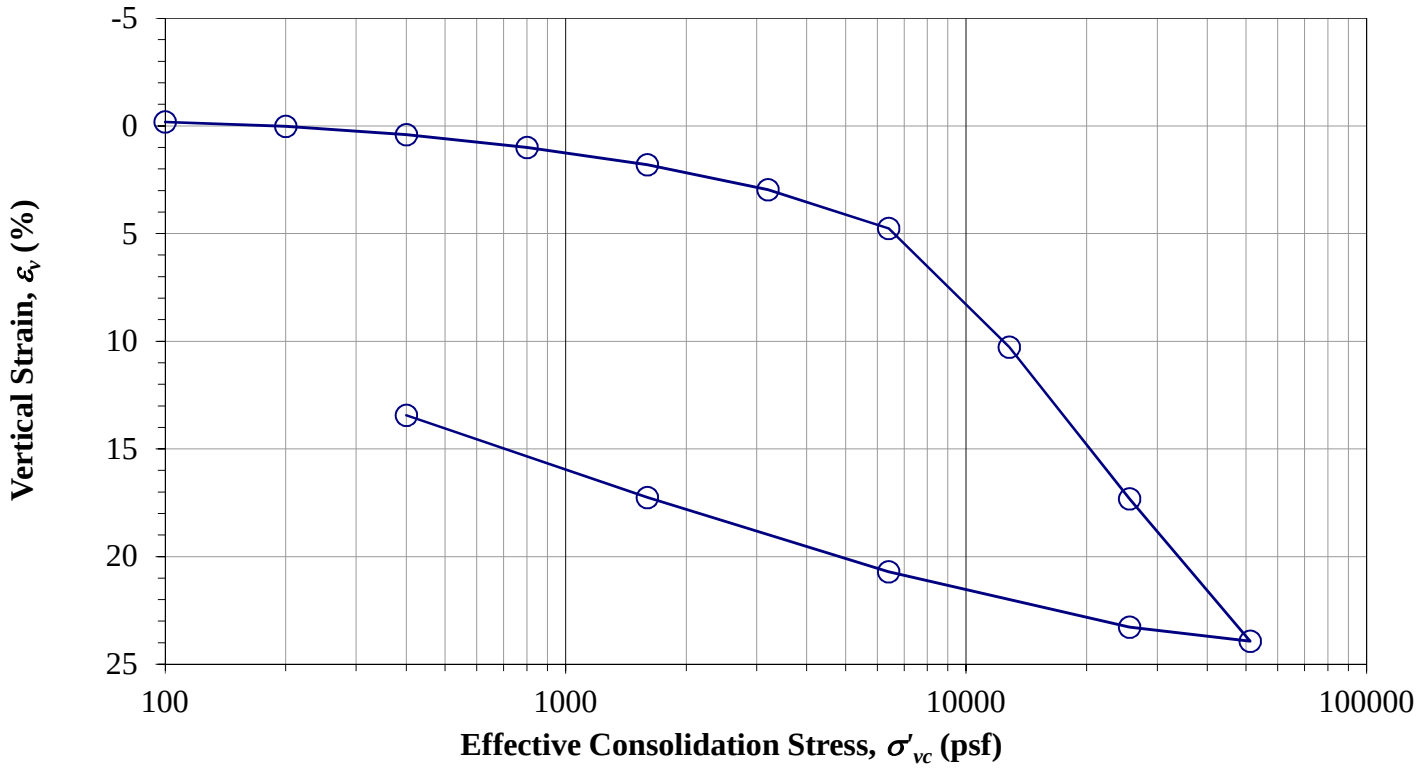
Test method:	B	
Inundation stress (psf), timing:	Seating	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation: Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.919	0.796
Sample diameter, D (in.)	2.418	2.418
Wt. rings + wet soil (g)	168.65	162.68
Wt. rings/tare (g)	42.55	42.55
Total unit wt., γ (pcf)	113.8	125.28
Wet soil + tare (g)	338.16	245.20
Dry soil + tare (g)	305.32	216.09
Tare (g)	221.93	127.28
Water content, ω (%)	39.4	32.8
Dry unit wt., γ_d (pcf)	81.7	94.3
Saturation, S	1.00	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9190	1.0638
100	-0.0017	-0.18	0.9207	1.0676
200	0.0001	0.02	0.9189	1.0635
400	0.0037	0.41	0.9153	1.0554
800	0.0091	0.99	0.9099	1.0433
1600	0.0166	1.80	0.9024	1.0266
3200	0.0273	2.97	0.8918	1.0026
6400	0.0437	4.76	0.8753	0.9656
12800	0.0945	10.28	0.8245	0.8517
25600	0.1591	17.31	0.7599	0.7065
51200	0.2199	23.93	0.6991	0.5700
25600	0.2139	23.28	0.7051	0.5835
6400	0.1903	20.71	0.7287	0.6365
1600	0.1586	17.26	0.7604	0.7076
400	0.1235	13.44	0.7955	0.7865



Comments: Specimen swelled upon inundation, and at the 100 psf loading.

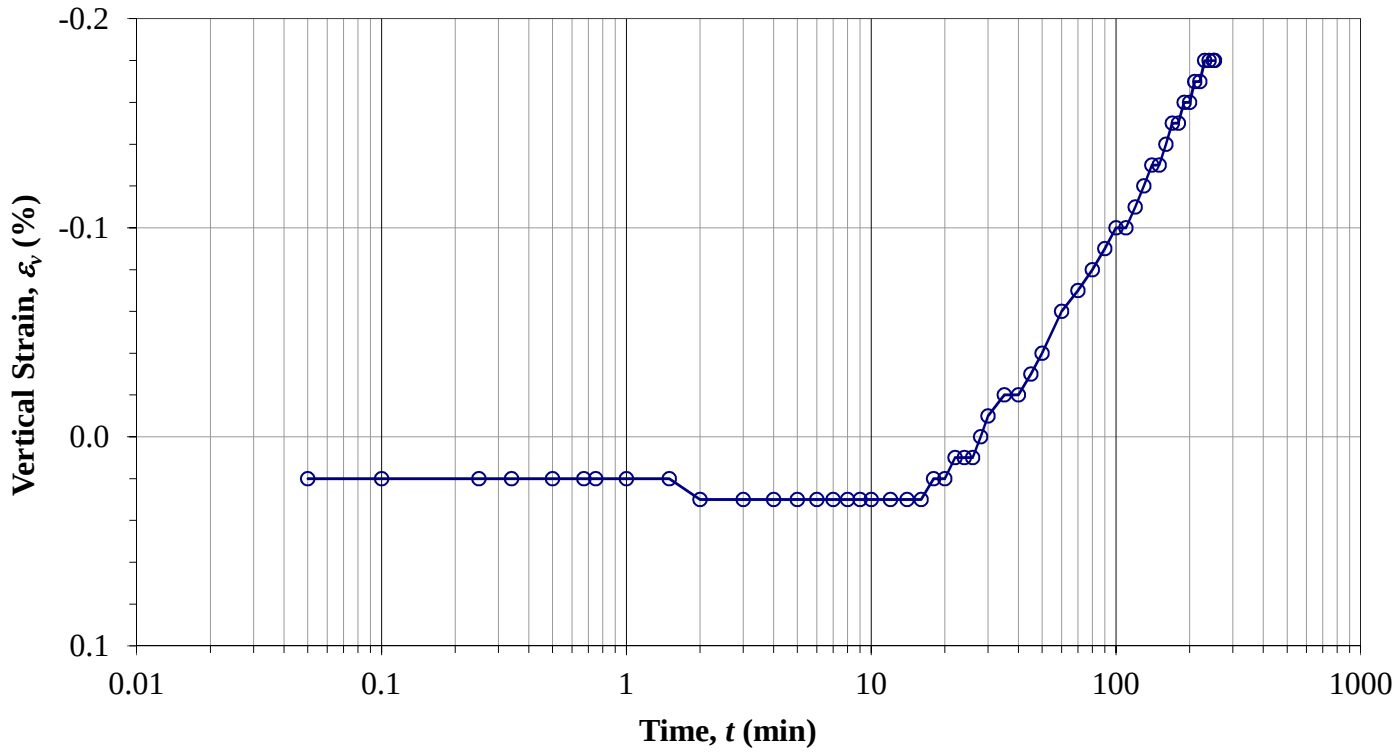
Entered: _____
Reviewed: _____

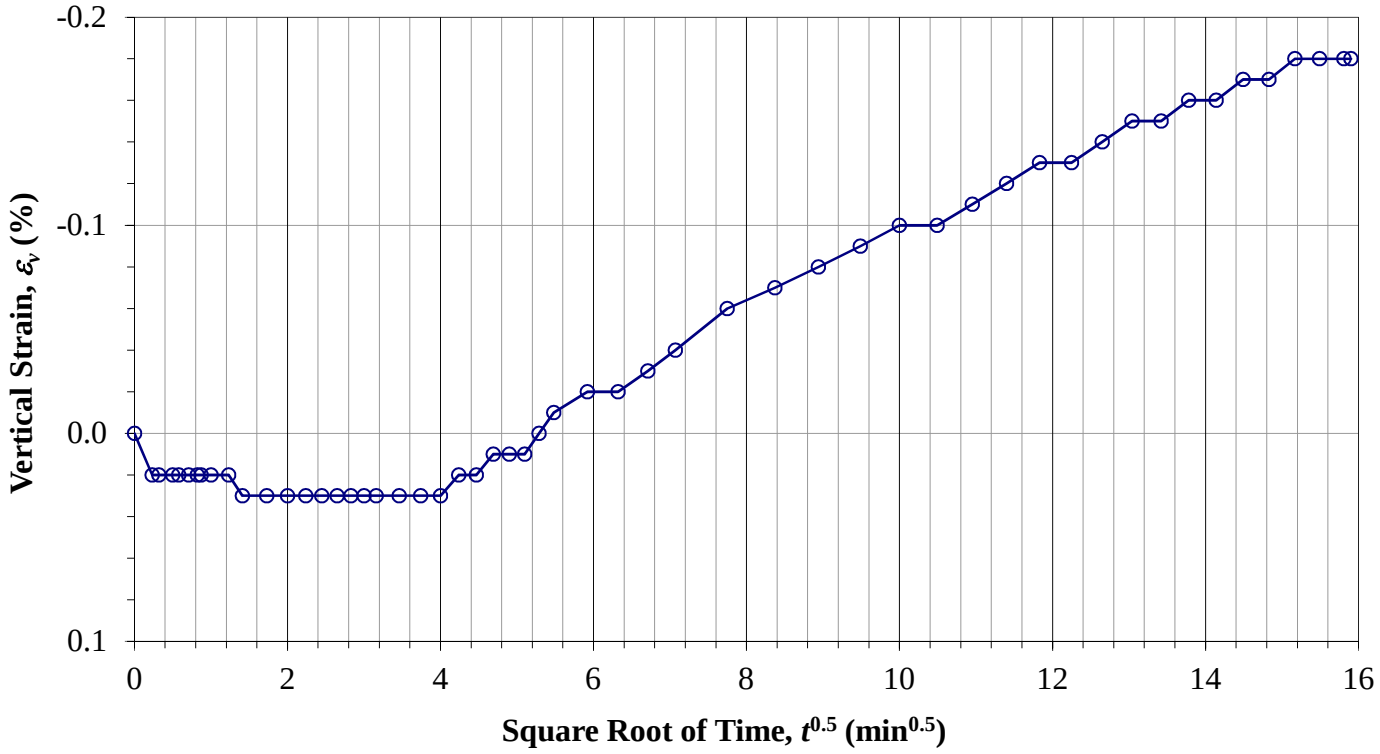
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 1 of 14
Stress: 100 psf



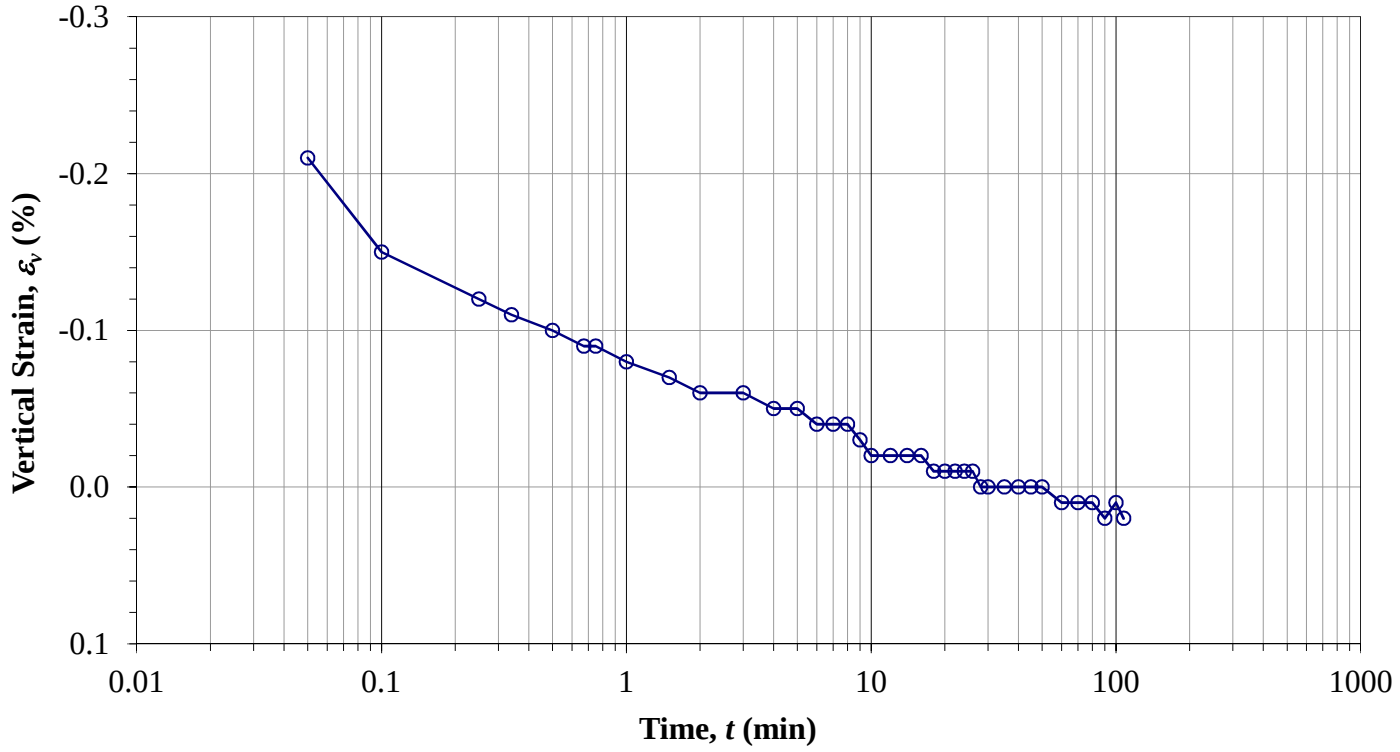


One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 2 of 14
Stress: 200 psf





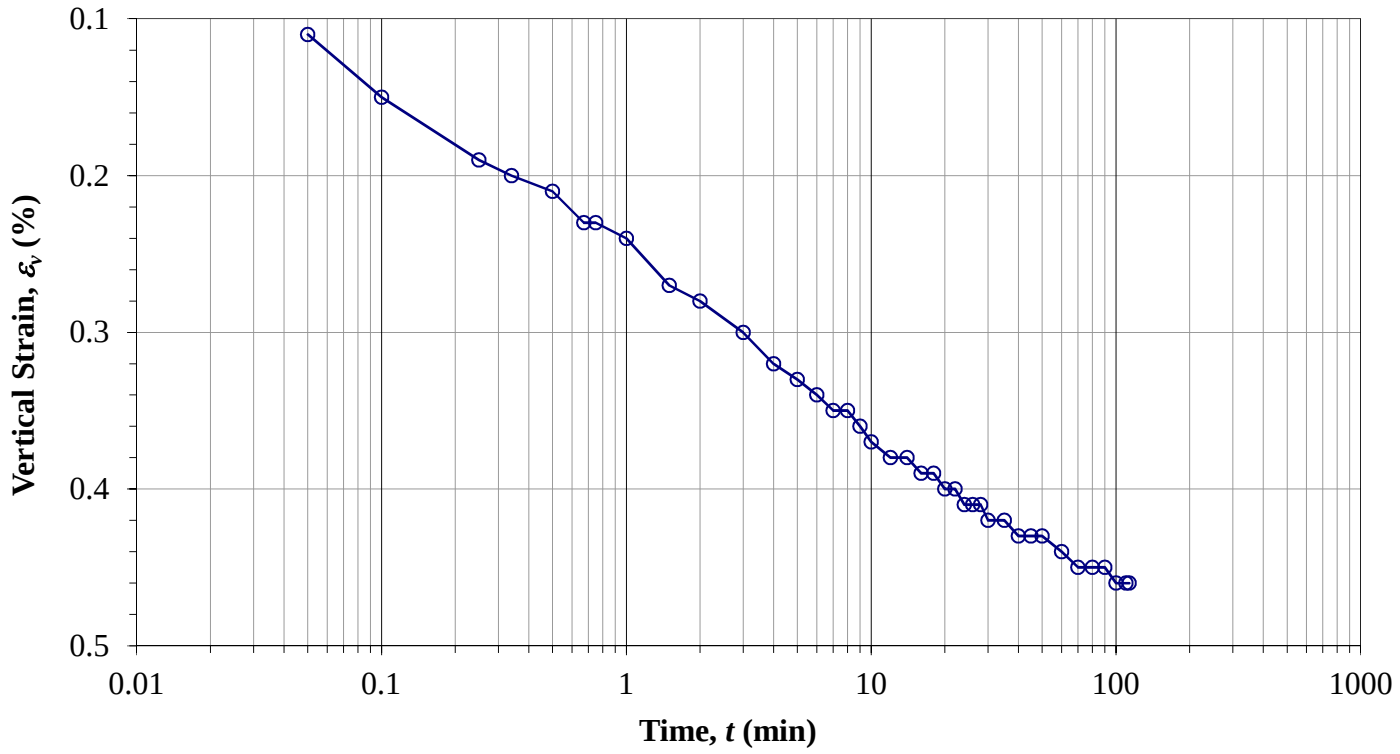
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

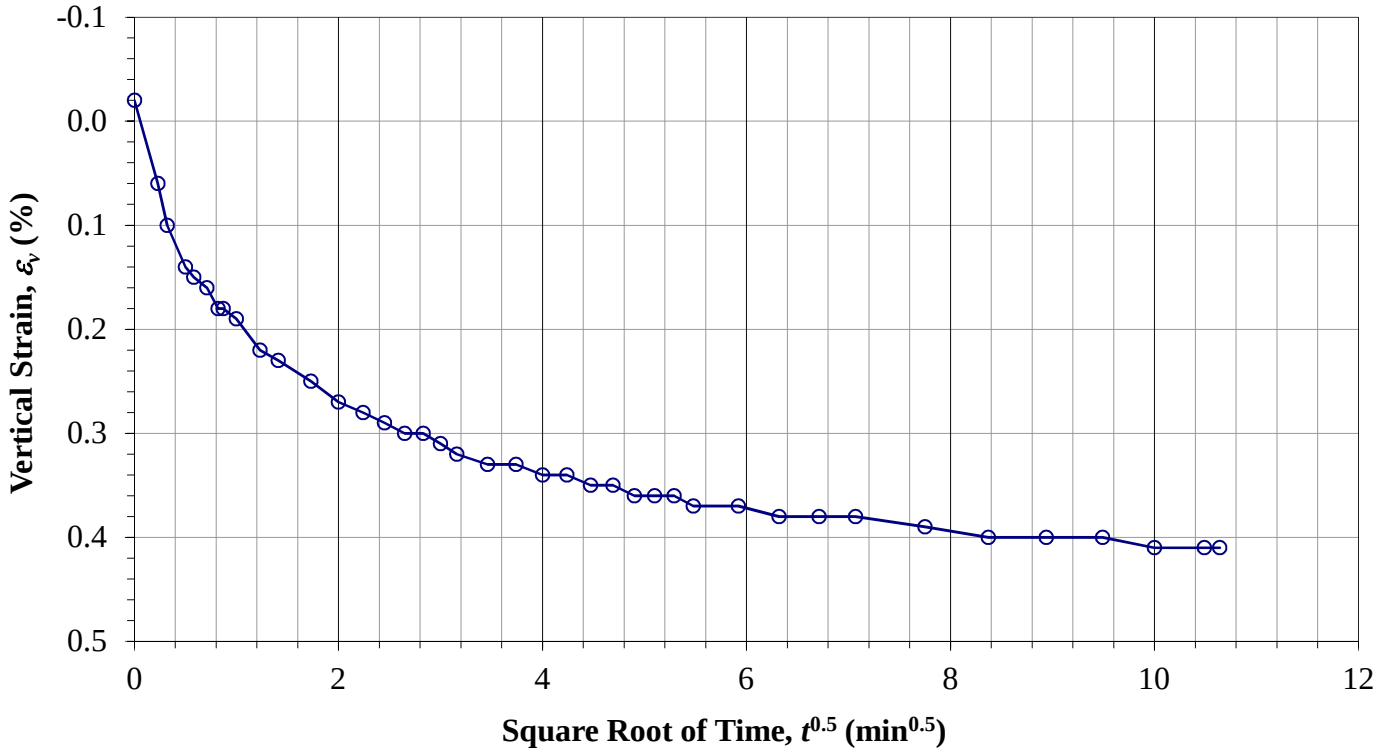
© IGES 2011, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-1
Sample: 24
Depth: 100'

Constant Load Step: 3 of 14
Stress: 400 psf



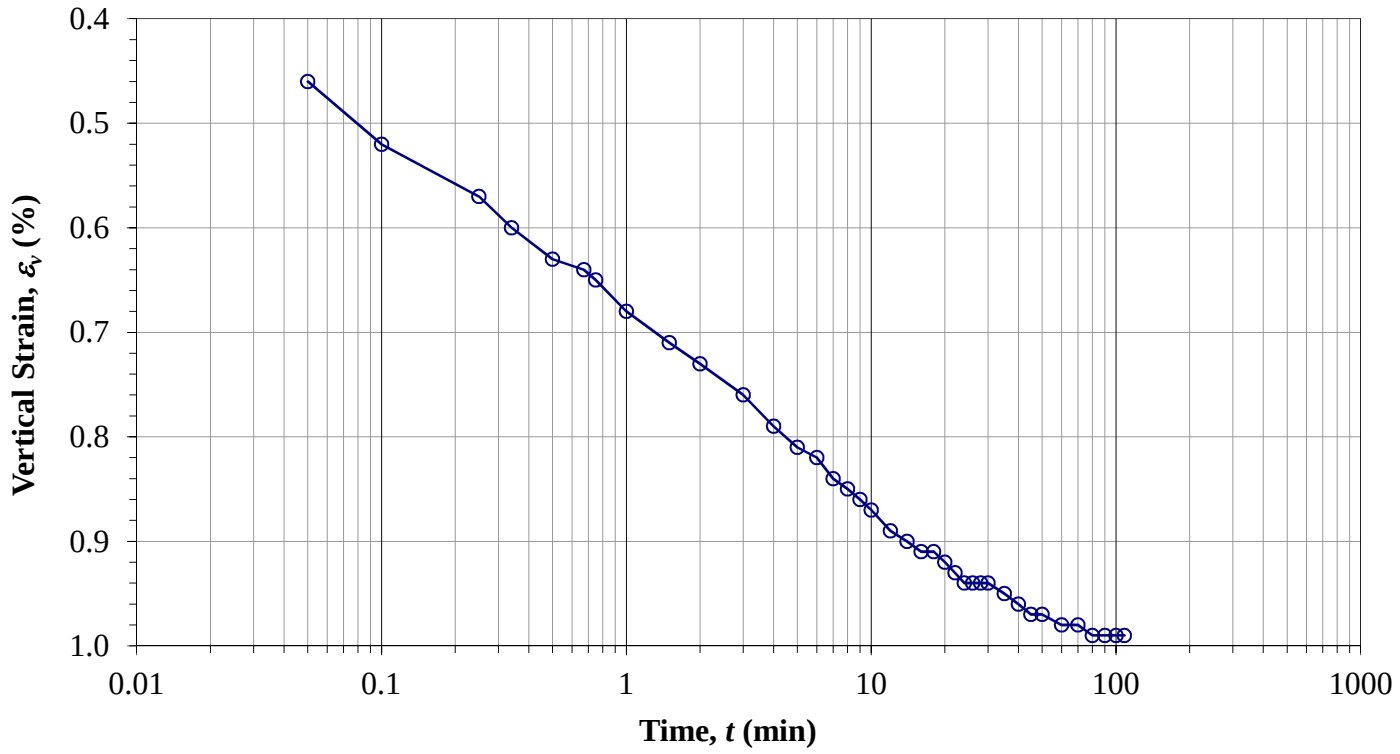


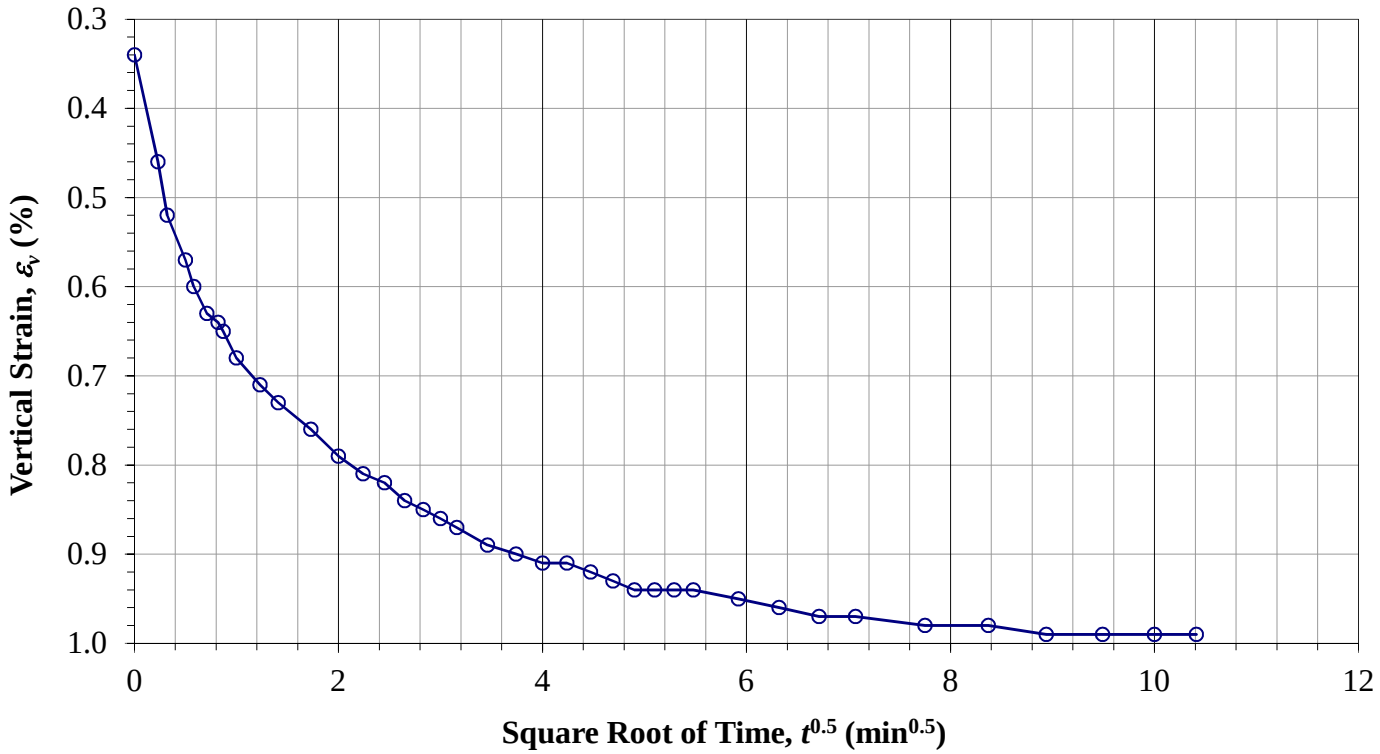
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 4 of 14
Stress: 800 psf



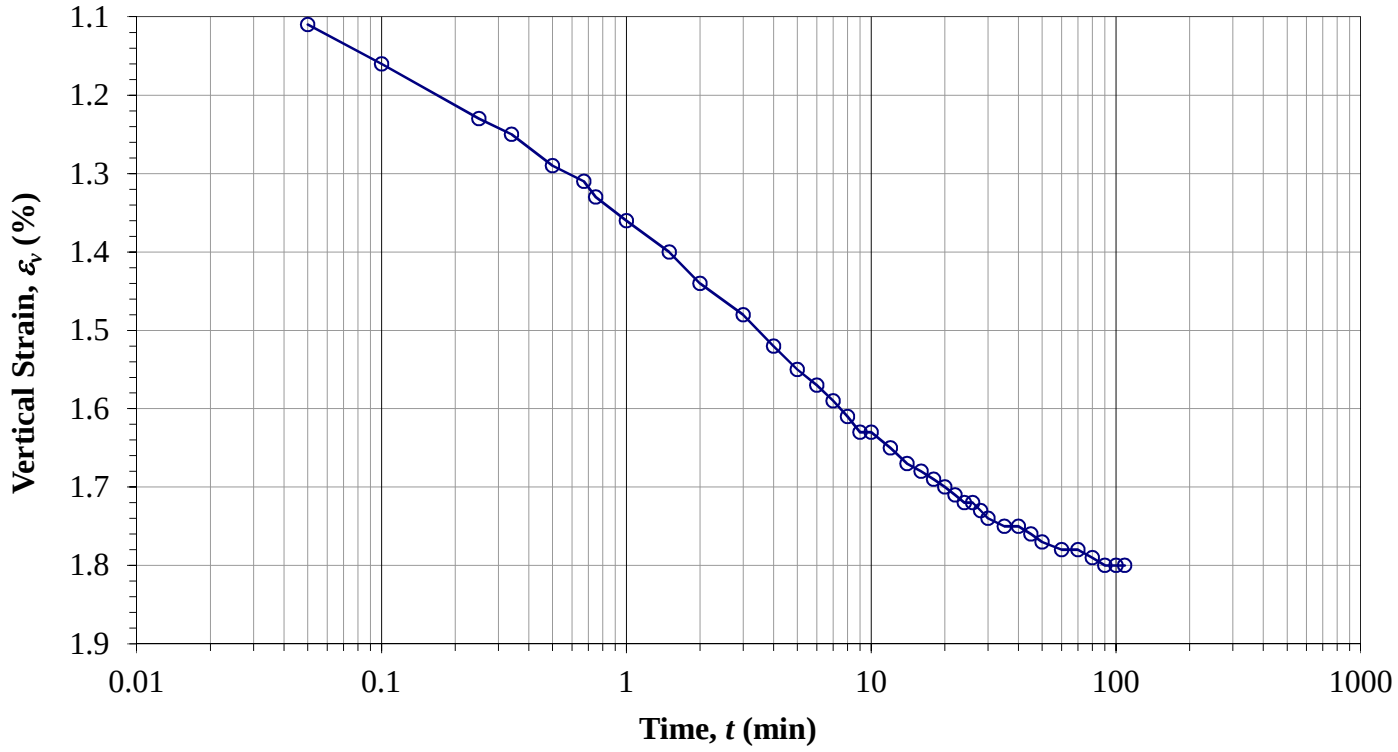


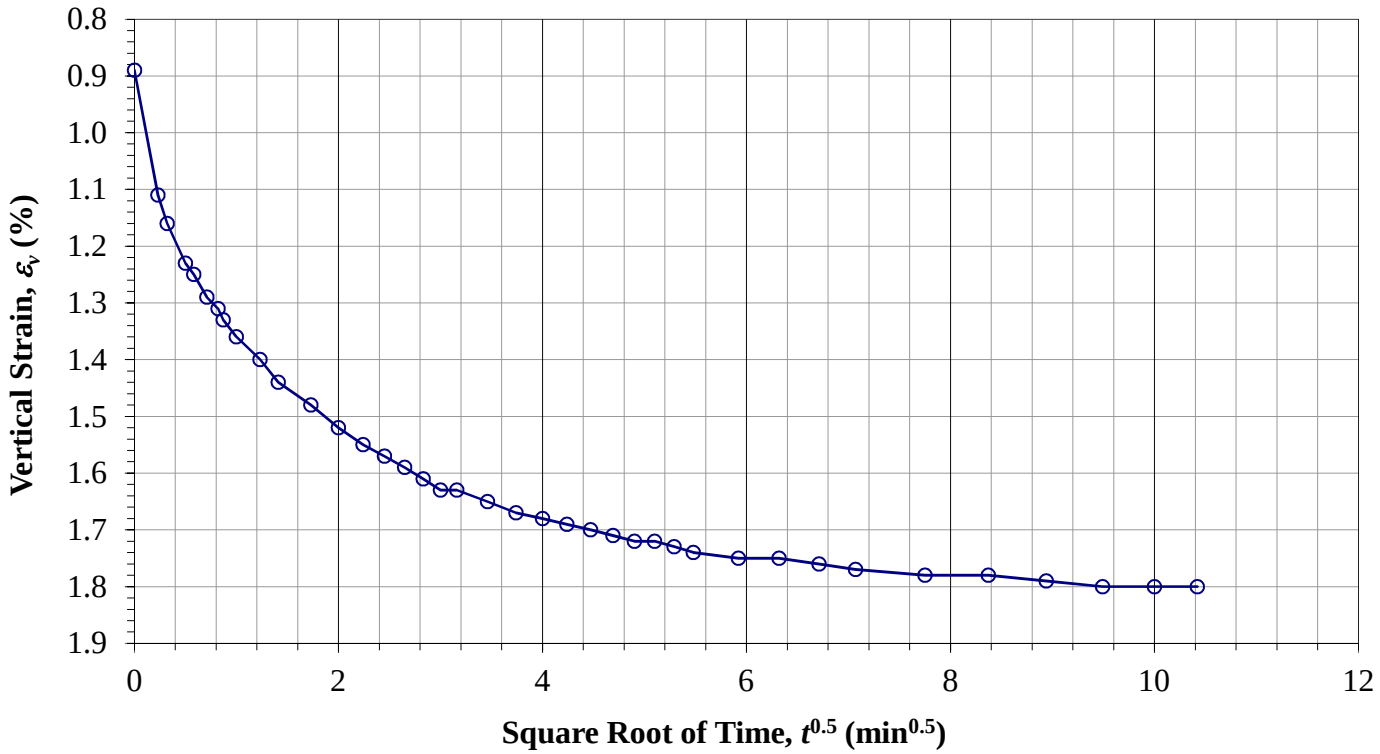
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 5 of 14
Stress: 1600 psf



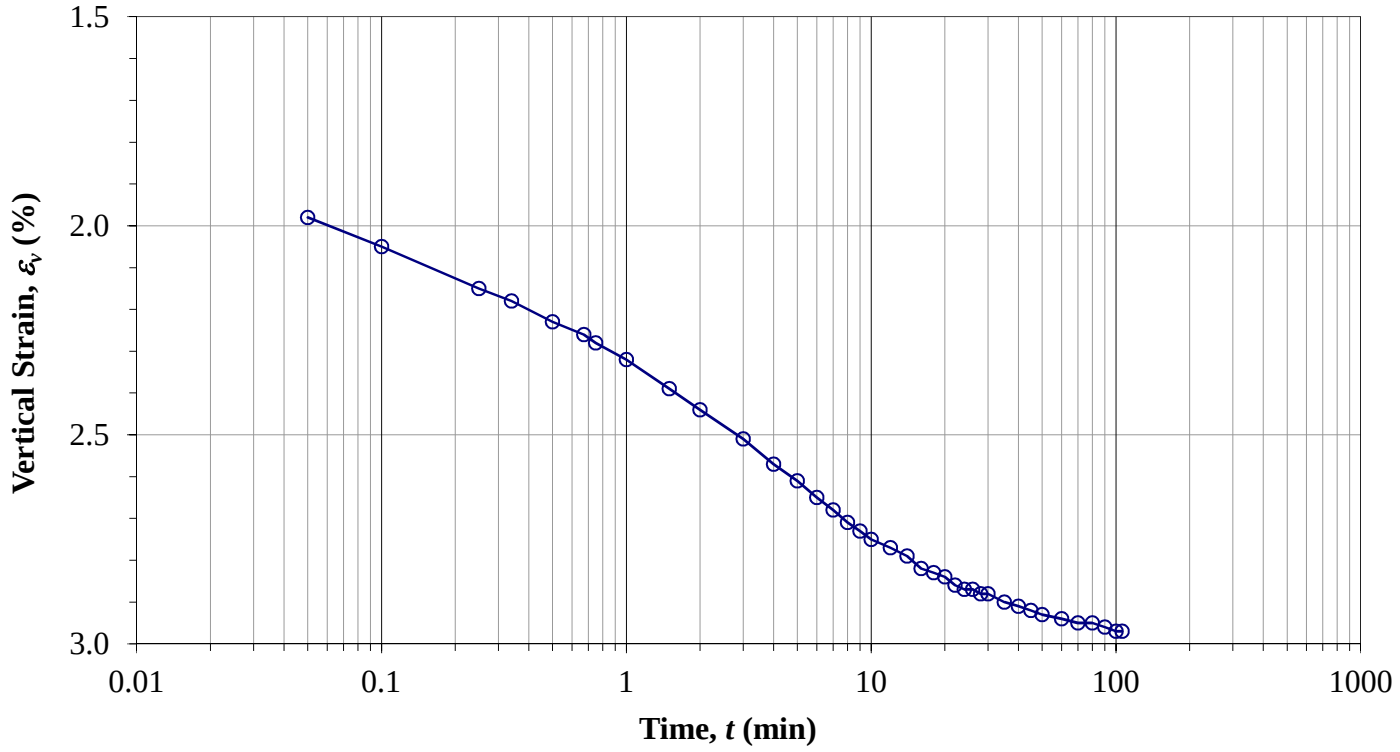


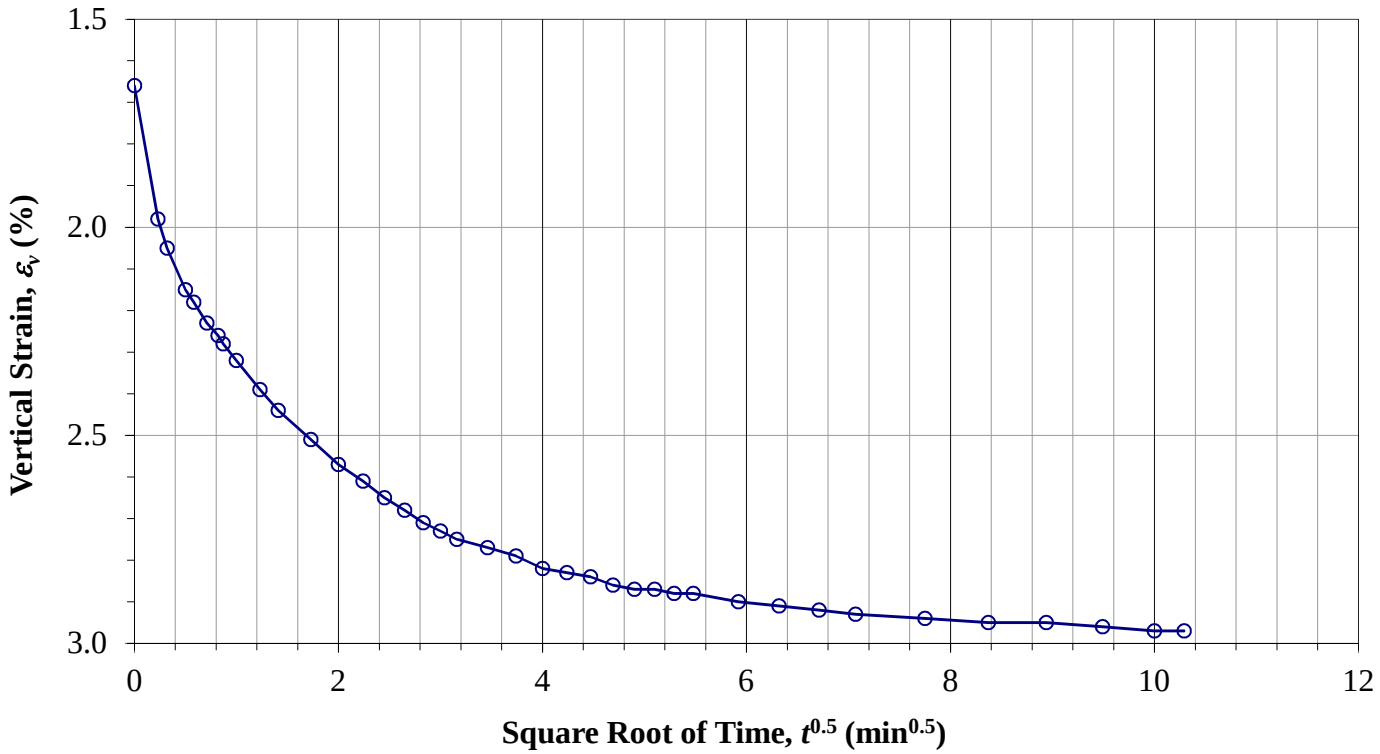
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 6 of 14
Stress: 3200 psf



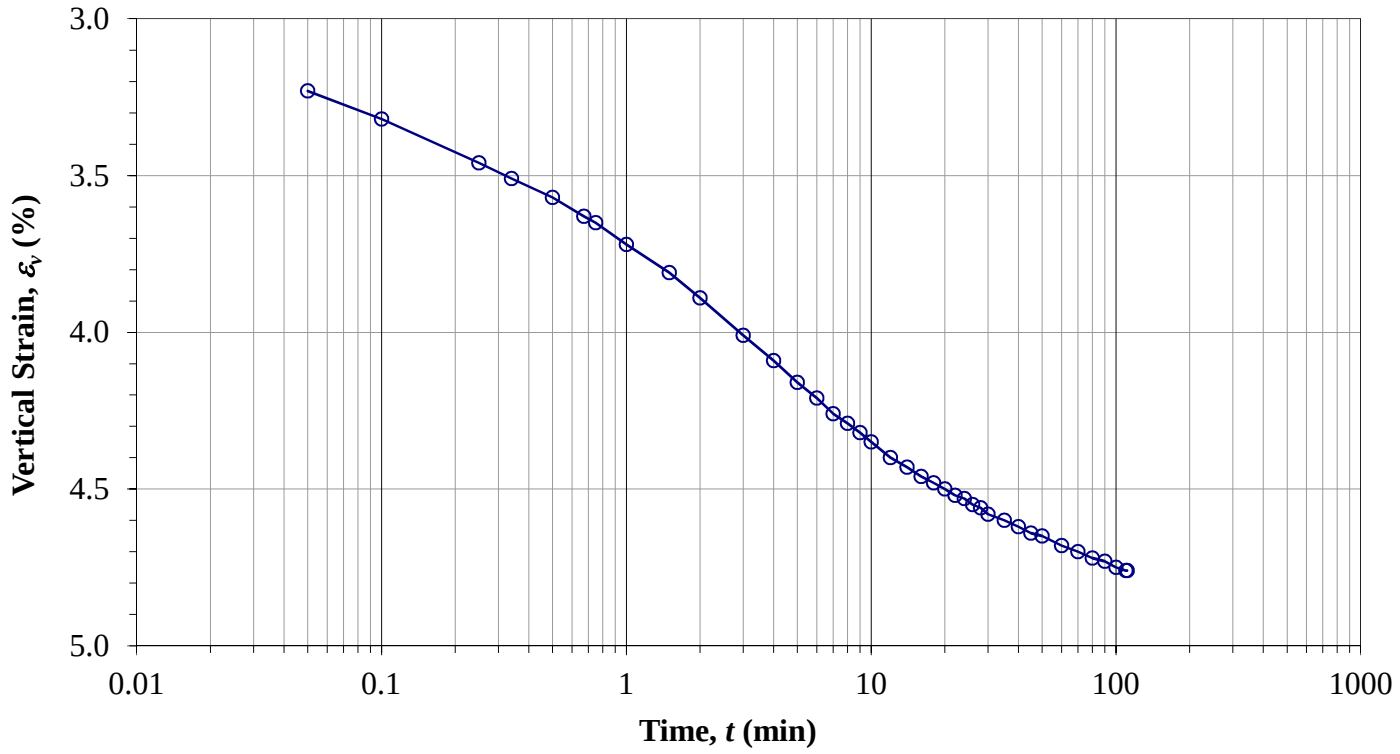


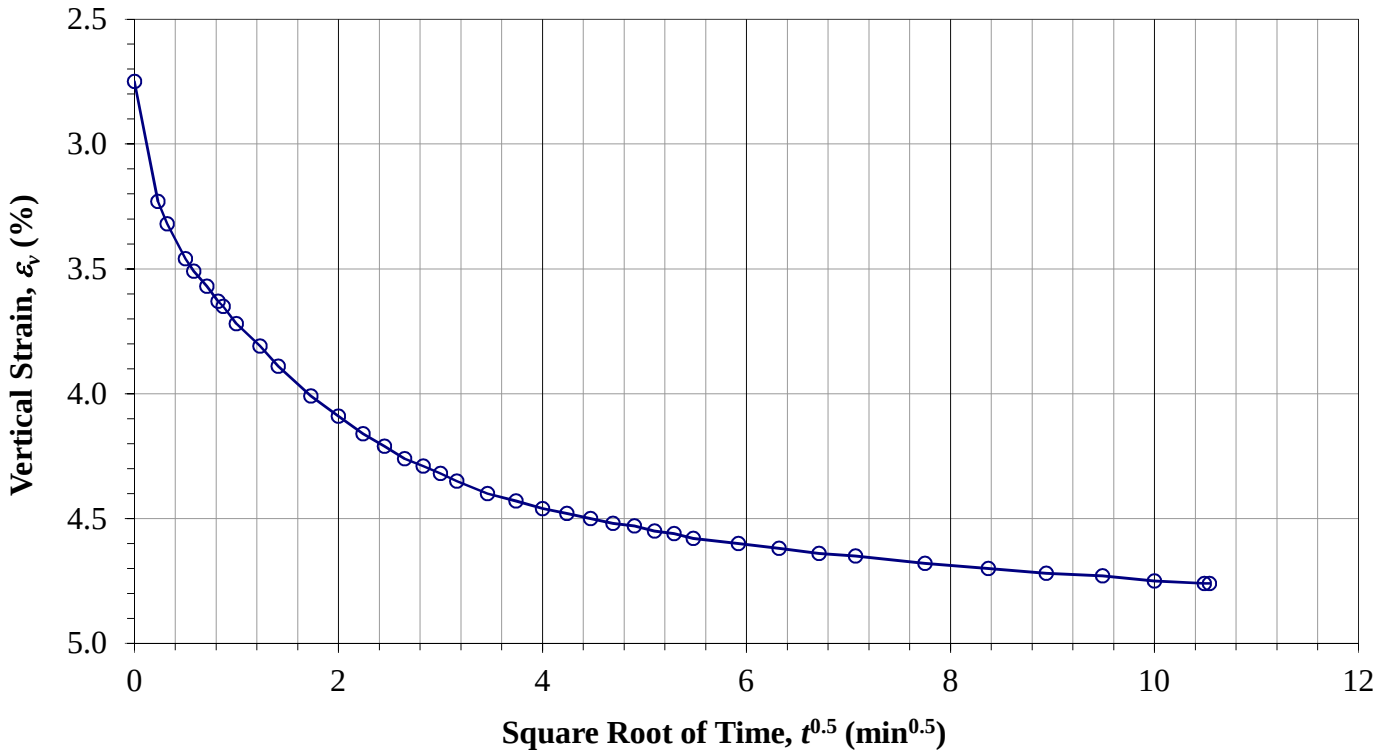
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 7 of 14
Stress: 6400 psf



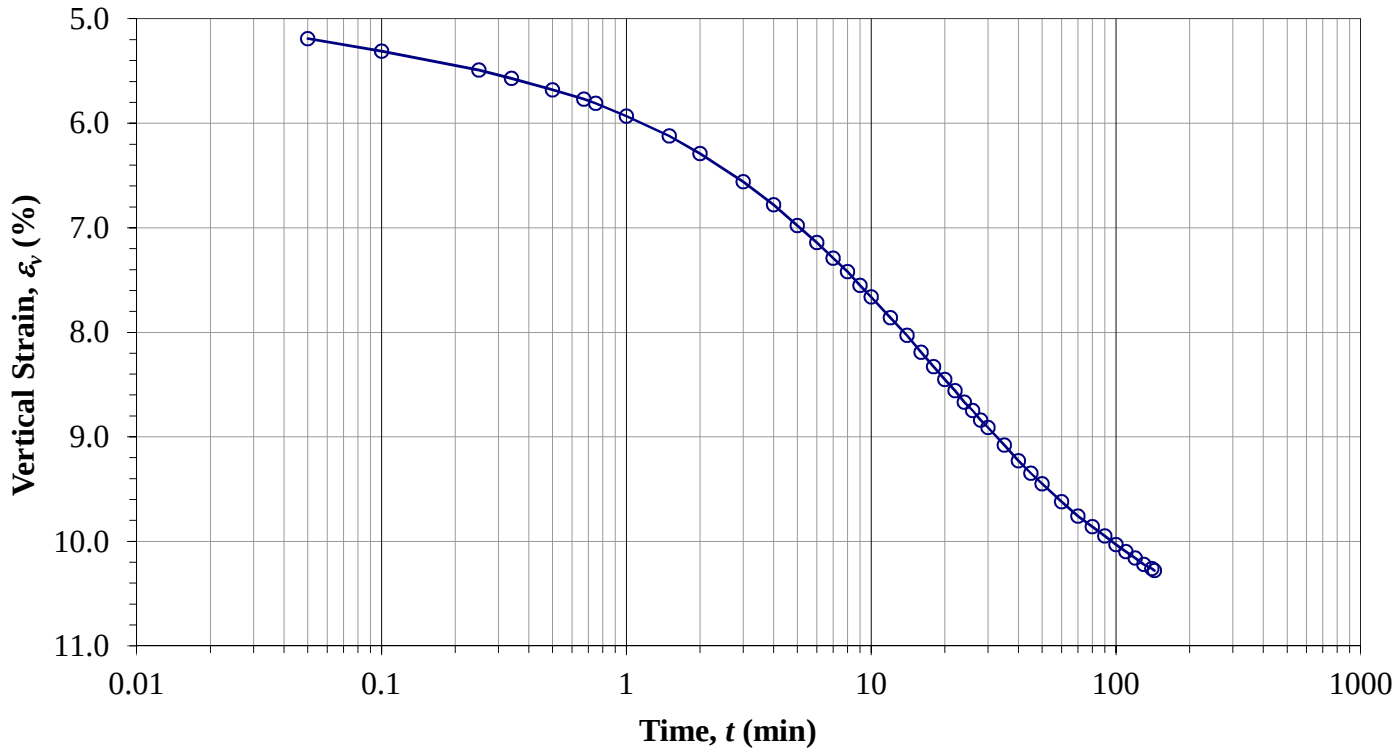


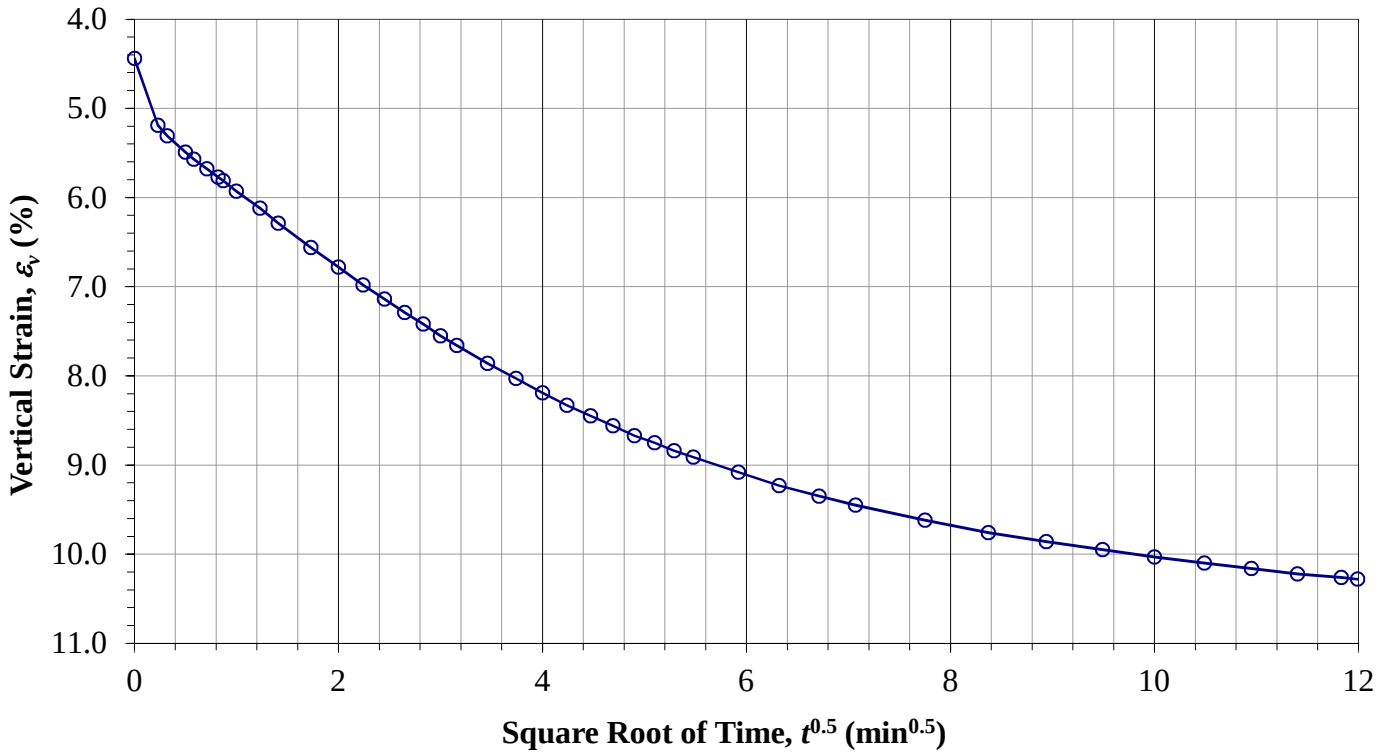
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 8 of 14
Stress: 12800 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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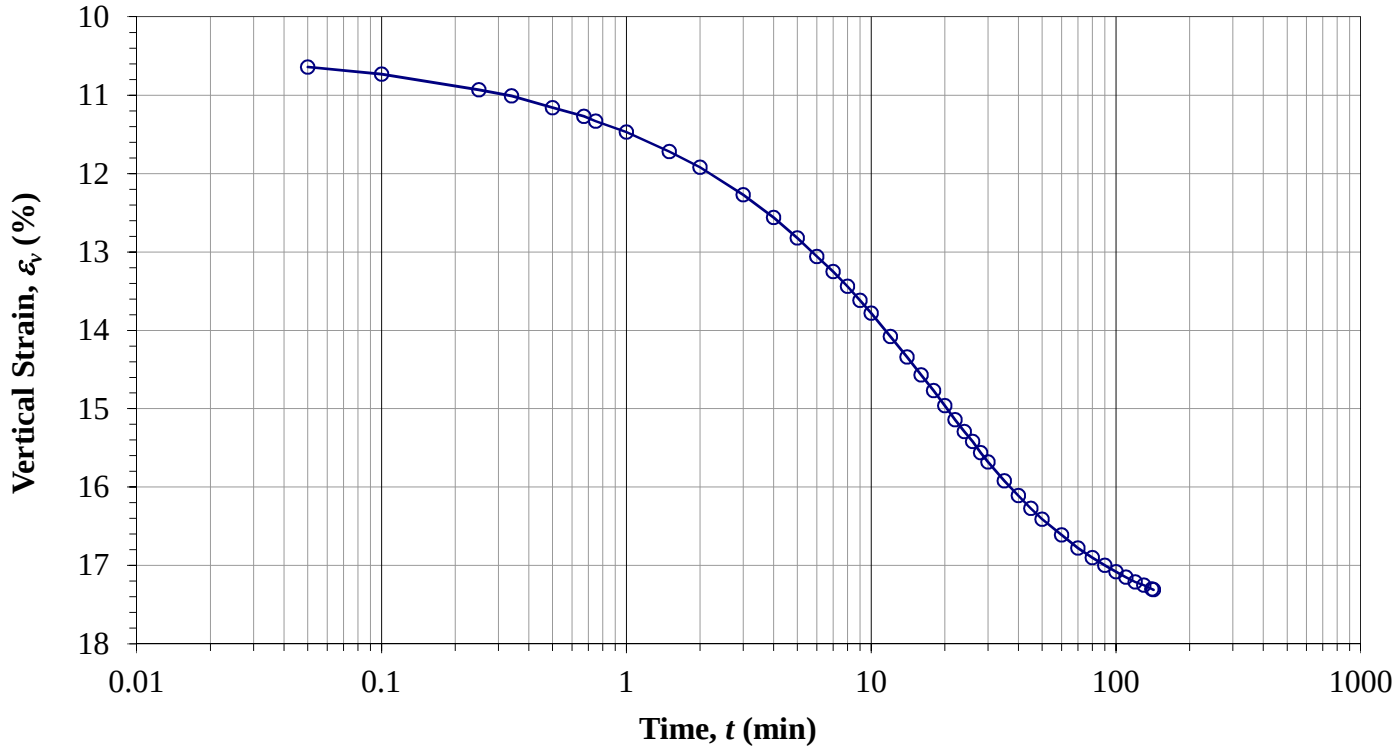
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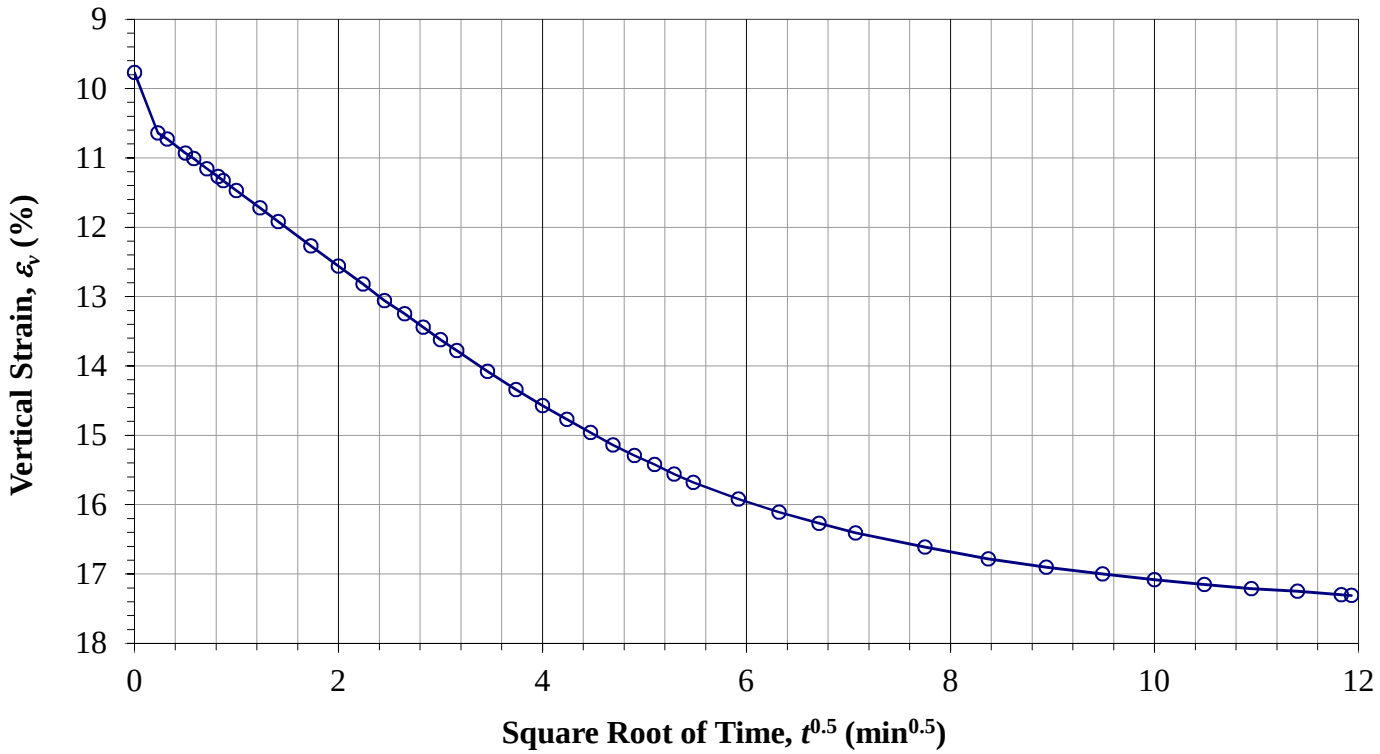
No: 00100-015, 3G2 (XIII) **Sample:** 24

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 9 of 14

Stress: 25600 psf



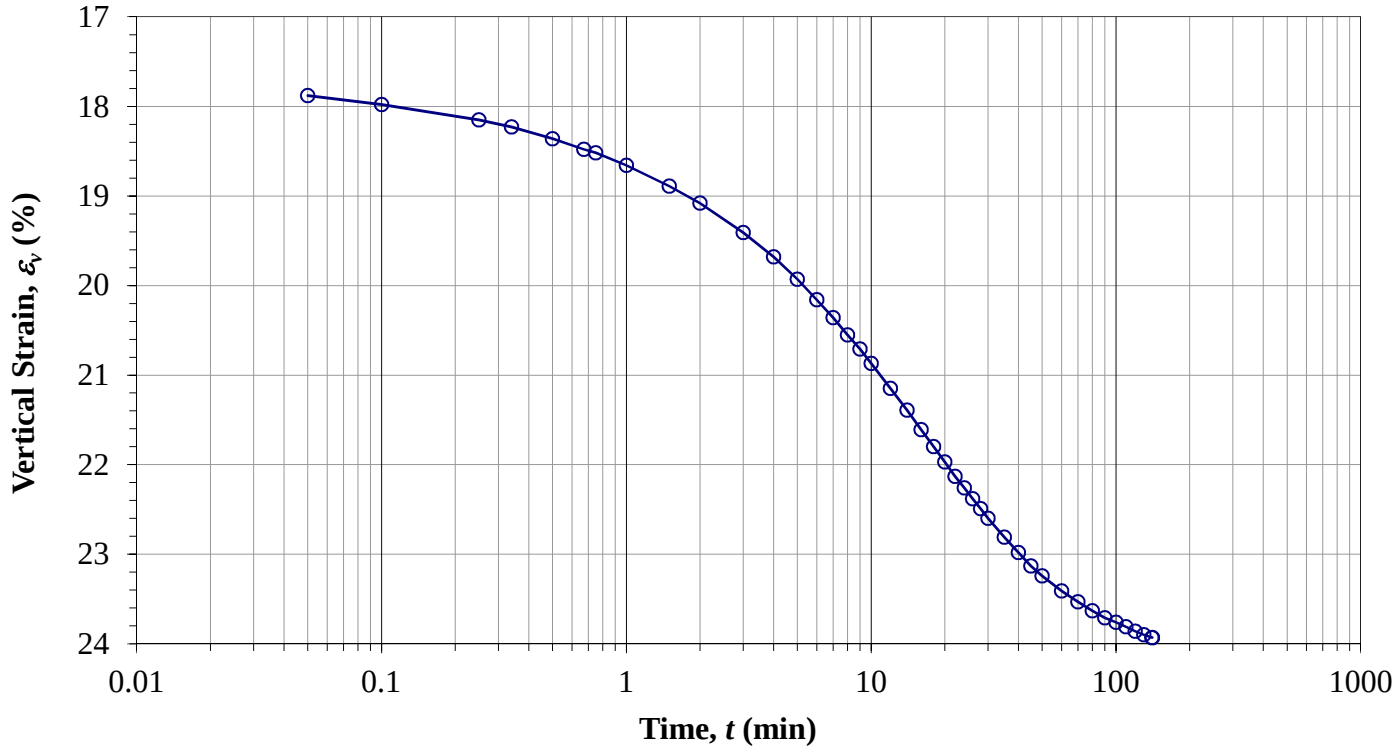


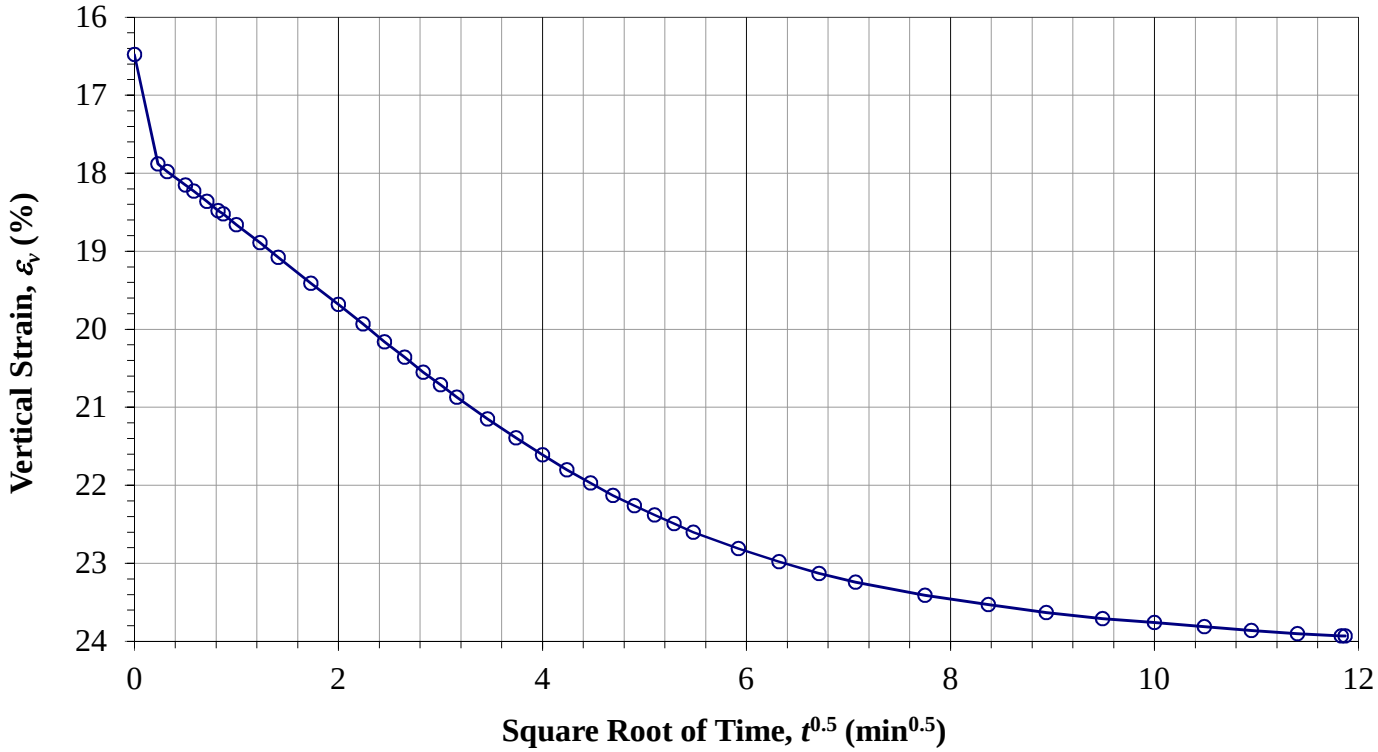
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 10 of 14
Stress: 51200 psf



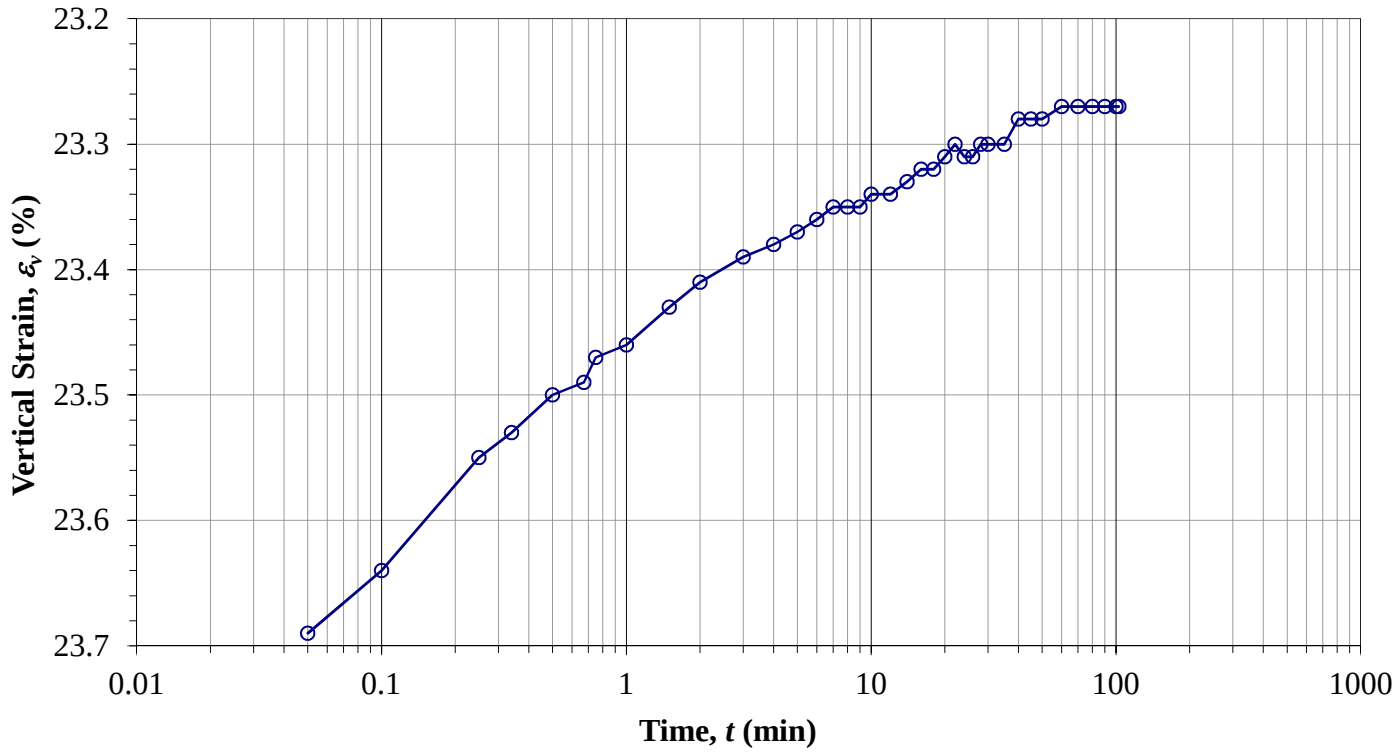


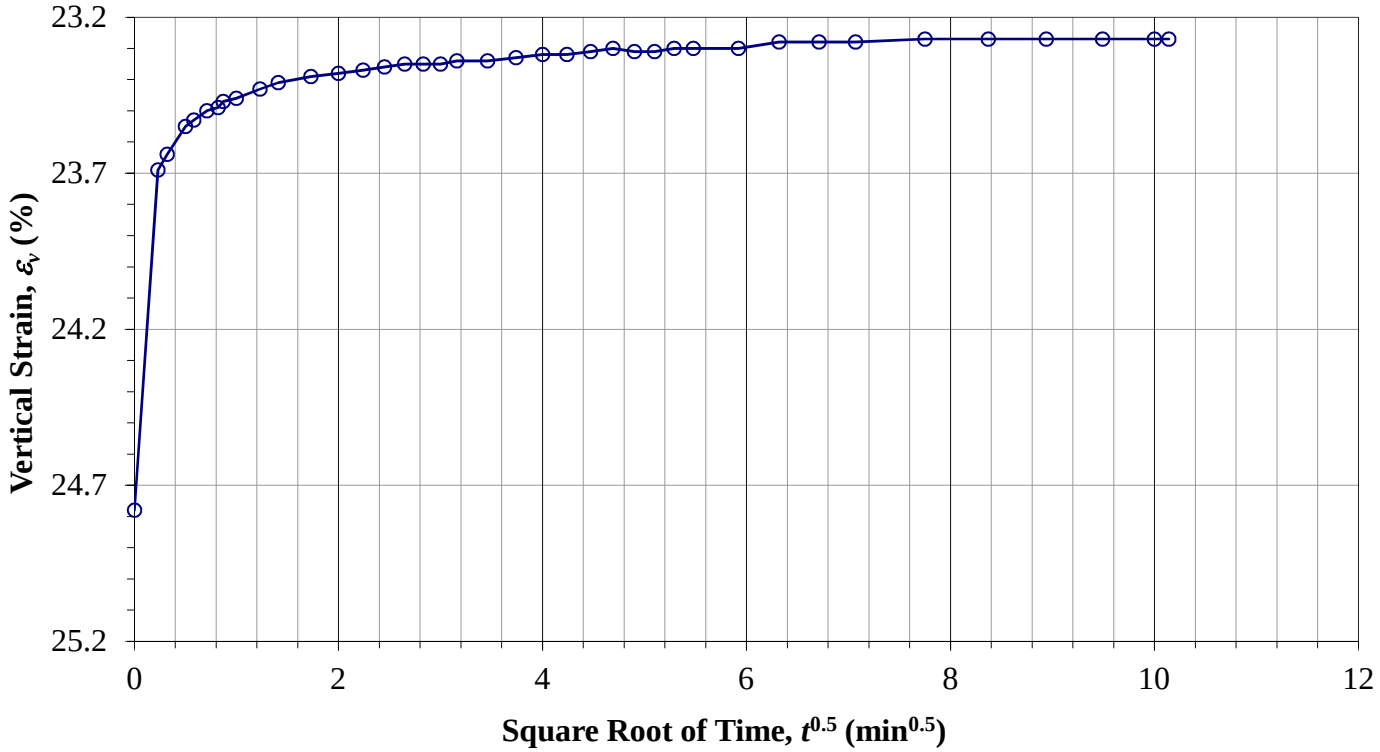
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 11 of 14
Stress: 25600 psf



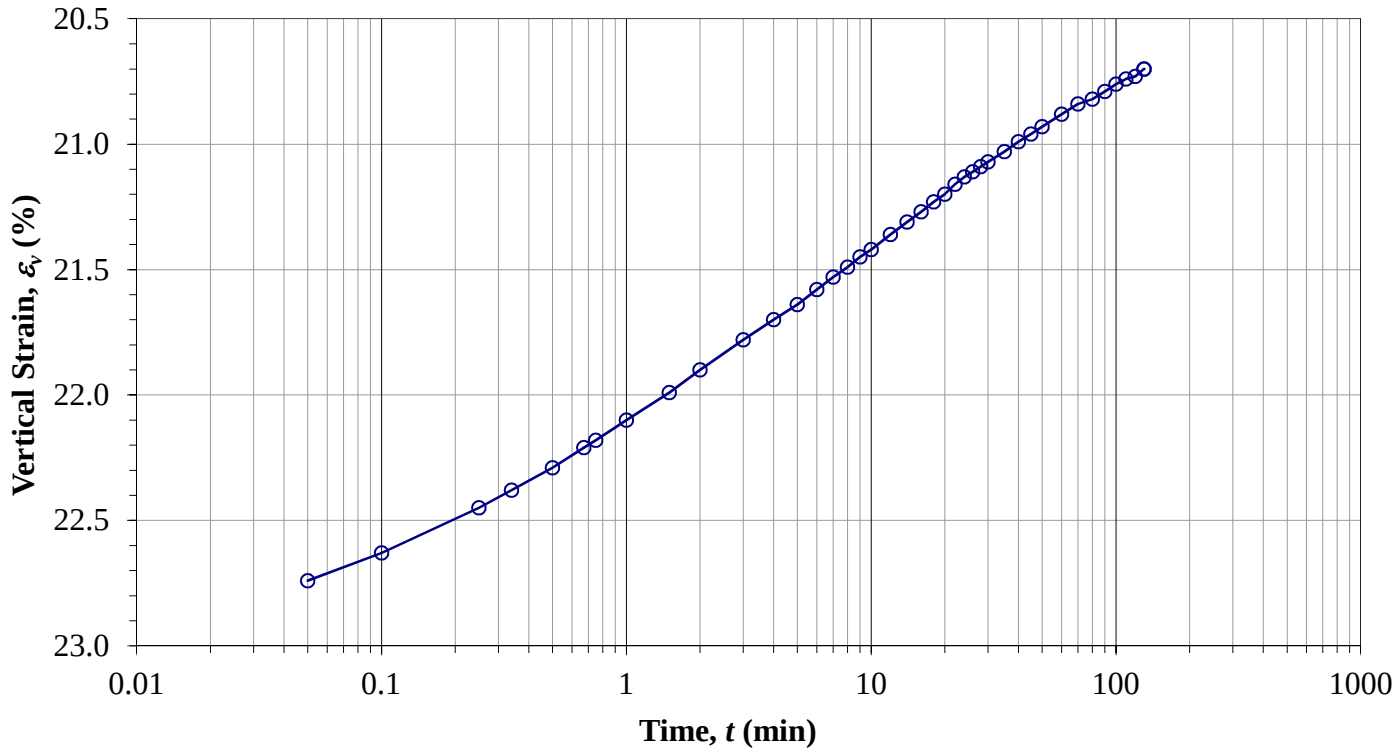


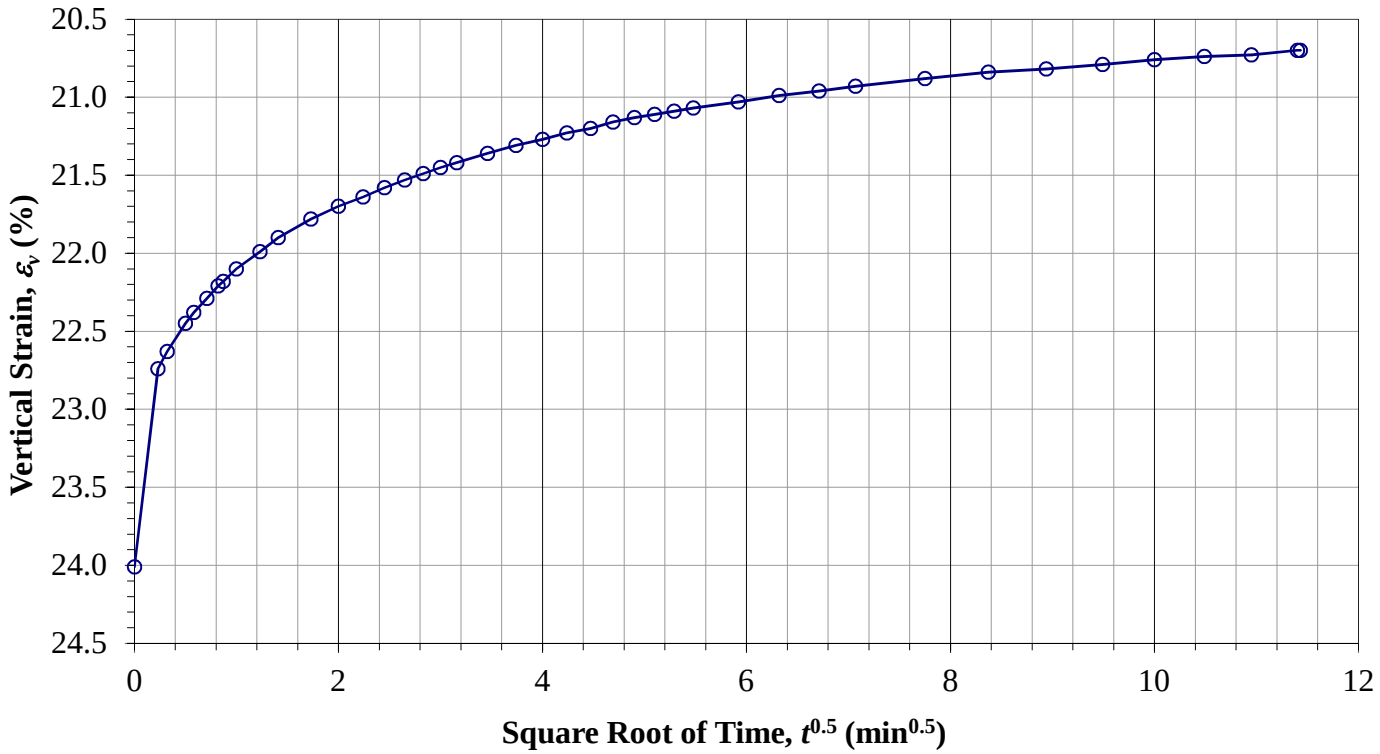
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 12 of 14
Stress: 6400 psf



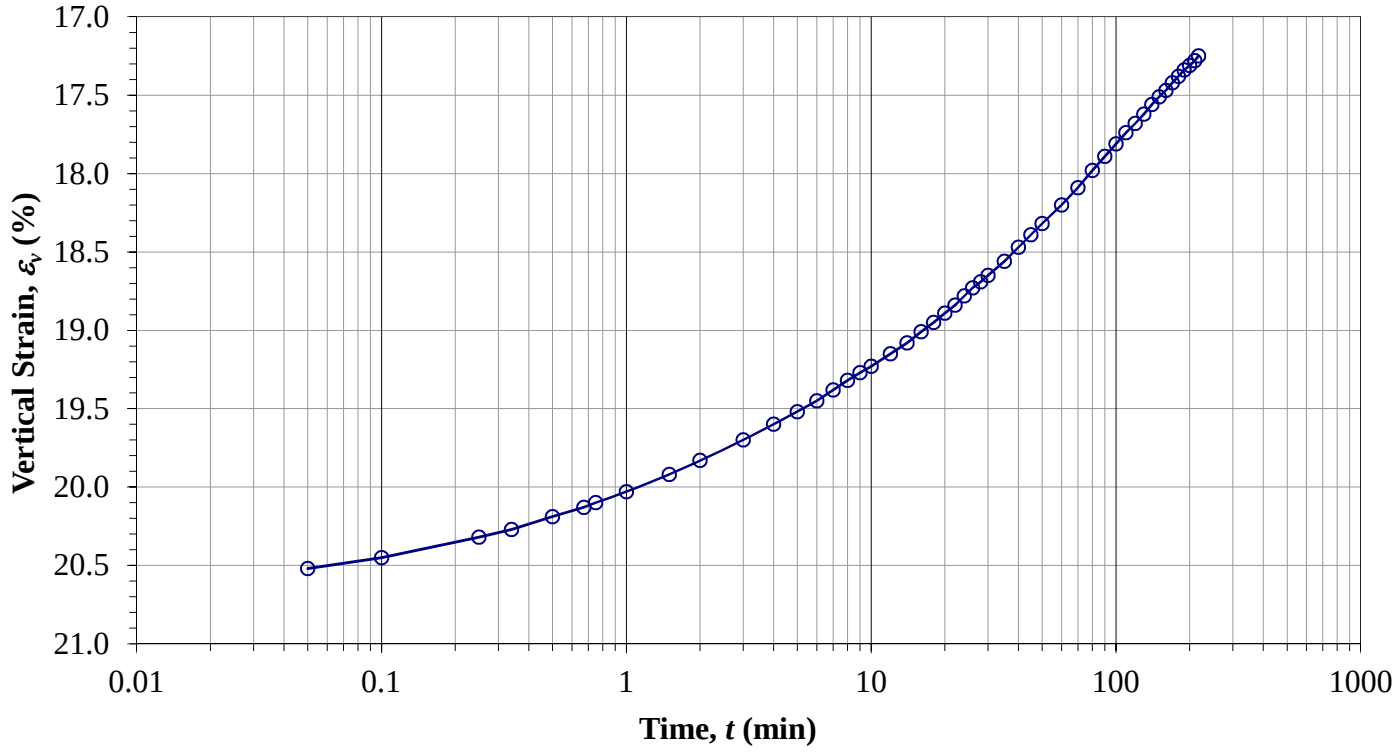


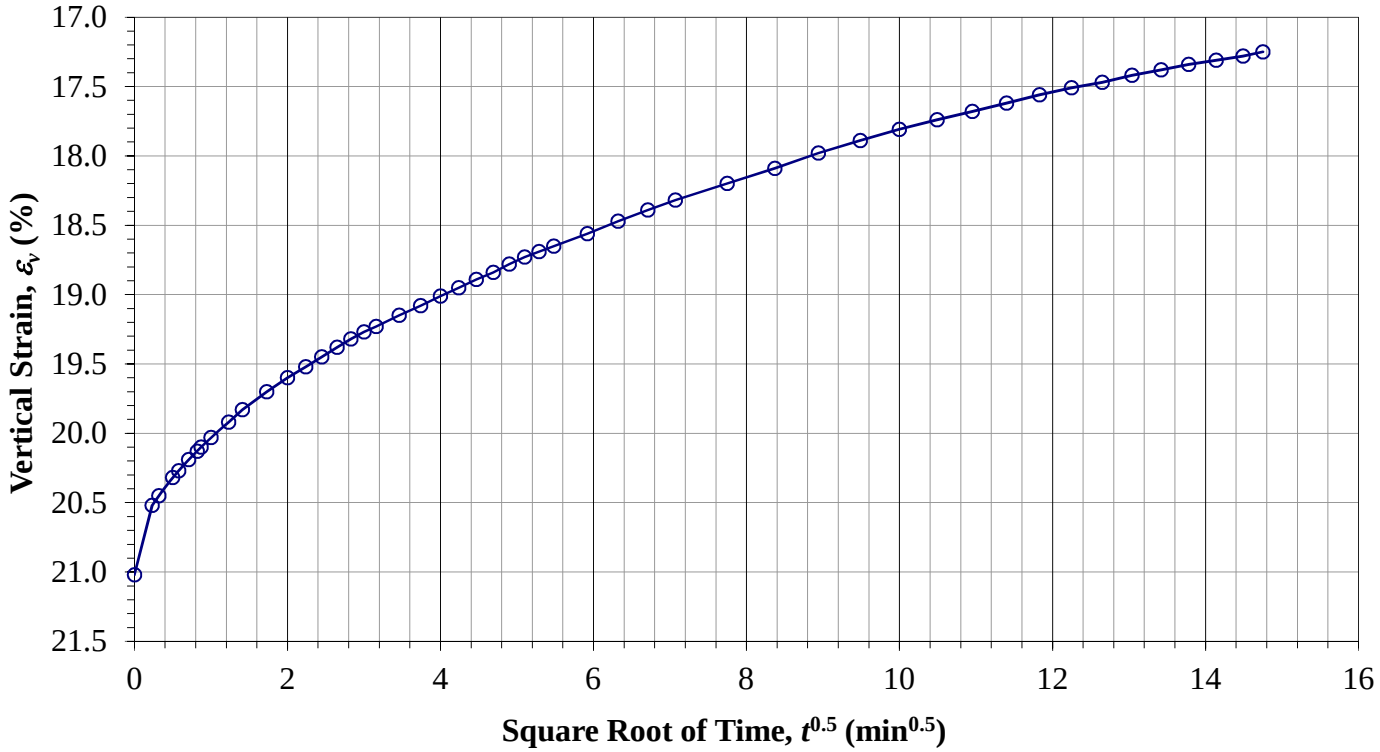
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-1
No: 00100-015, 3G2 (XIII) **Sample:** 24
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 13 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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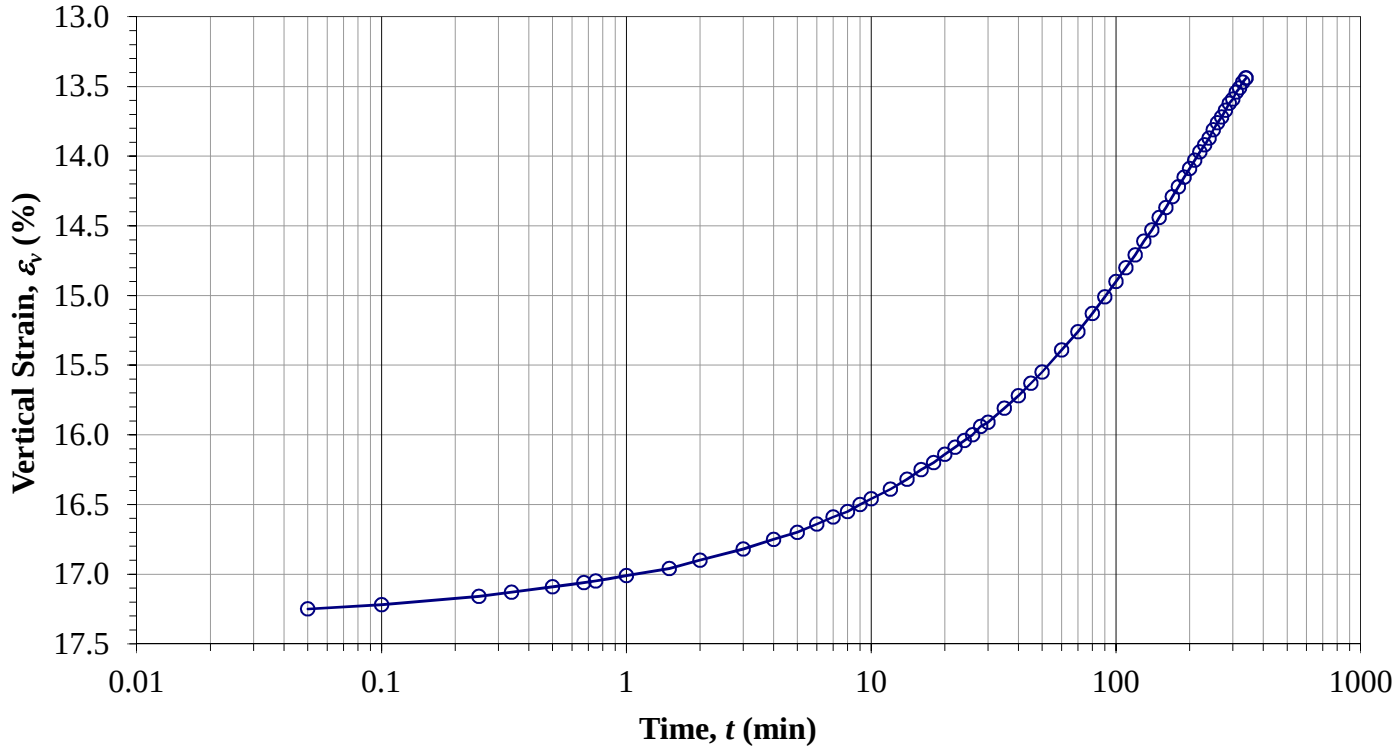
Project: AECOM **Boring No.:** BH19-ES-1

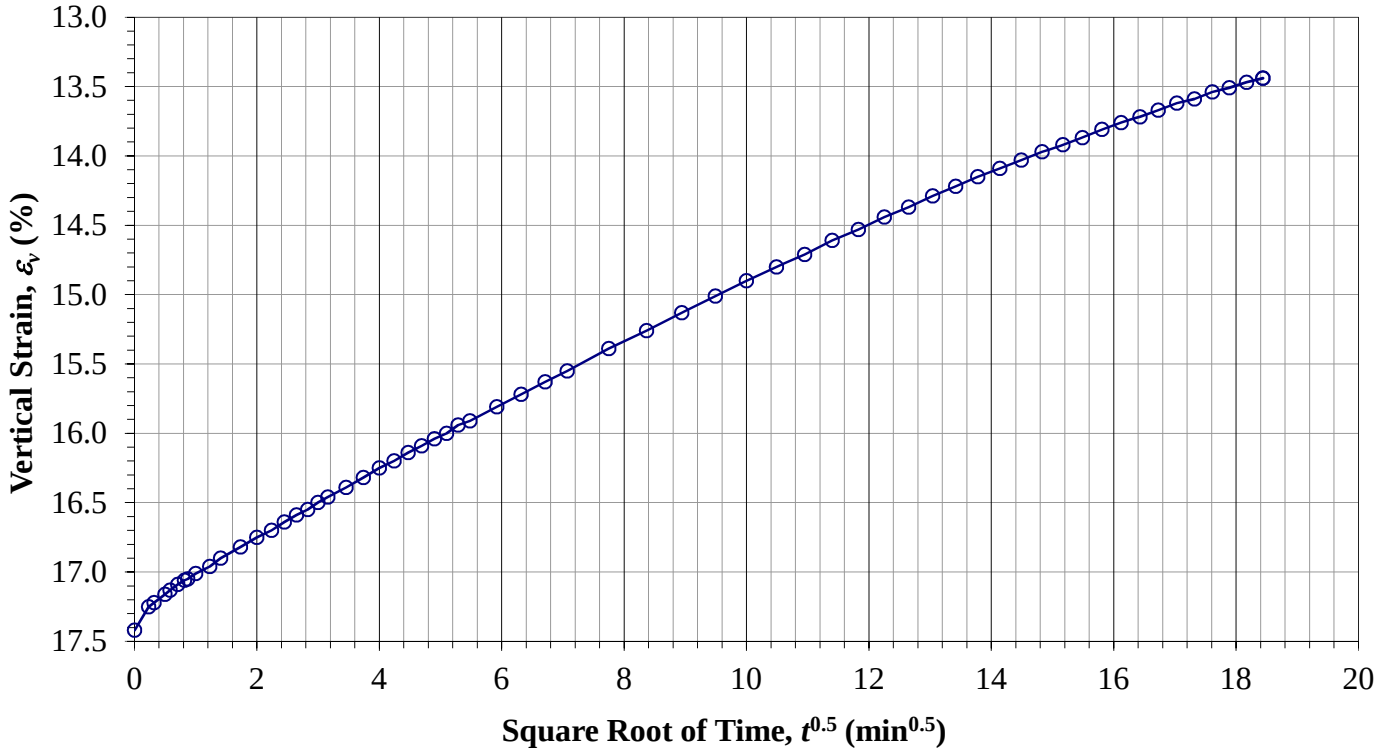
No: 00100-015, 3G2 (XIII) **Sample:** 24

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 14 of 14

Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: JDF/EH

Boring No.: BH19-ES-2
Sample: 6
Depth: 20'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

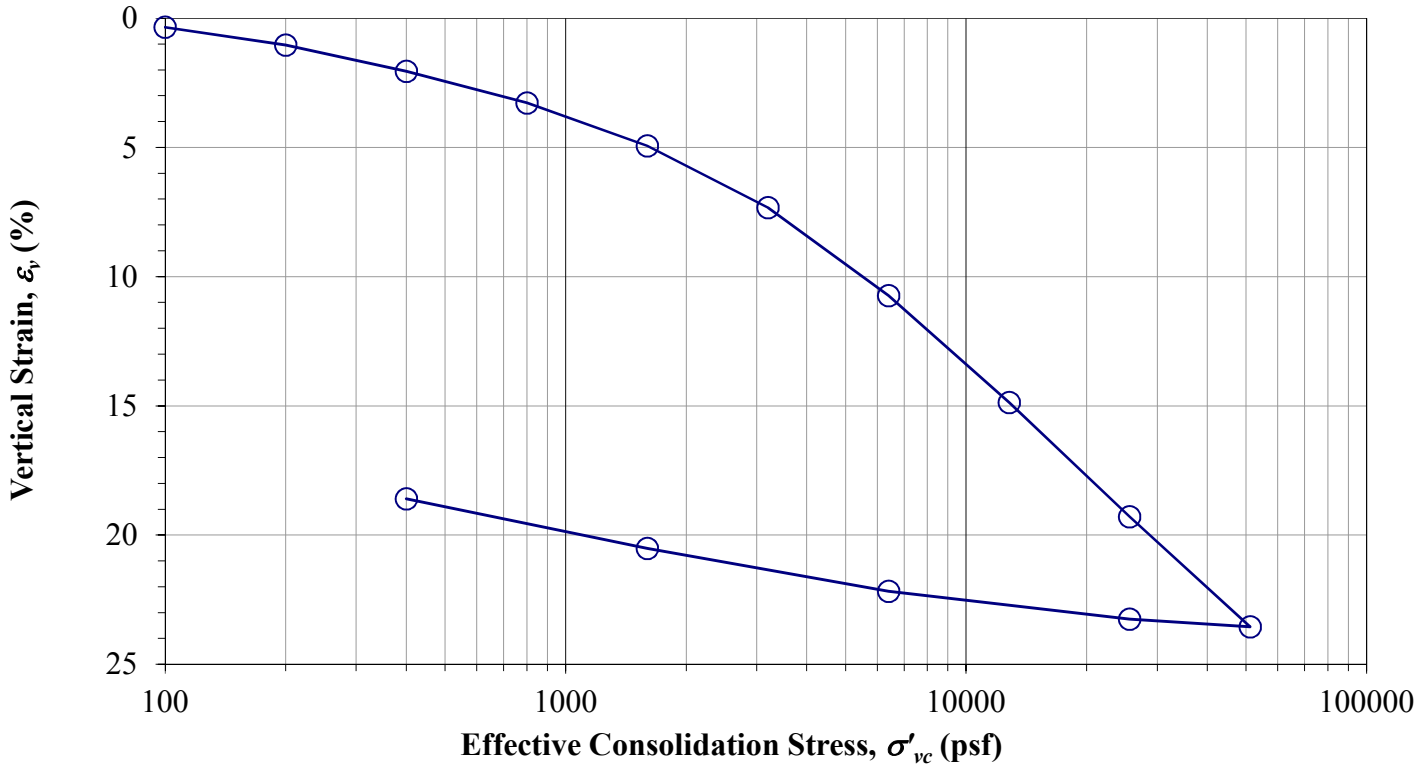
Test method:	B	
Inundation stress (psf), timing:	Seating	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation: Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.921	0.750
Sample diameter, D (in.)	2.416	2.416
Wt. rings + wet soil (g)	170.31	161.30
Wt. rings/tare (g)	44.65	44.65
Total unit wt., γ (pcf)	113.4	129.30
Wet soil + tare (g)	241.84	241.78
Dry soil + tare (g)	210.52	216.80
Tare (g)	127.59	127.24
Water content, ω (%)	37.8	27.9
Dry unit wt., γ_d (pcf)	82.3	101.1
Saturation, S	0.97	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9210	1.0481
100	0.0032	0.35	0.9178	1.0410
200	0.0096	1.04	0.9114	1.0268
400	0.0189	2.05	0.9021	1.0062
800	0.0302	3.27	0.8908	0.9811
1600	0.0455	4.94	0.8755	0.9470
3200	0.0675	7.33	0.8535	0.8980
6400	0.0988	10.73	0.8222	0.8283
12800	0.1369	14.86	0.7841	0.7437
25600	0.1777	19.29	0.7433	0.6530
51200	0.2169	23.55	0.7041	0.5658
25600	0.2142	23.26	0.7068	0.5718
6400	0.2042	22.17	0.7168	0.5940
1600	0.1890	20.52	0.7320	0.6278
400	0.1713	18.60	0.7497	0.6672



Entered: _____
Reviewed: _____

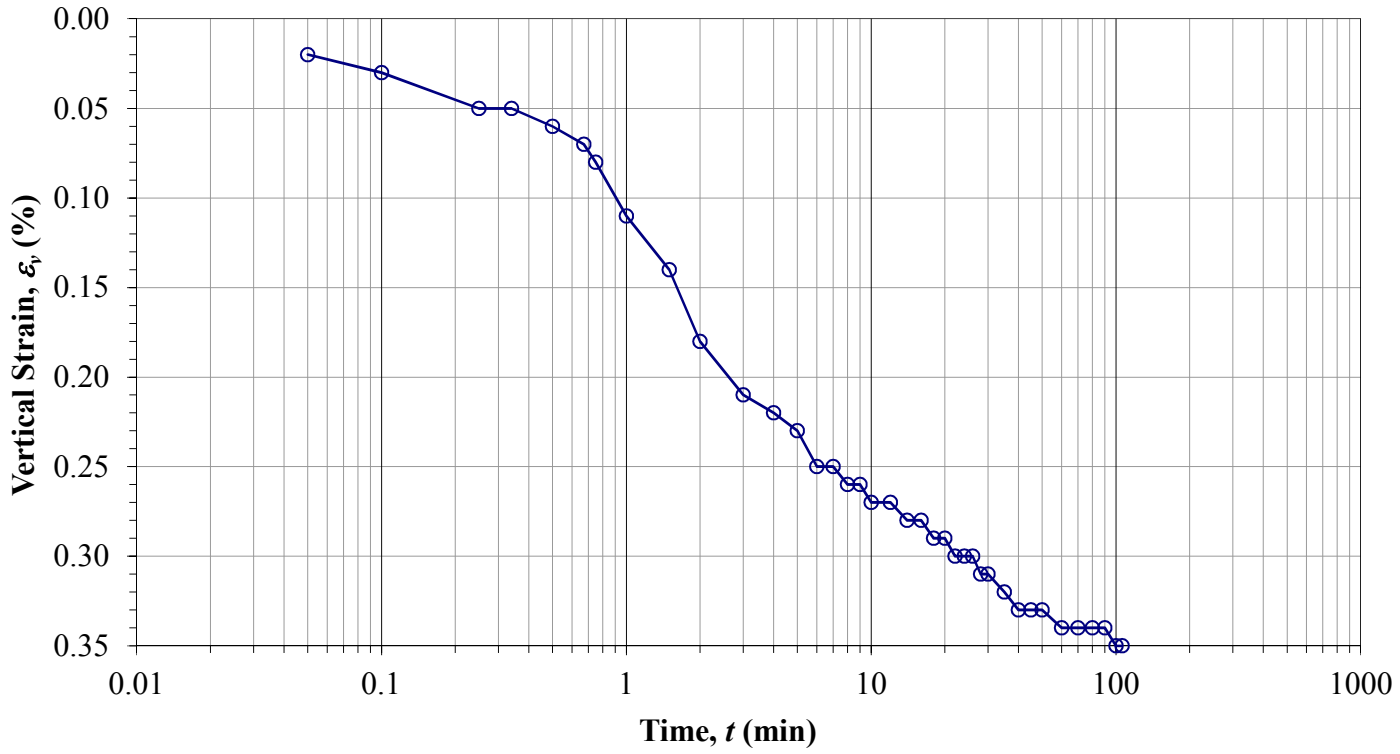
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

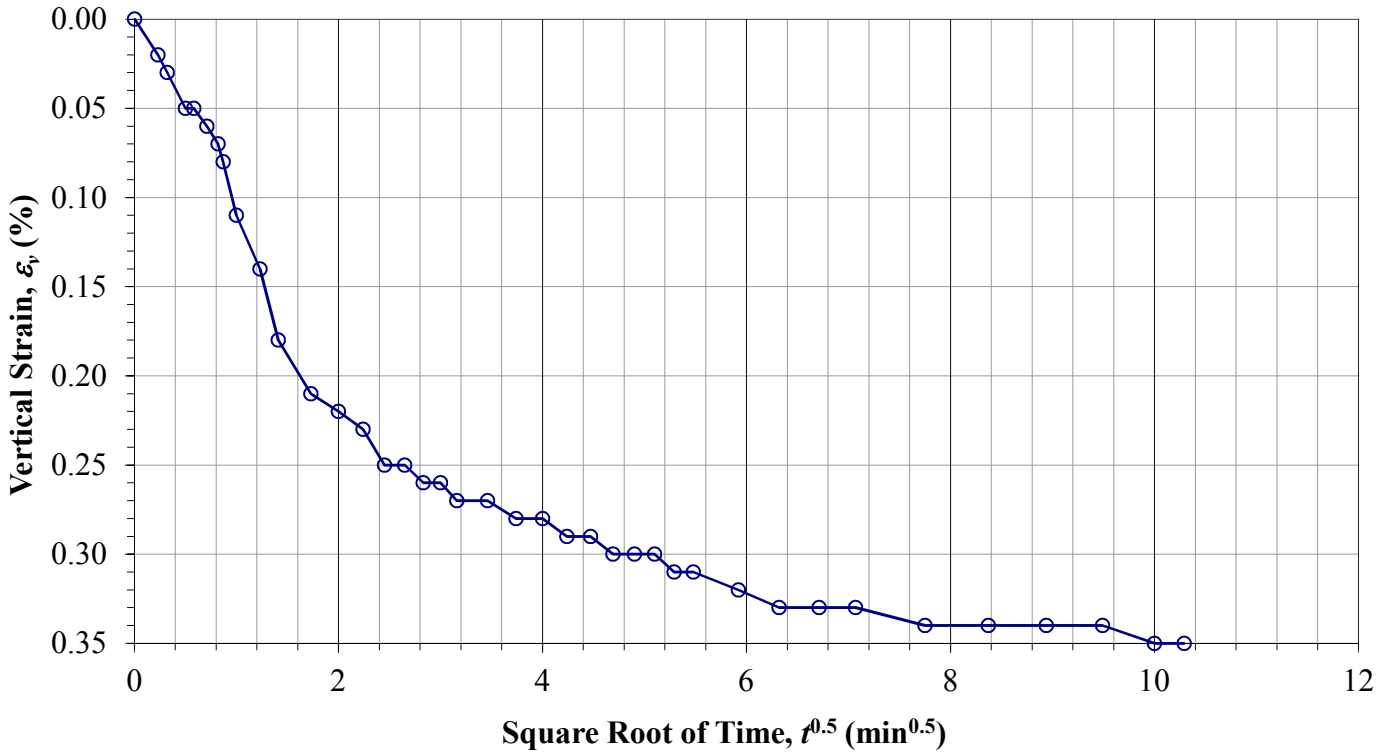
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 6
Depth: 20'

Constant Load Step: 1 of 14
Stress: 100 psf





One-Dimensional Consolidation Properties of Soils

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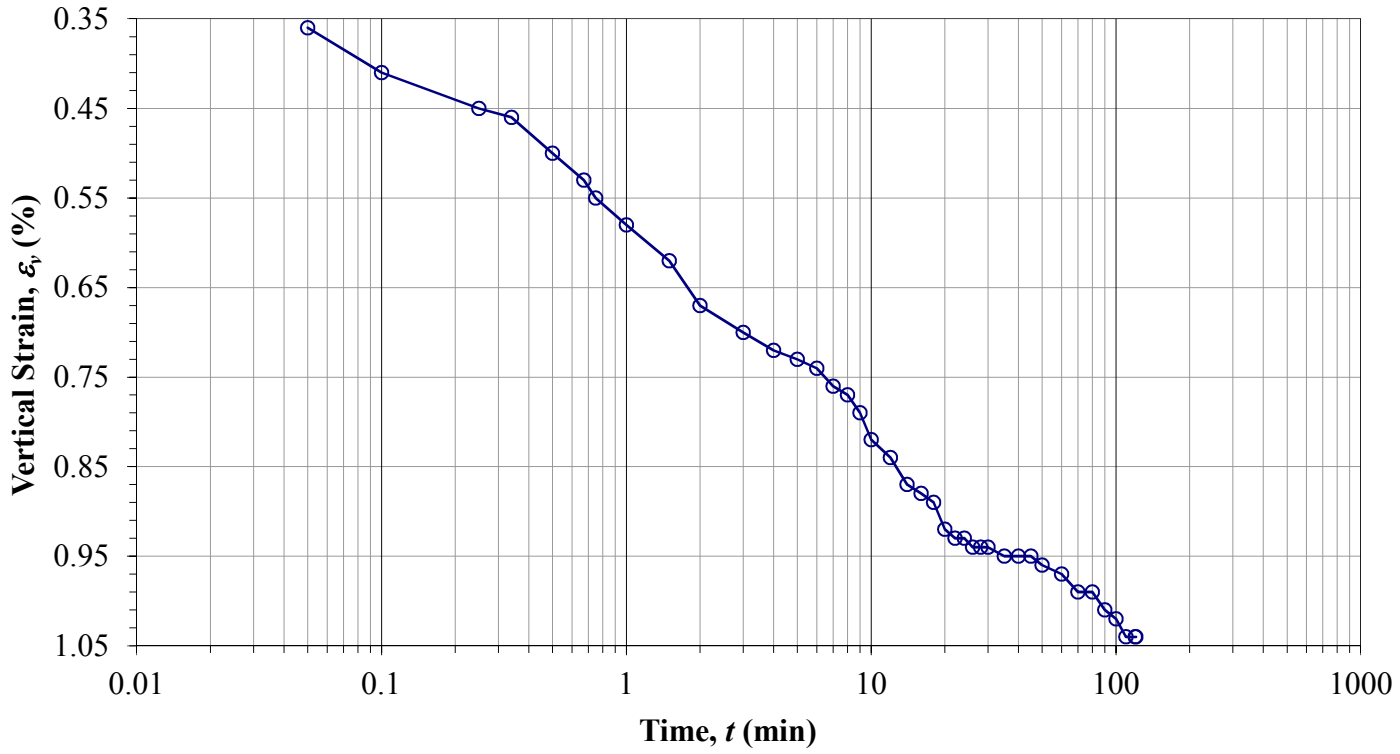
Project: AECOM **Boring No.:** BH19-ES-2

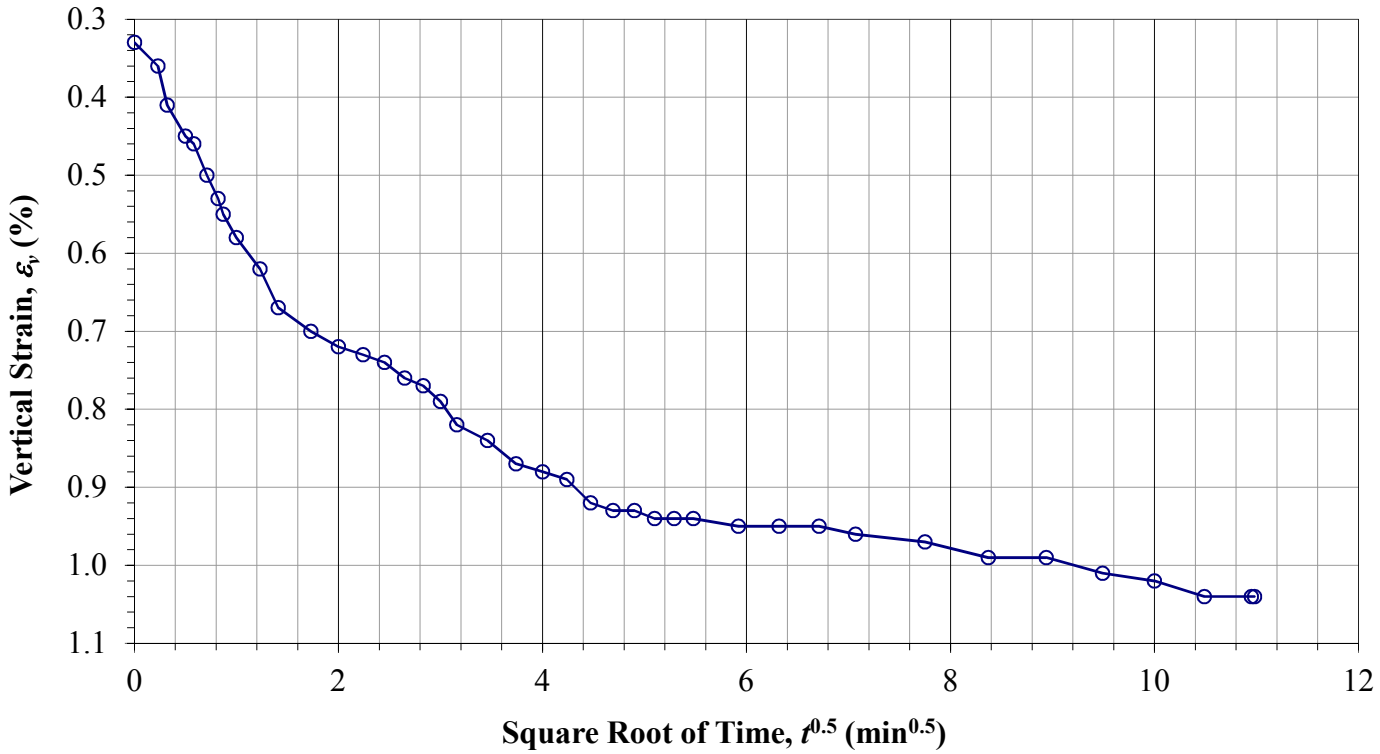
No: 00100-015, 3G2 (XIII) **Sample:** 6

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 20'

Constant Load Step: 2 of 14

Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

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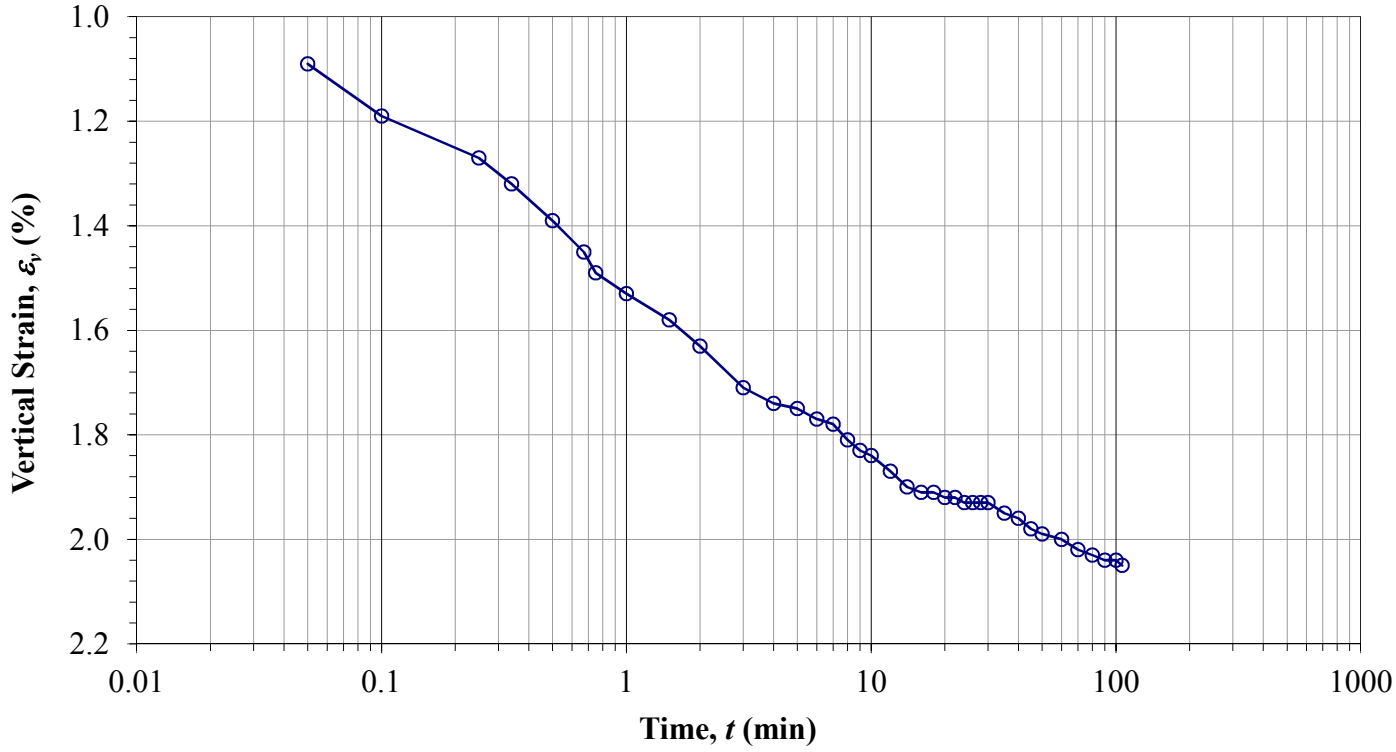
Project: AECOM **Boring No.:** BH19-ES-2

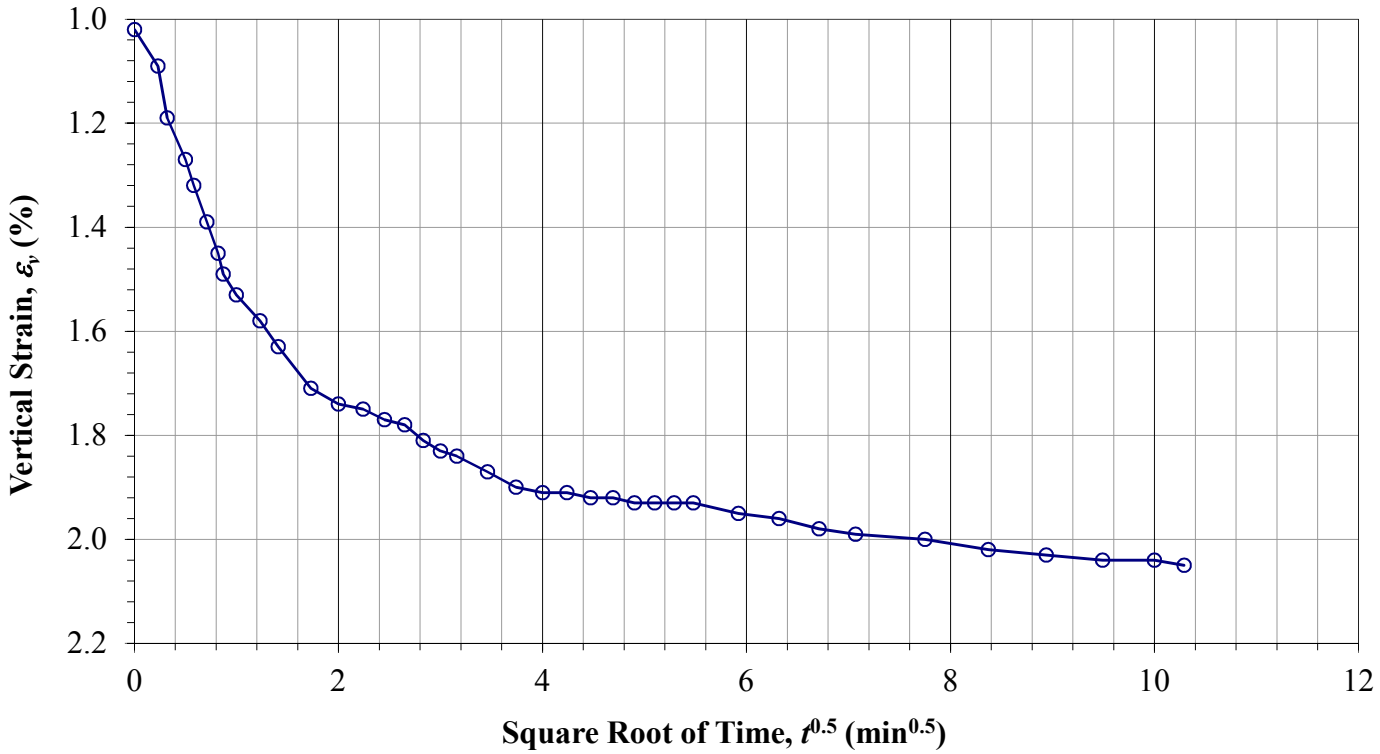
No: 00100-015, 3G2 (XIII) **Sample:** 6

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 20'

Constant Load Step: 3 of 14

Stress: 400 psf



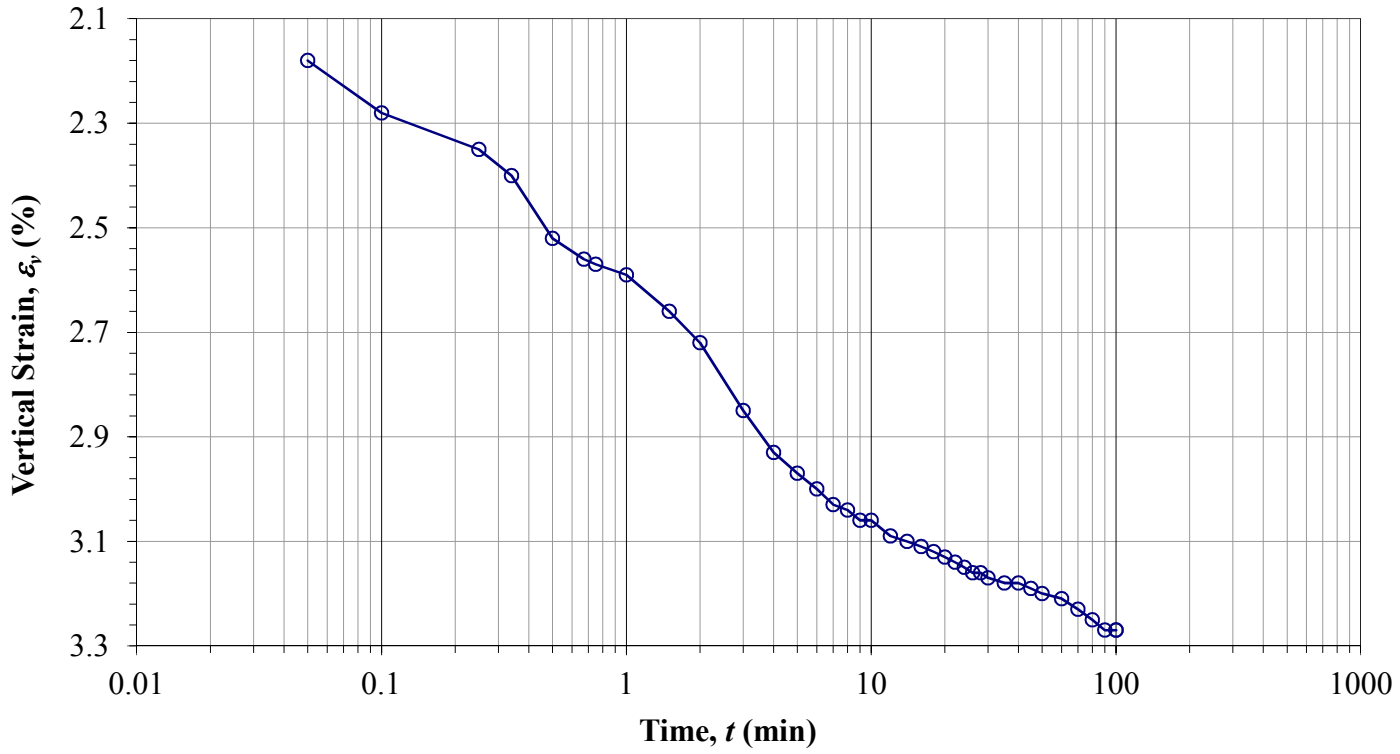


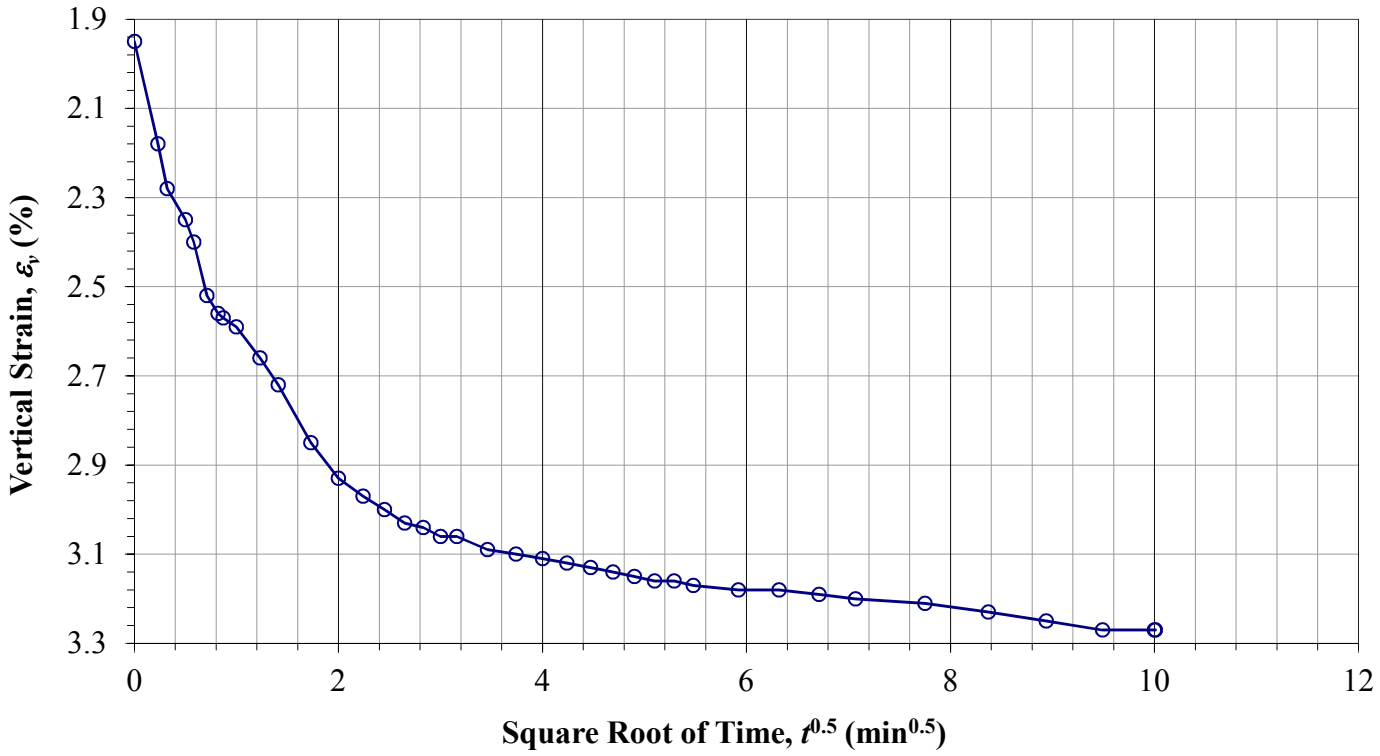
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 6
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 20'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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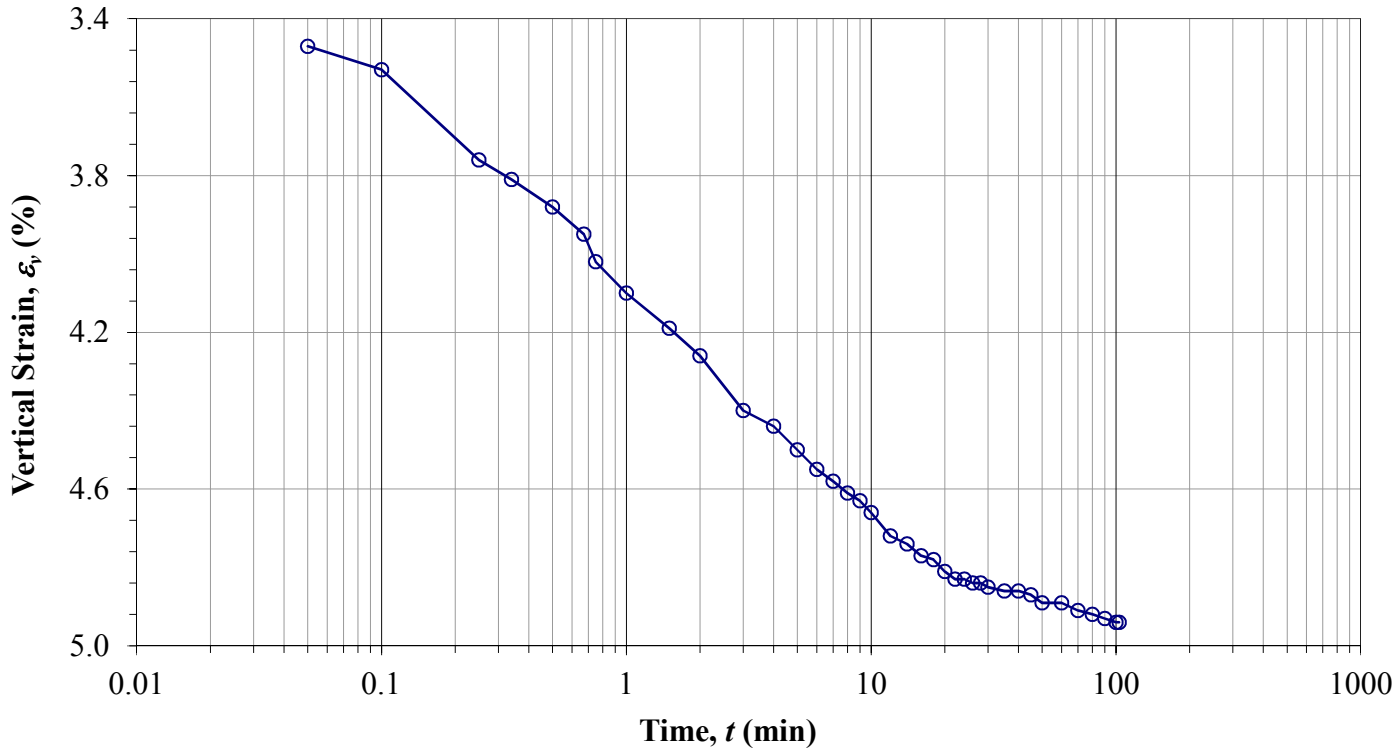
Project: AECOM **Boring No.:** BH19-ES-2

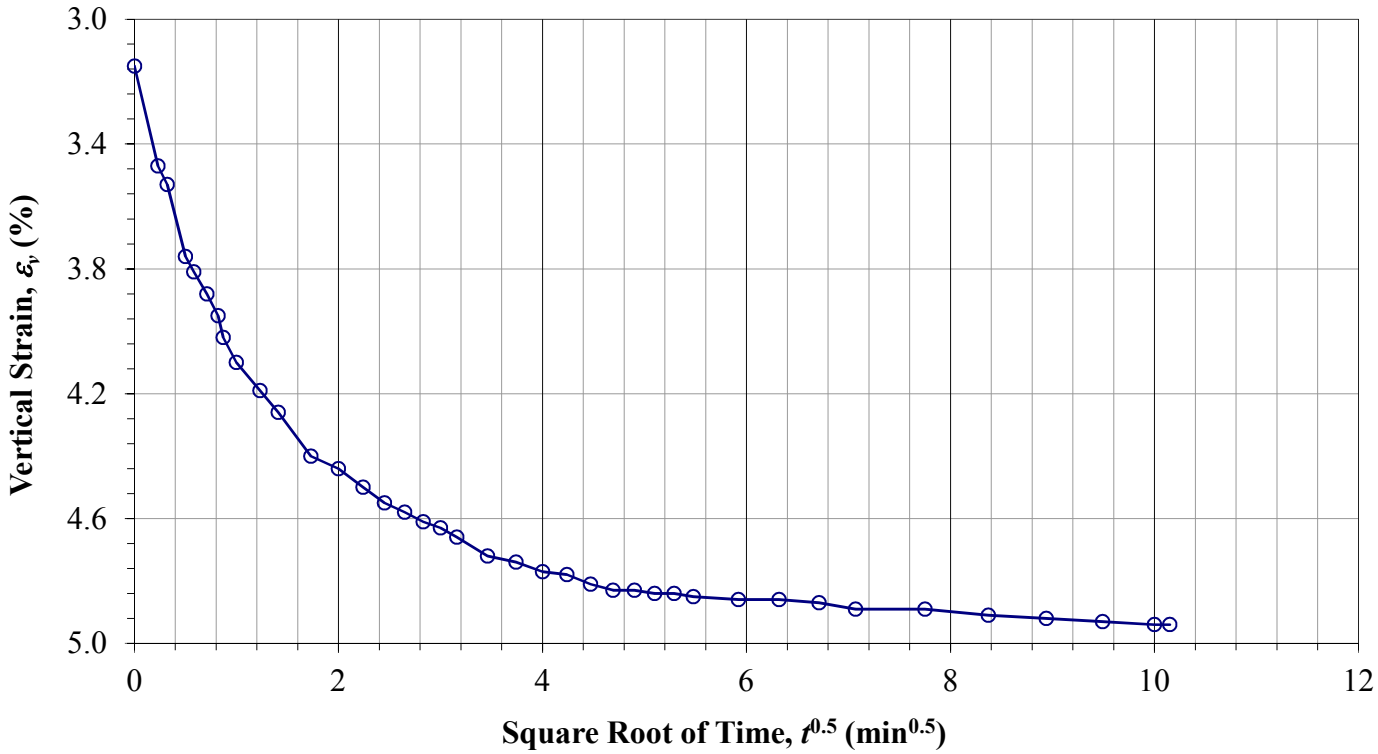
No: 00100-015, 3G2 (XIII) **Sample:** 6

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 20'

Constant Load Step: 5 of 14

Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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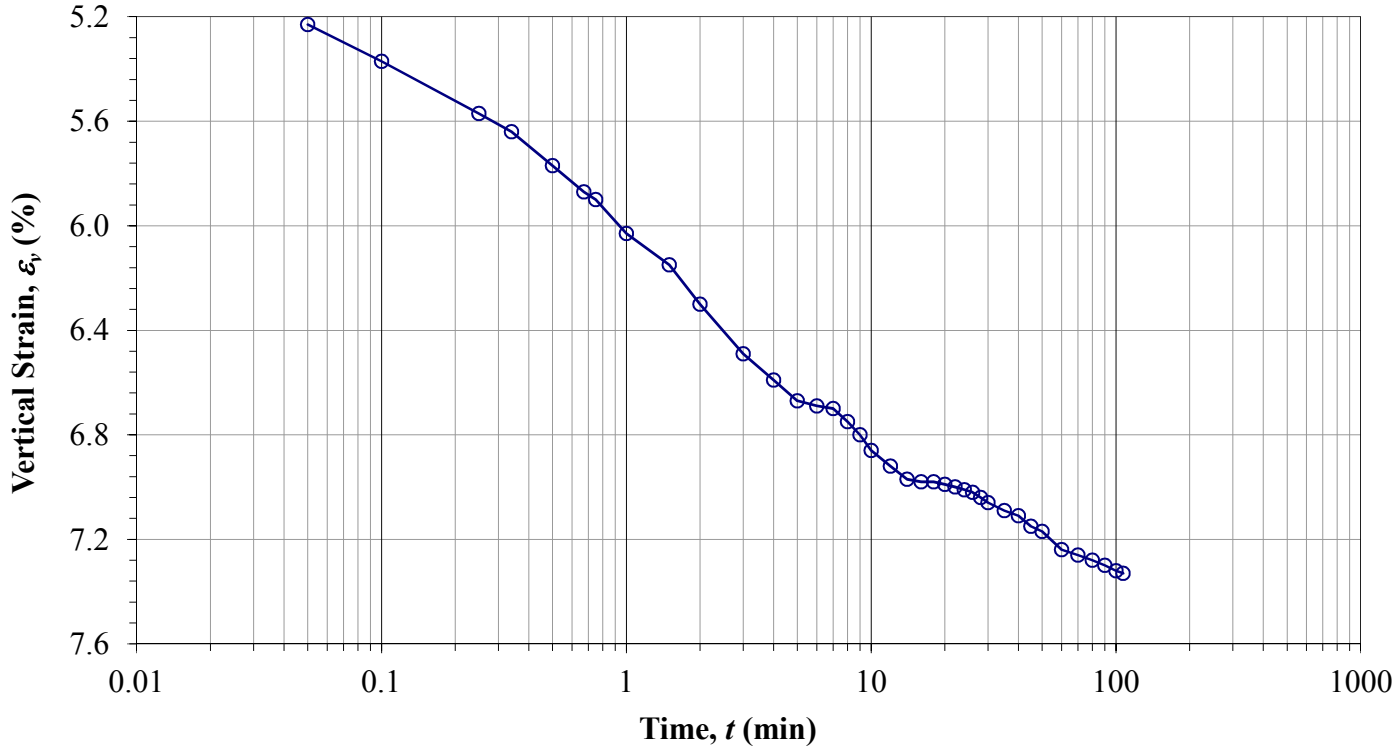
Project: AECOM **Boring No.:** BH19-ES-2

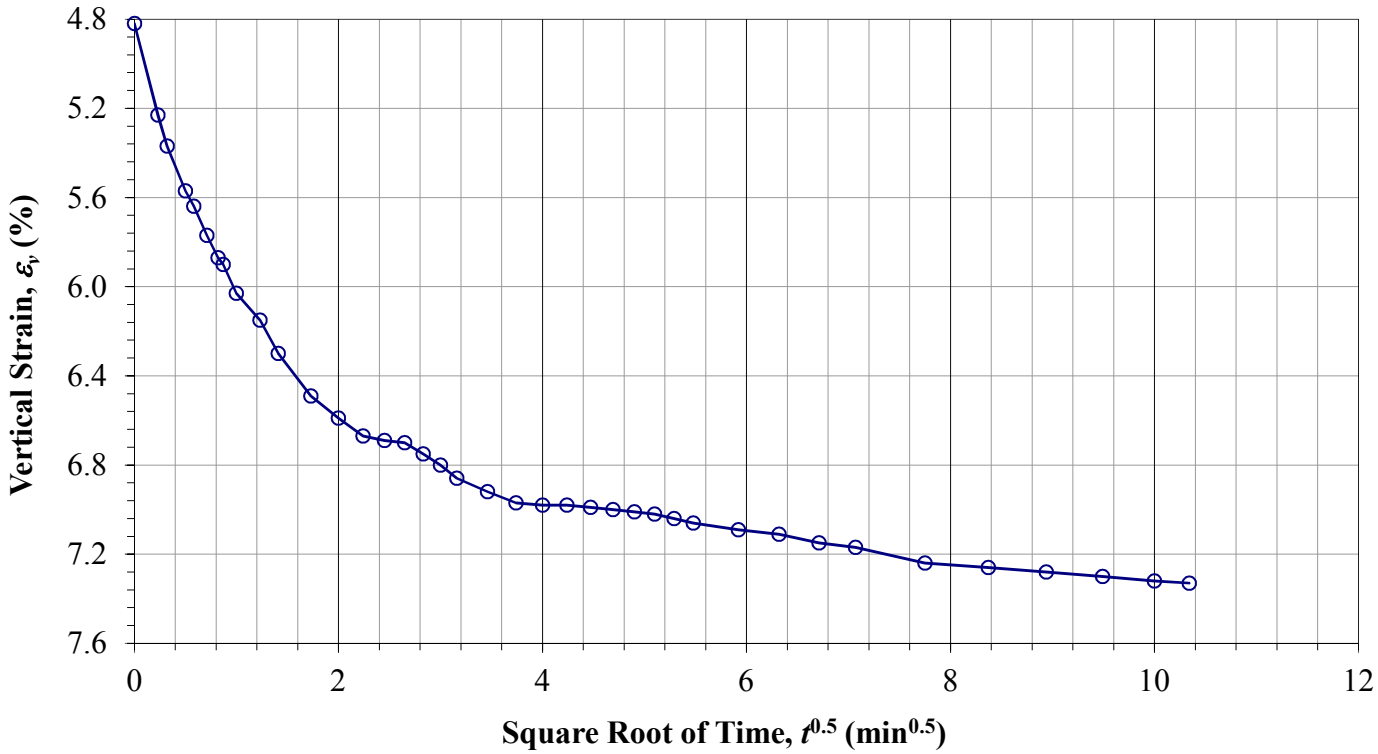
No: 00100-015, 3G2 (XIII) **Sample:** 6

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 20'

Constant Load Step: 6 of 14

Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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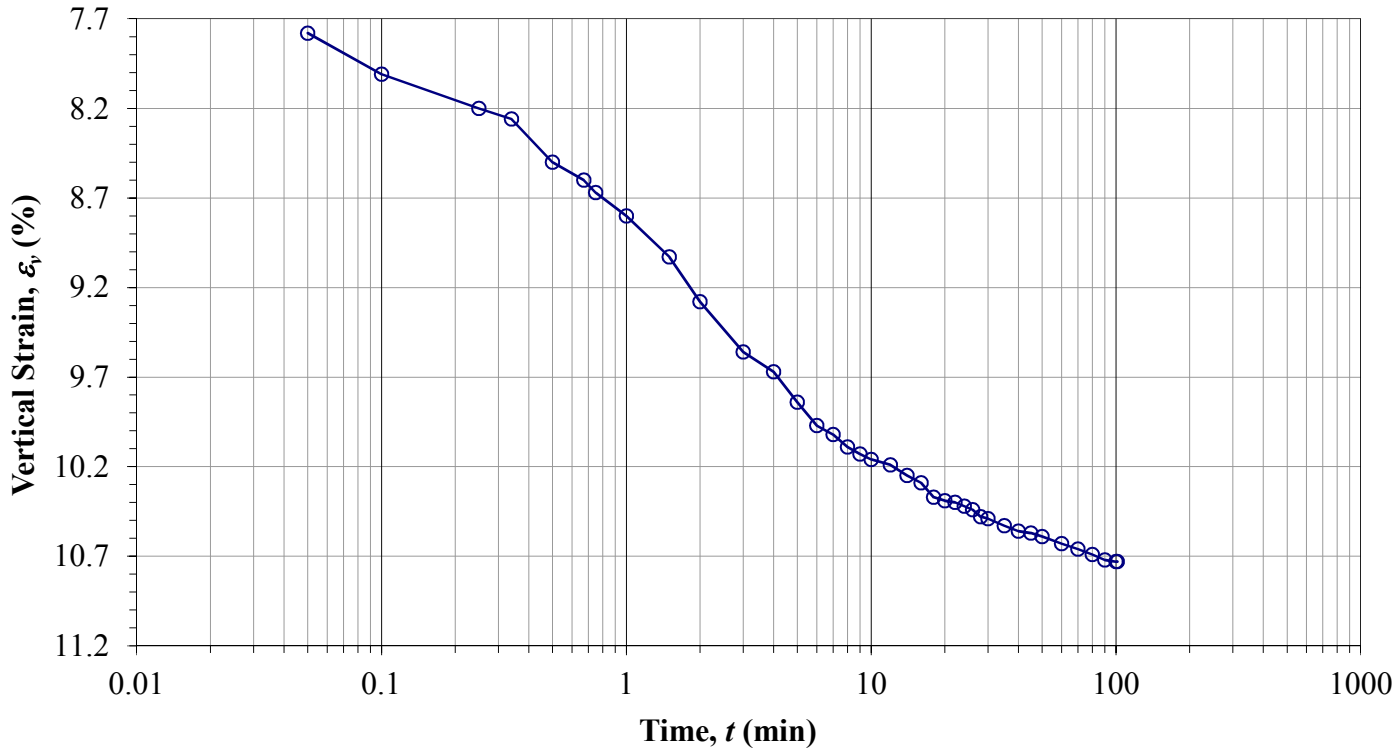
Project: AECOM **Boring No.:** BH19-ES-2

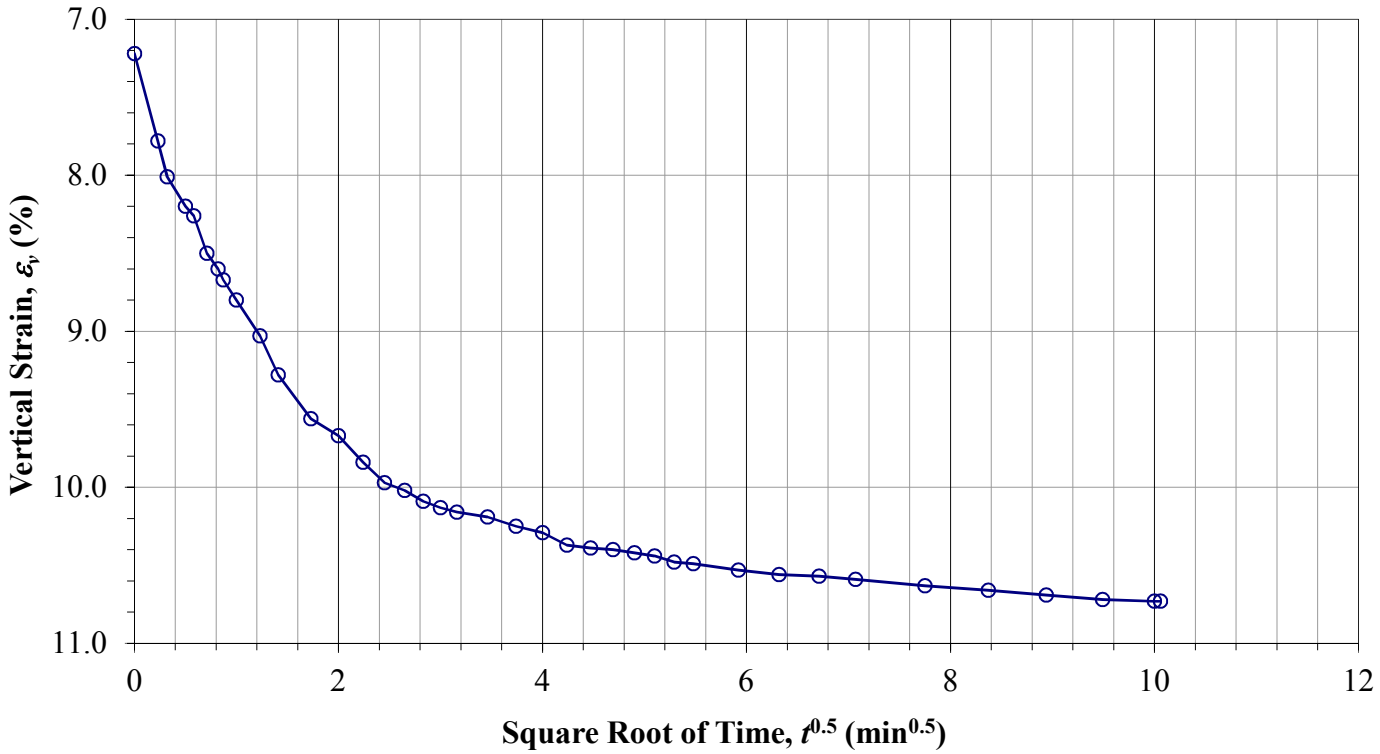
No: 00100-015, 3G2 (XIII) **Sample:** 6

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 20'

Constant Load Step: 7 of 14

Stress: 6400 psf



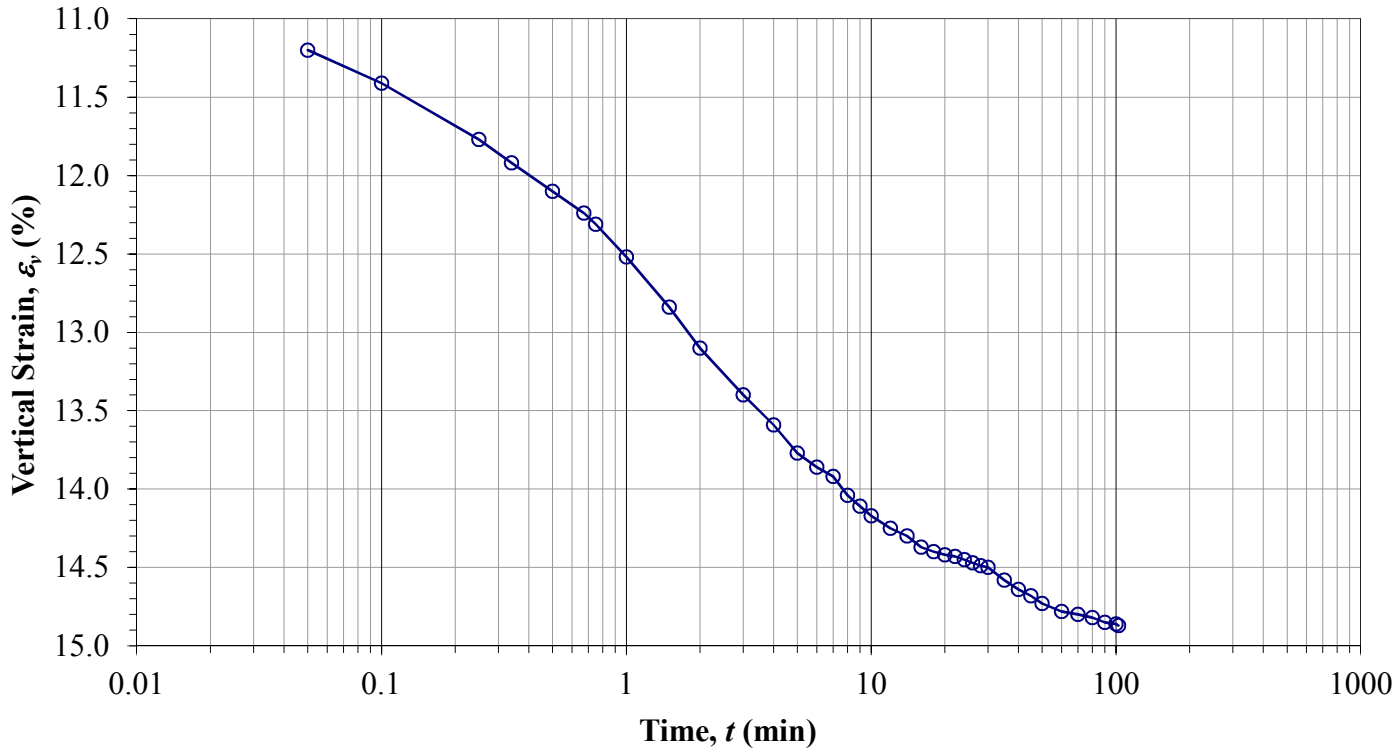


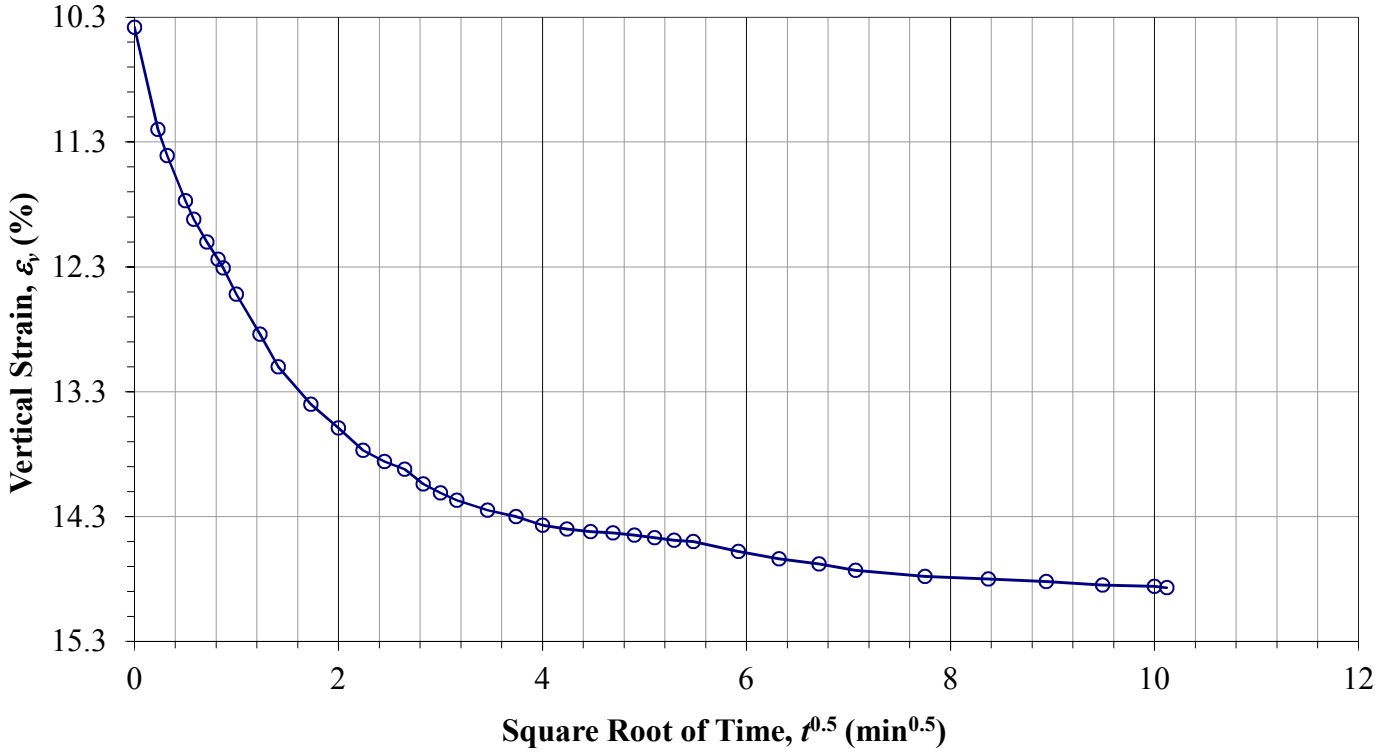
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 6
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 20'

Constant Load Step: 8 of 14
Stress: 12800 psf





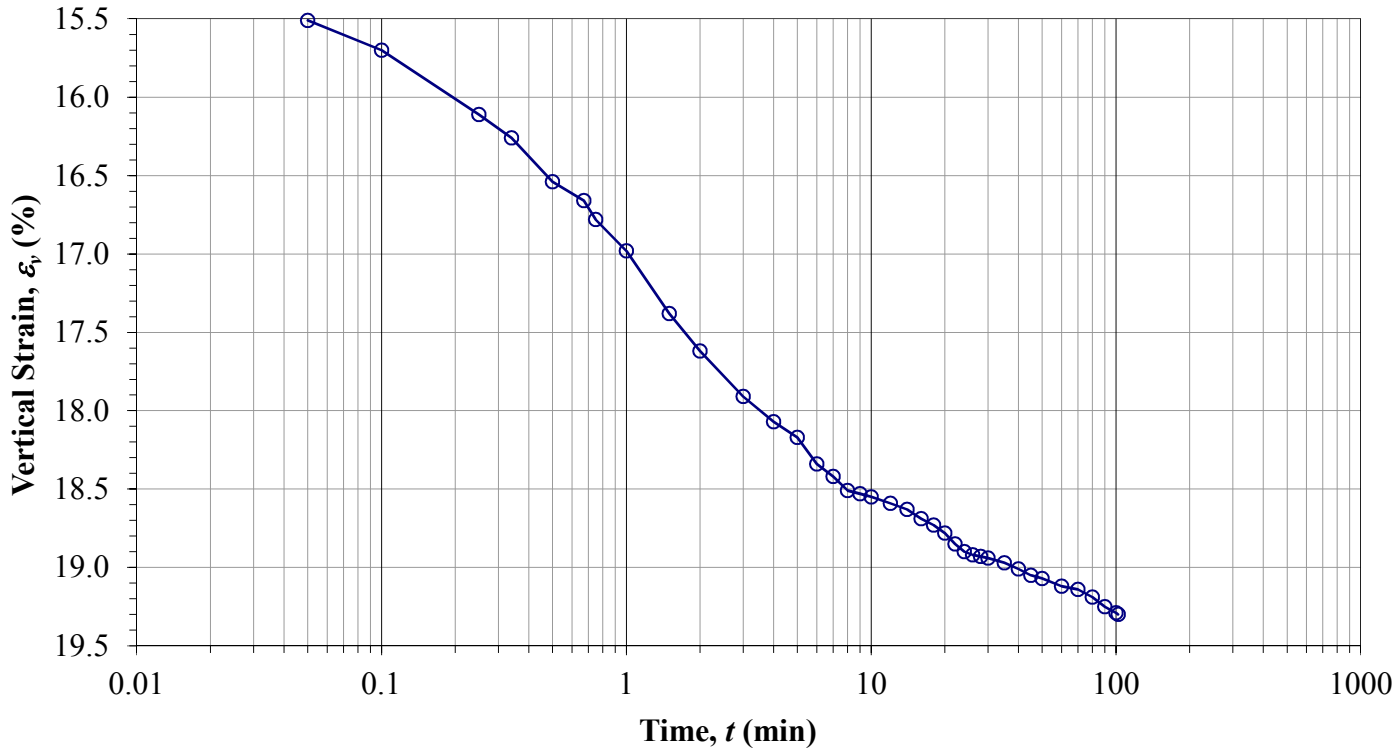
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

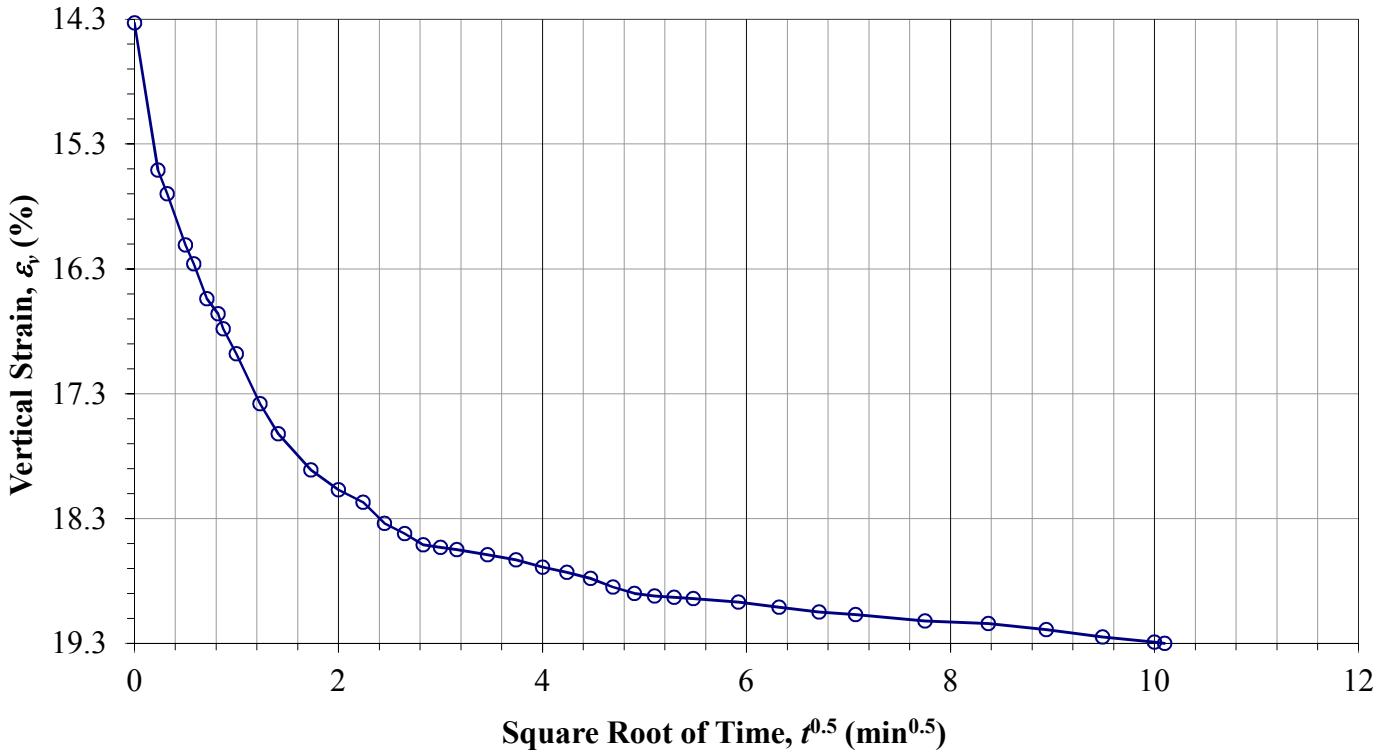
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 6
Depth: 20'

Constant Load Step: 9 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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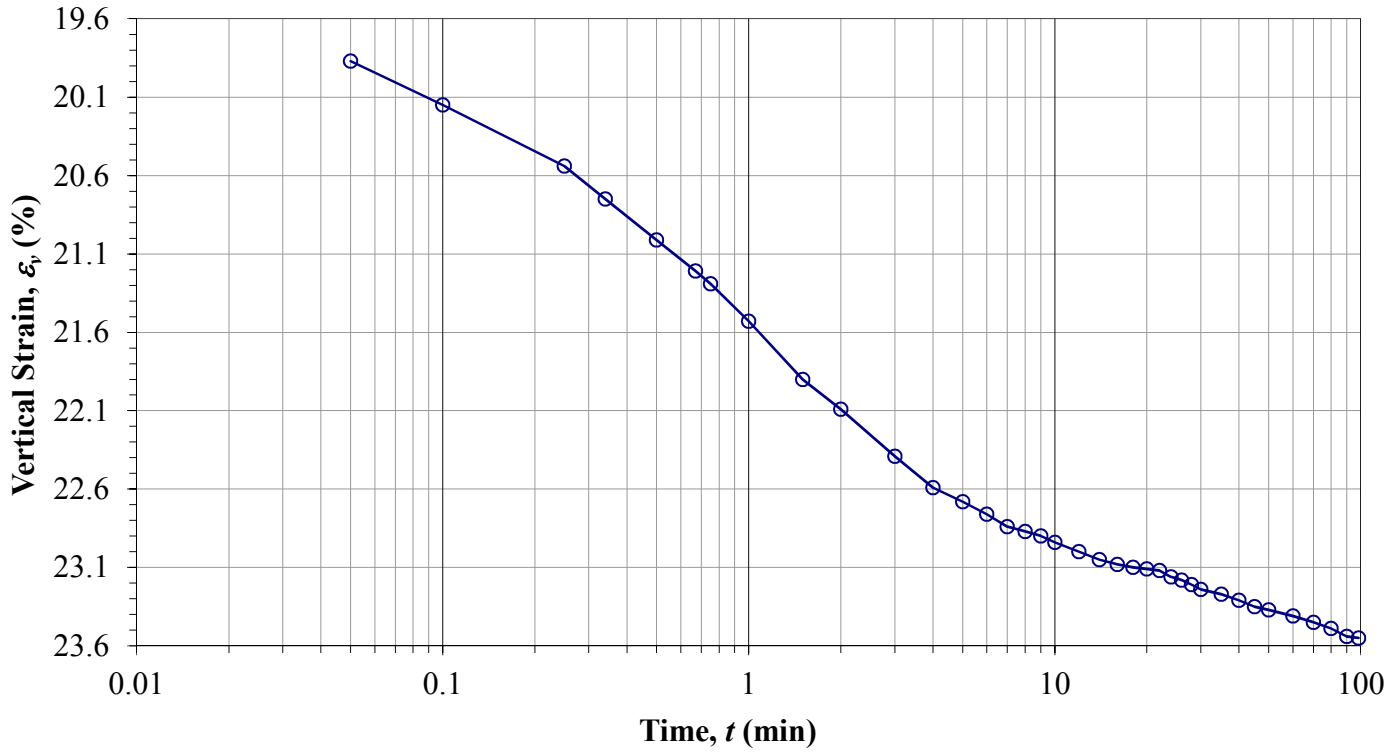
Project: AECOM **Boring No.:** BH19-ES-2

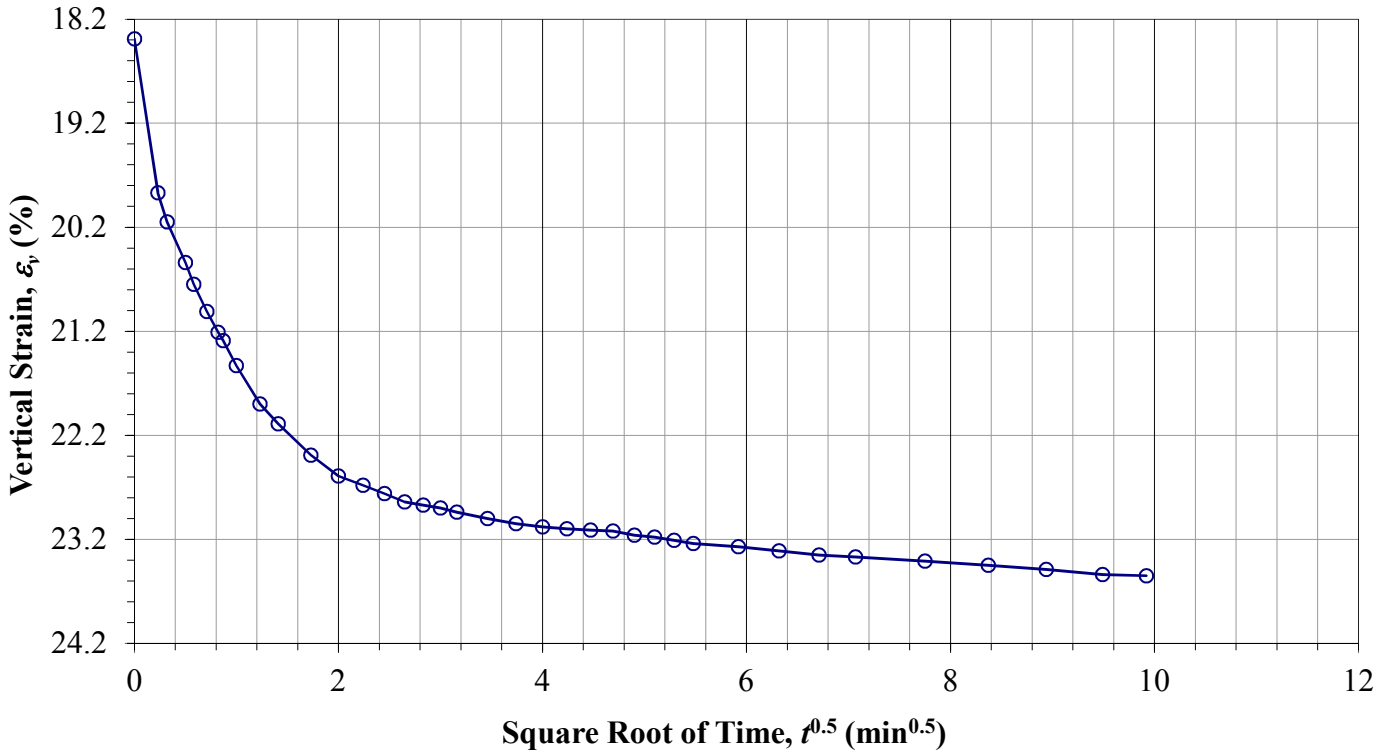
No: 00100-015, 3G2 (XIII) **Sample:** 6

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 20'

Constant Load Step: 10 of 14

Stress: 51200 psf





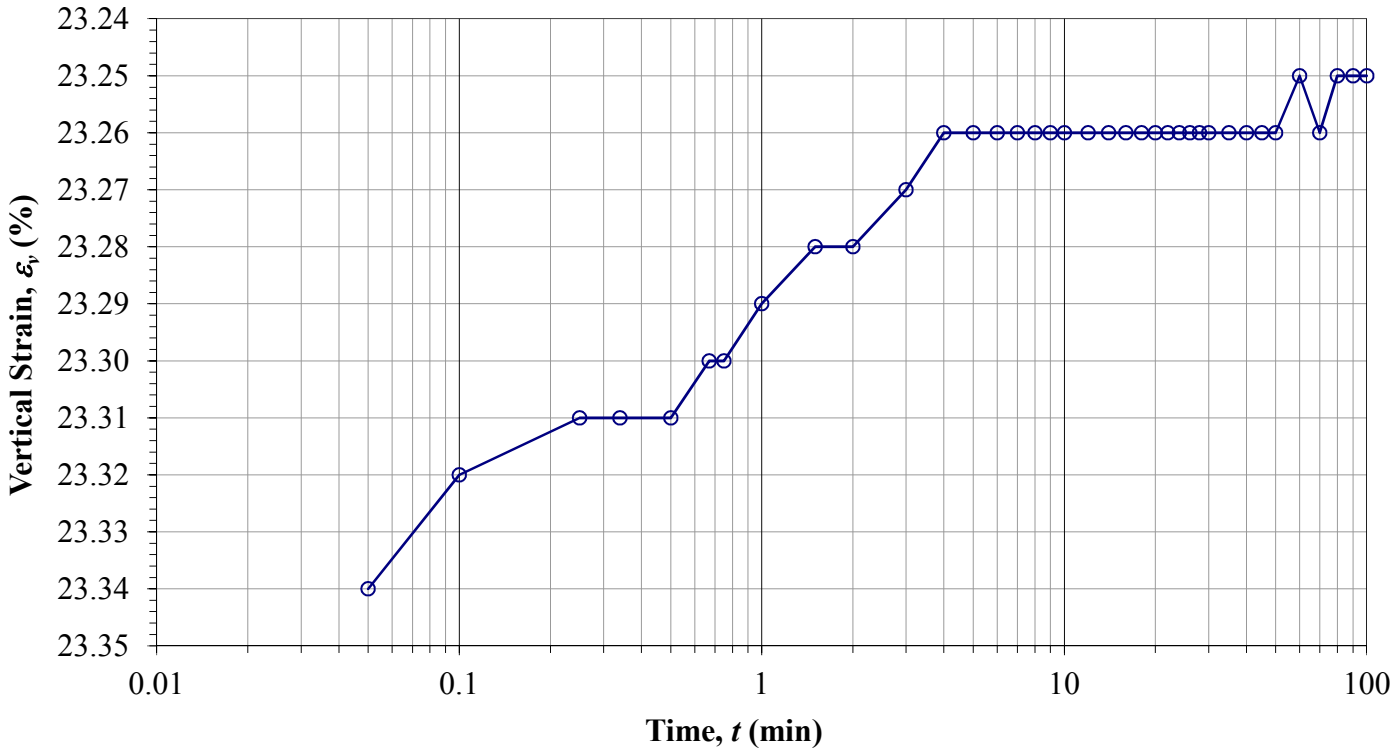
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

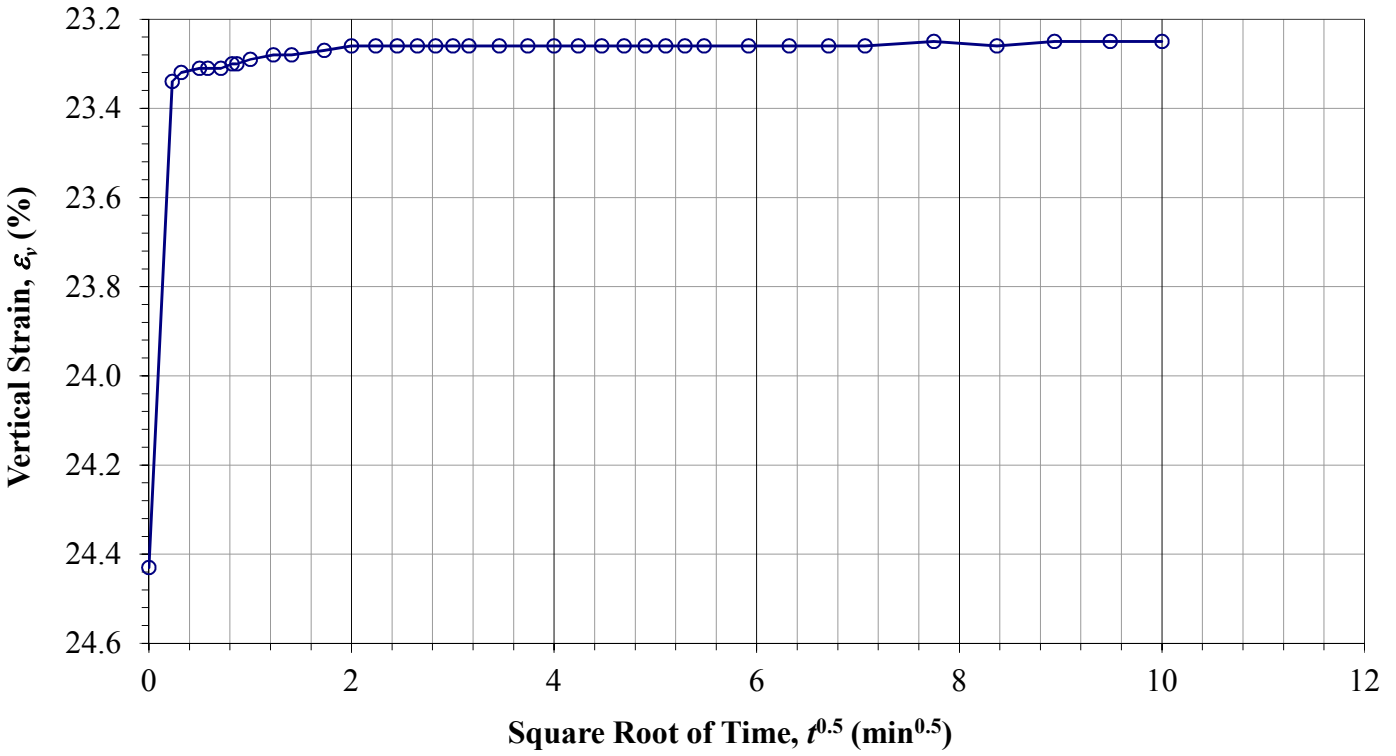
© IGES 2011, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 6
Depth: 20'

Constant Load Step: 11 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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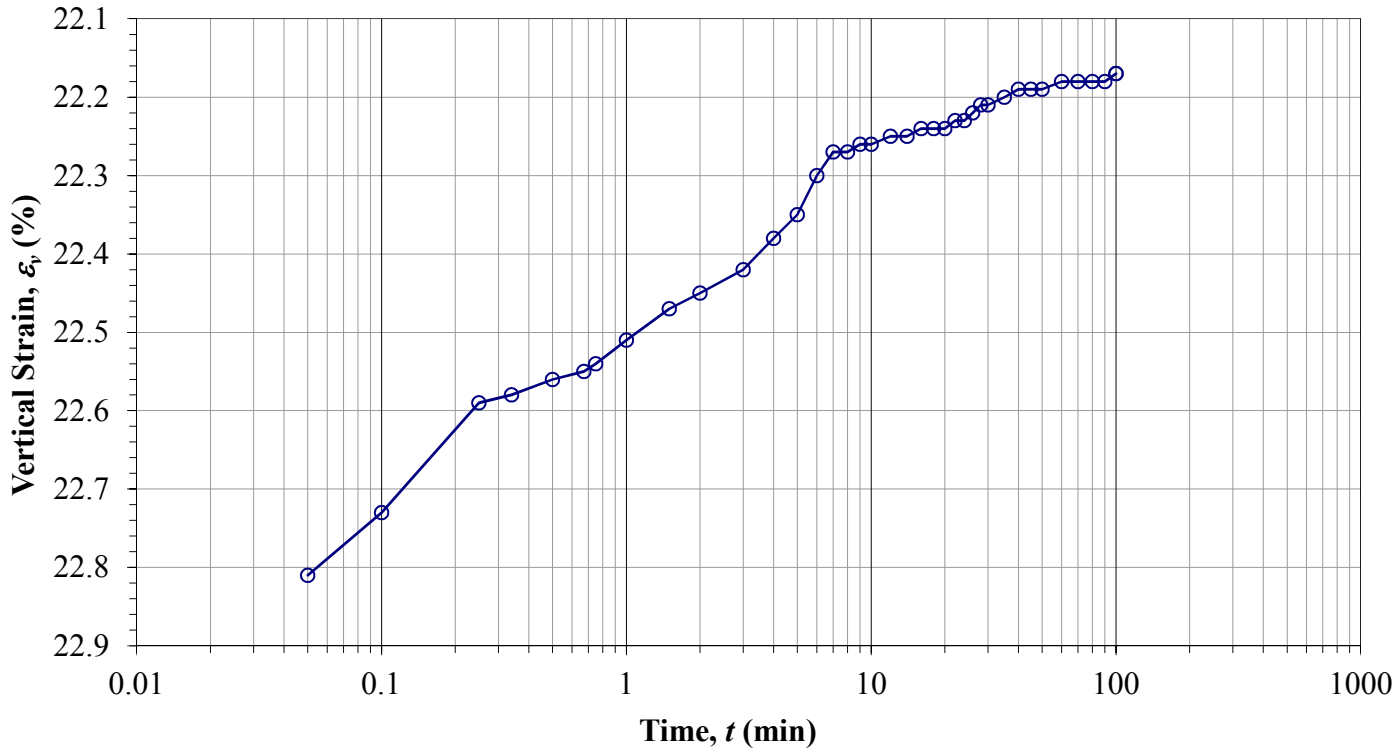
Project: AECOM **Boring No.:** BH19-ES-2

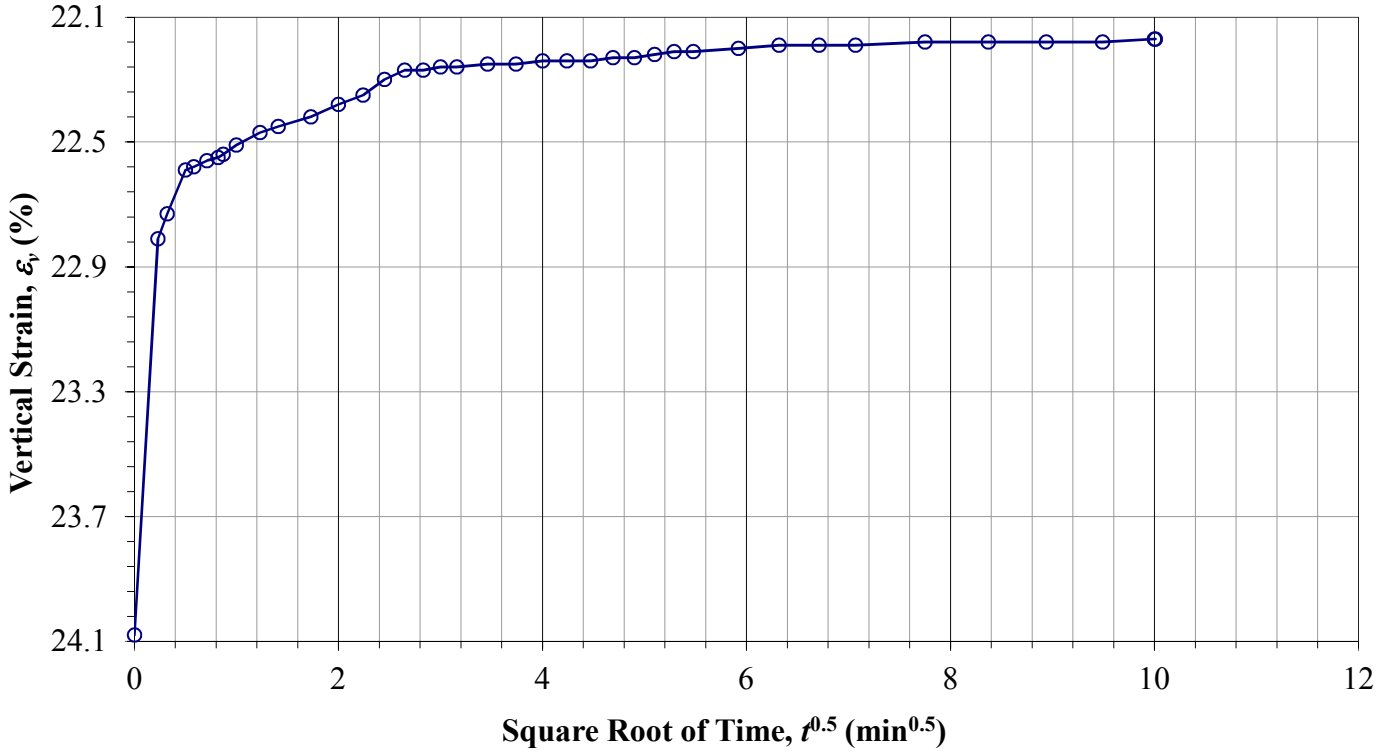
No: 00100-015, 3G2 (XIII) **Sample:** 6

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 20'

Constant Load Step: 12 of 14

Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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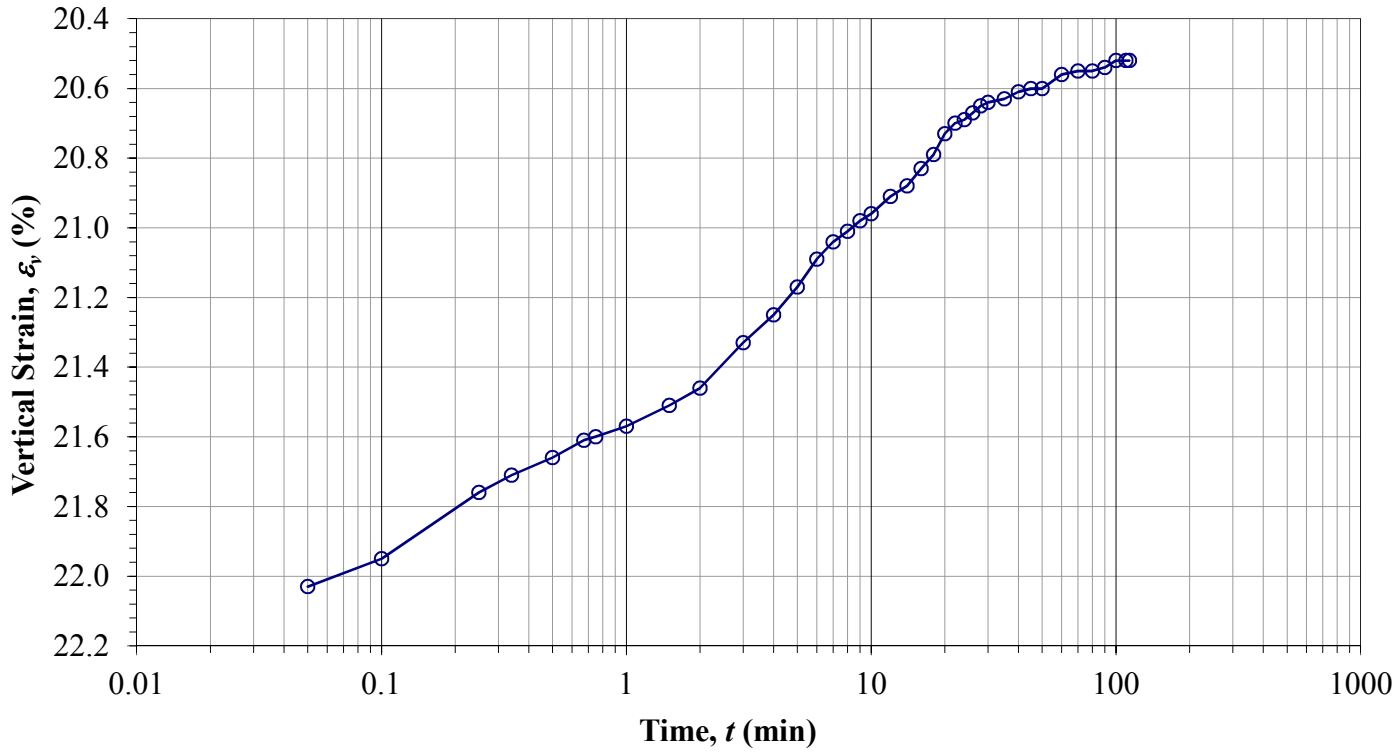
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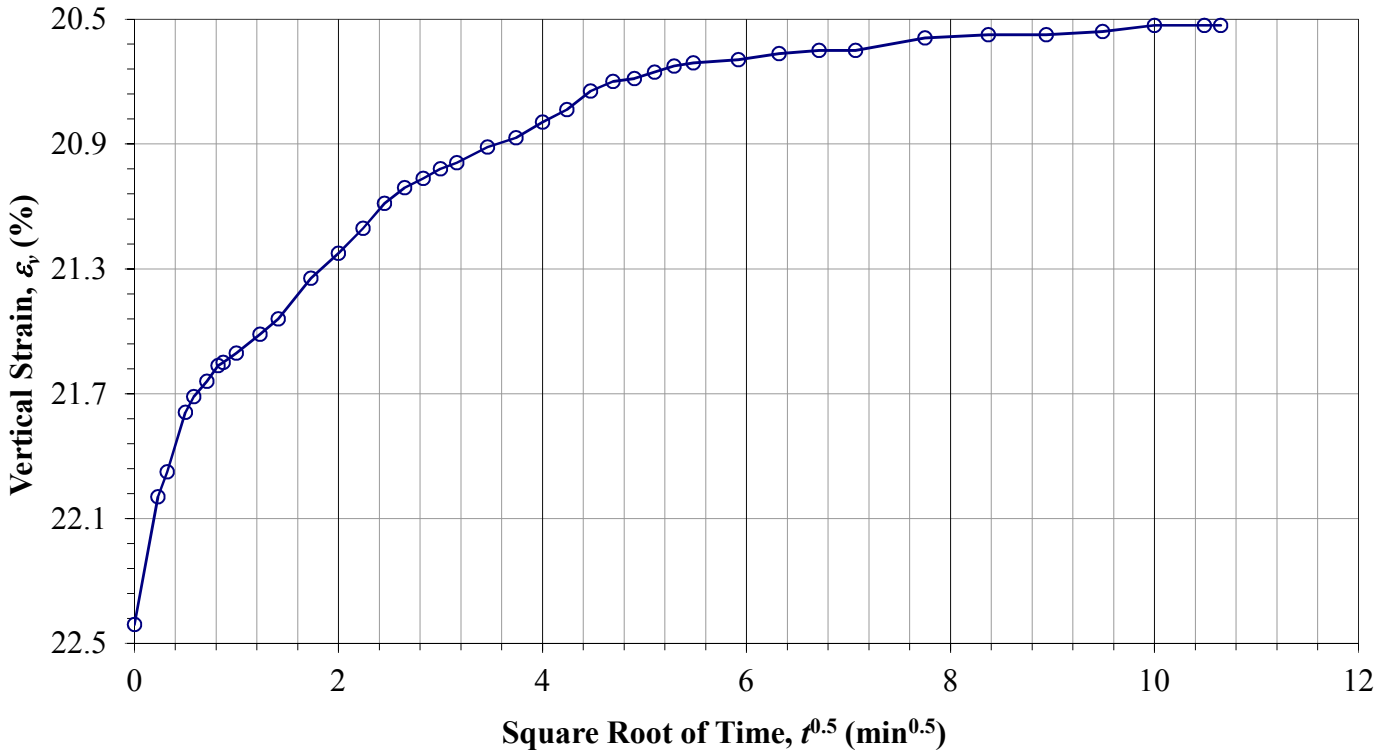
No: 00100-015, 3G2 (XIII) **Sample:** 6

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 20'

Constant Load Step: 13 of 14

Stress: 1600 psf





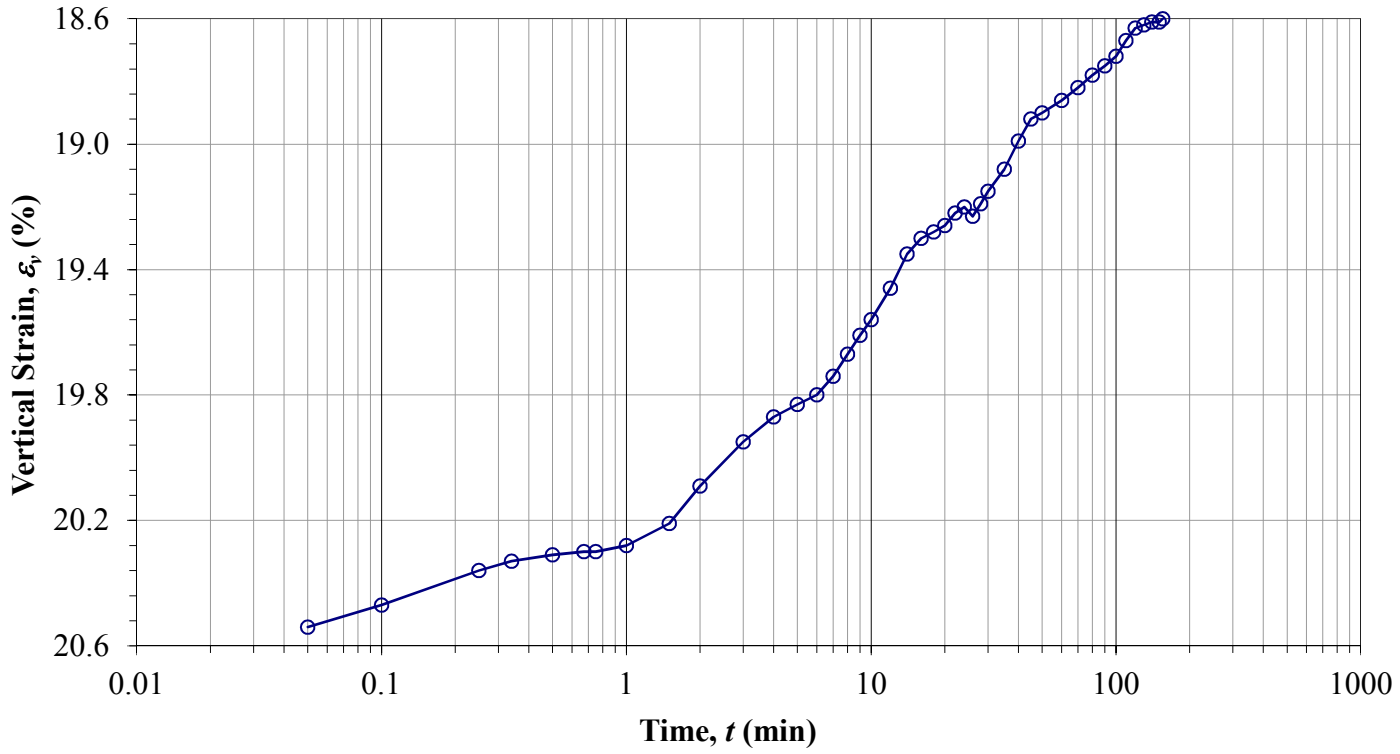
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 6
Depth: 20'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: JDF

Boring No.: BH19-ES-2
Sample: 10
Depth: 35'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

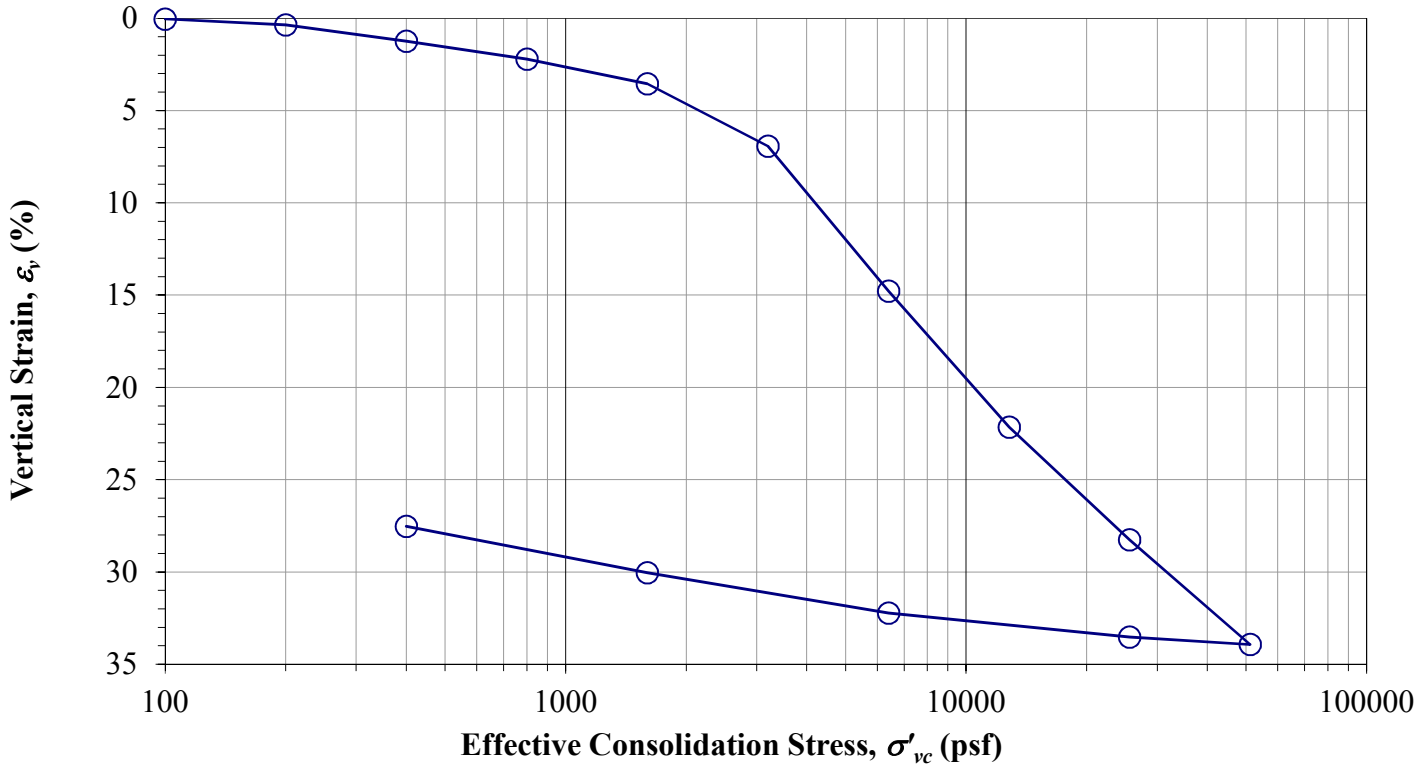
Test method:	B	
Inundation stress (psf), timing:	Seating	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation: Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.919	0.666
Sample diameter, D (in.)	2.410	2.410
Wt. rings + wet soil (g)	159.02	144.91
Wt. rings/tare (g)	44.65	44.65
Total unit wt., γ (pcf)	103.9	125.72
Wet soil + tare (g)	349.07	225.27
Dry soil + tare (g)	304.42	199.14
Tare (g)	225.14	128.59
Water content, ω (%)	56.3	37.0
Dry unit wt., γ_d (pcf)	66.5	91.7
Saturation, S	0.99	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9190	1.5352
100	0.0004	0.04	0.9186	1.5341
200	0.0033	0.35	0.9157	1.5262
400	0.0115	1.25	0.9075	1.5034
800	0.0203	2.21	0.8987	1.4791
1600	0.0326	3.55	0.8864	1.4453
3200	0.0637	6.93	0.8553	1.3594
6400	0.1358	14.78	0.7832	1.1605
12800	0.2036	22.15	0.7154	0.9735
25600	0.2596	28.25	0.6594	0.8190
51200	0.3118	33.93	0.6072	0.6750
25600	0.3081	33.53	0.6109	0.6852
6400	0.2961	32.22	0.6229	0.7183
1600	0.2761	30.04	0.6429	0.7735
400	0.2530	27.53	0.6660	0.8372



Entered: _____
Reviewed: _____

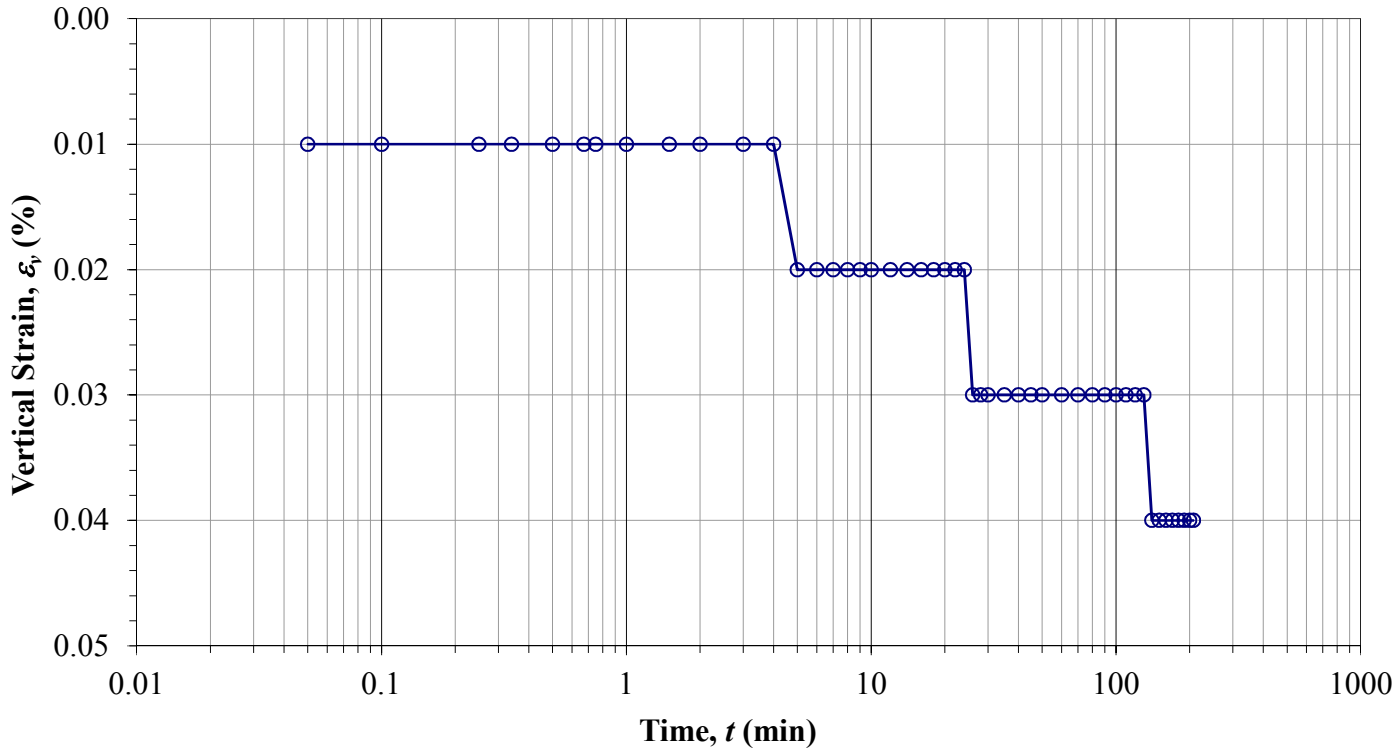
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

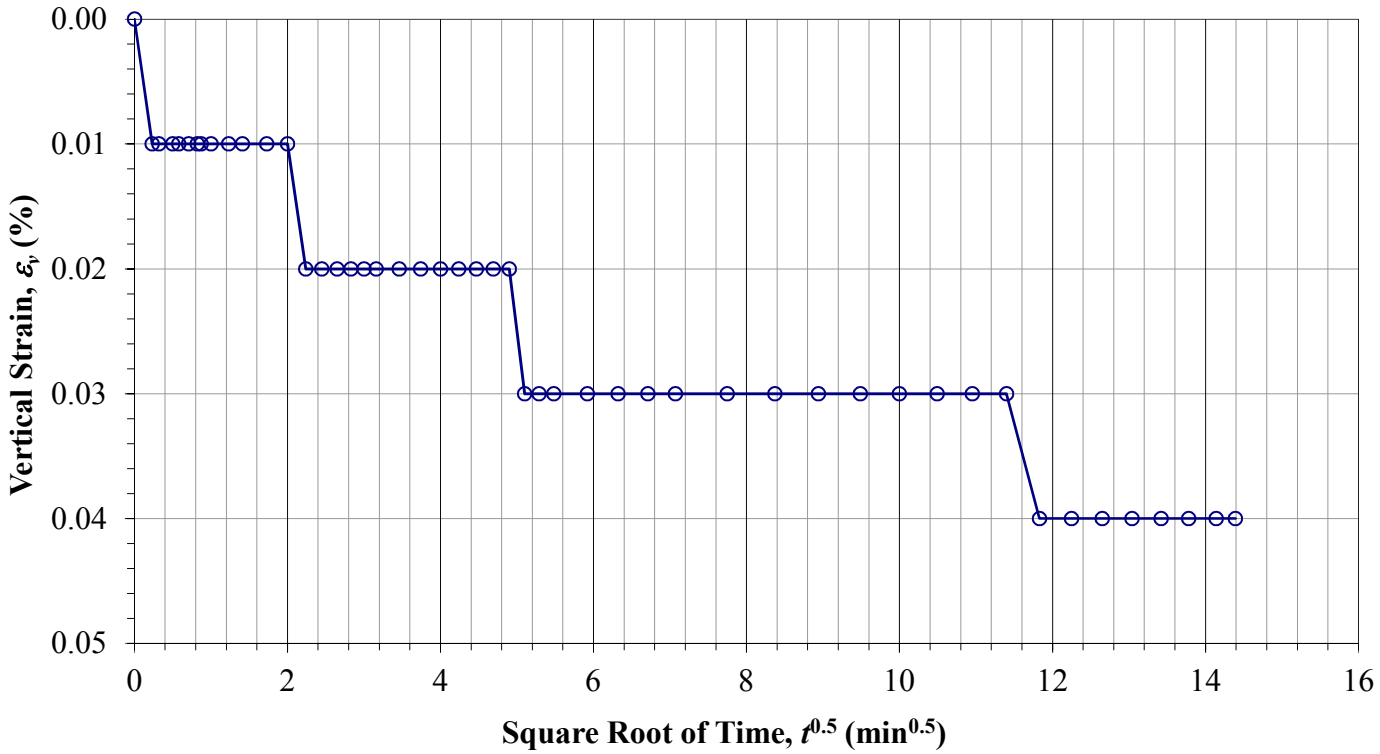
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 10
Depth: 35'

Constant Load Step: 1 of 14
Stress: 100 psf





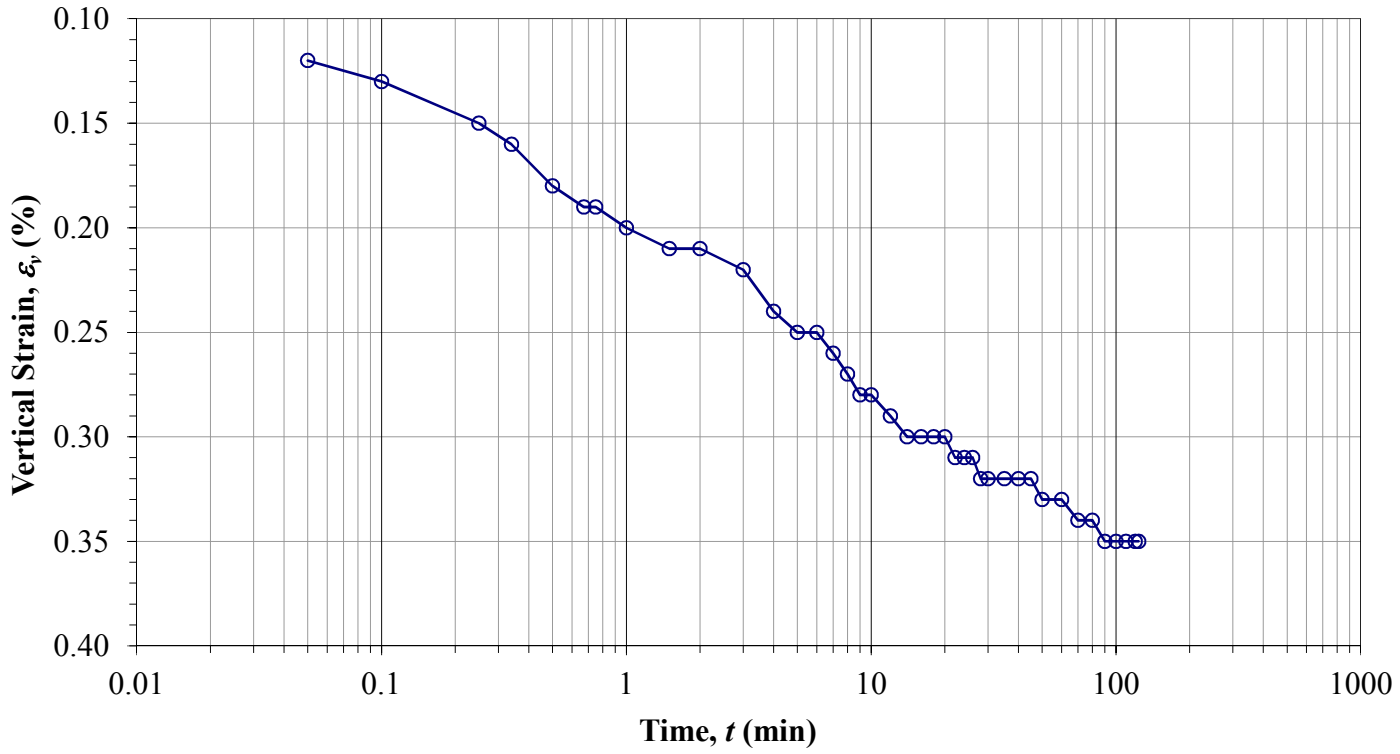
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

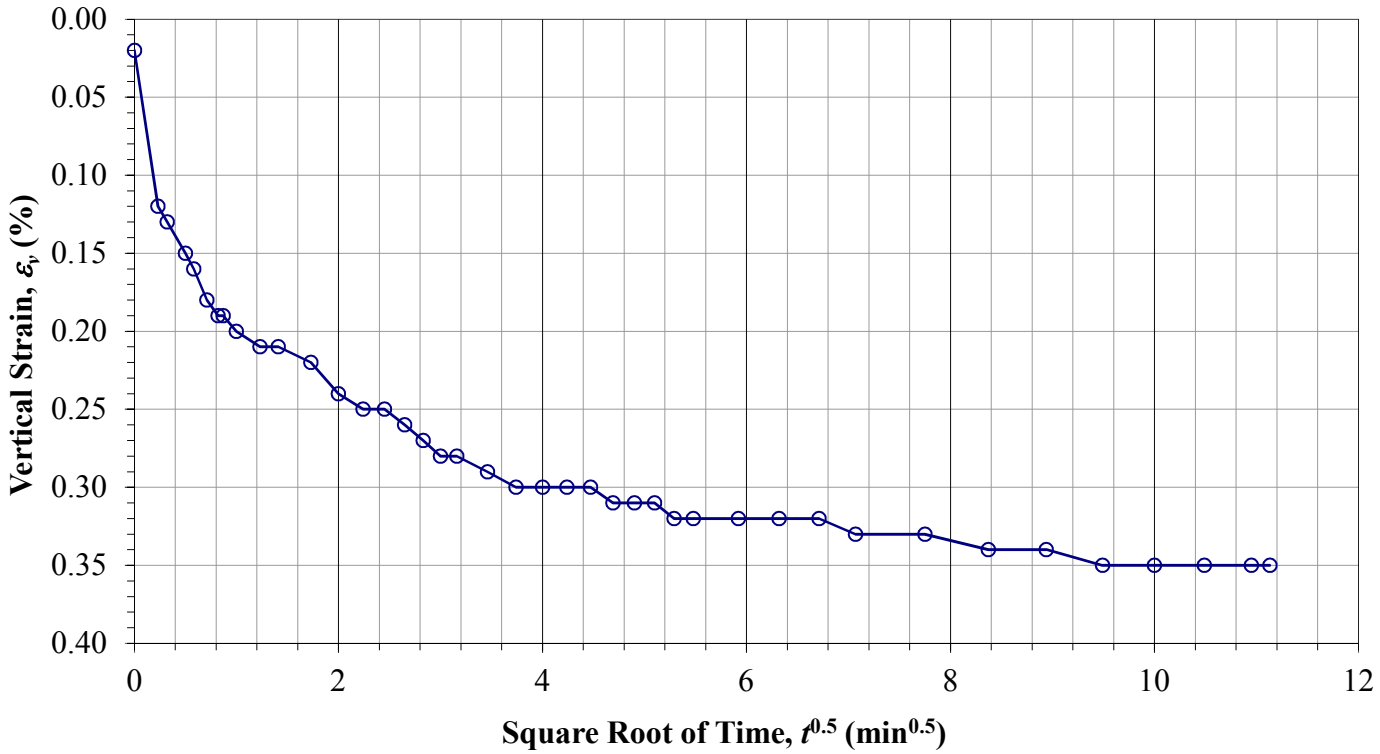
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 10
Depth: 35'

Constant Load Step: 2 of 14
Stress: 200 psf





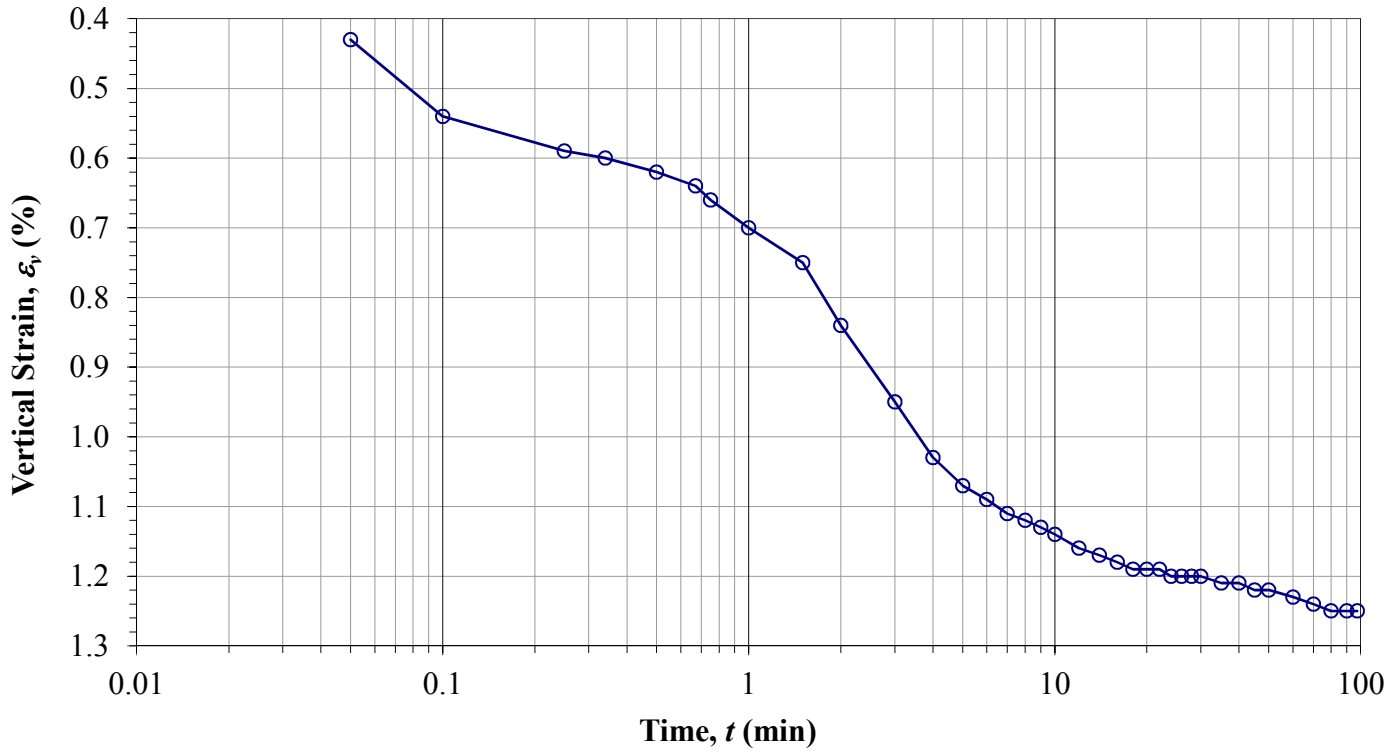
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

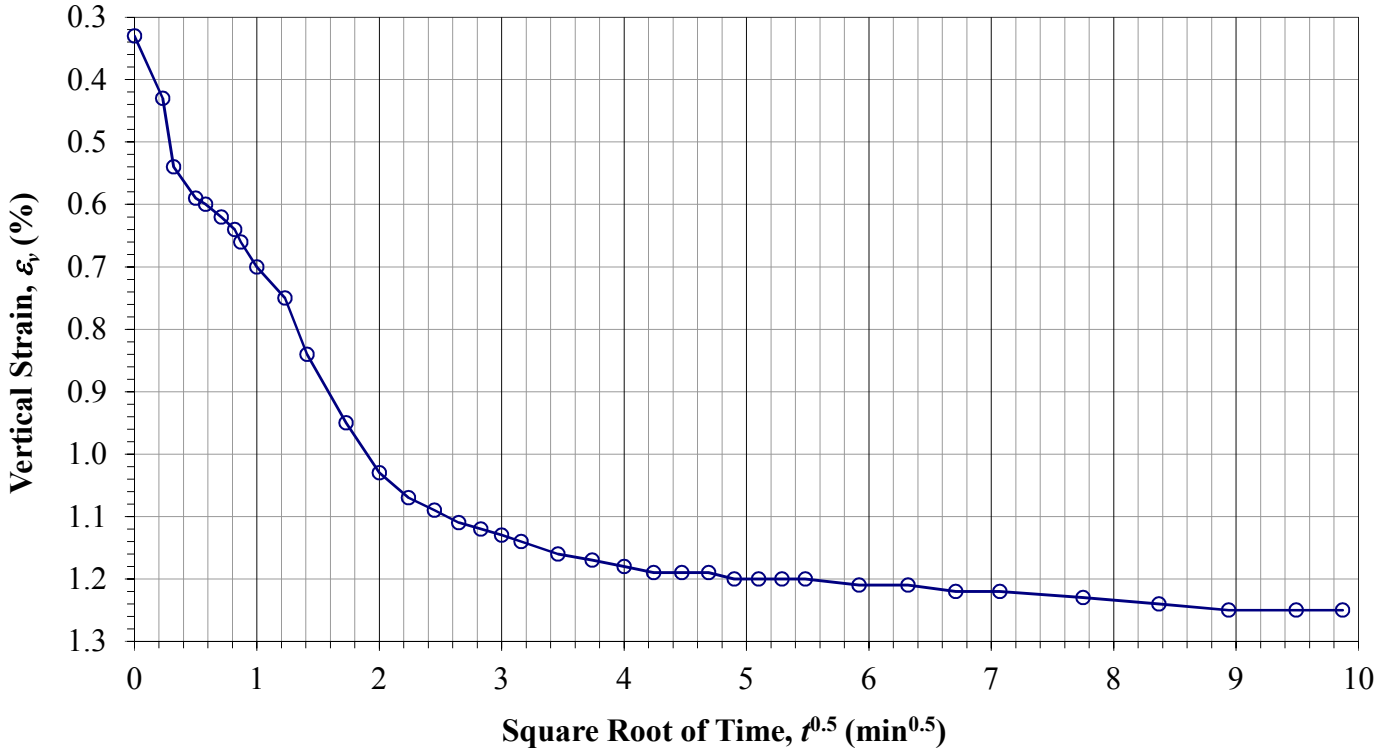
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 10
Depth: 35'

Constant Load Step: 3 of 14
Stress: 400 psf



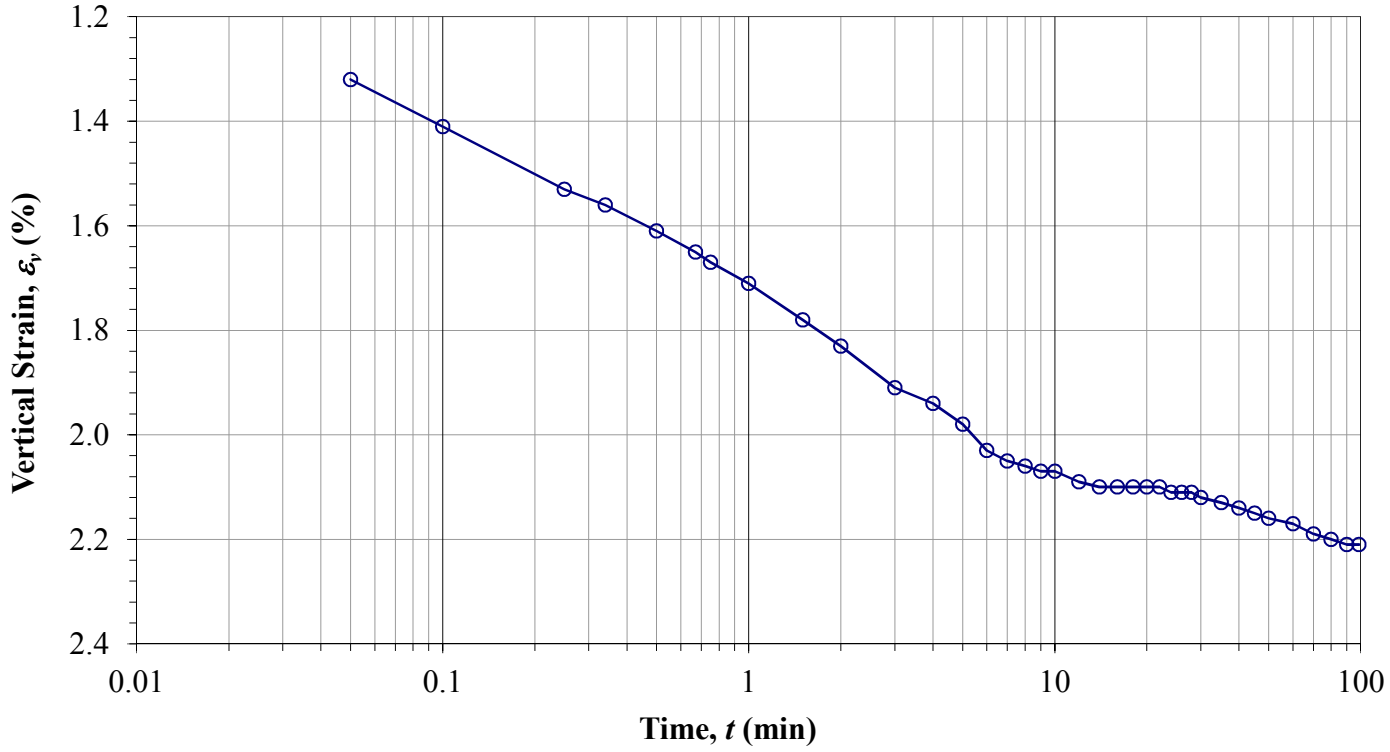


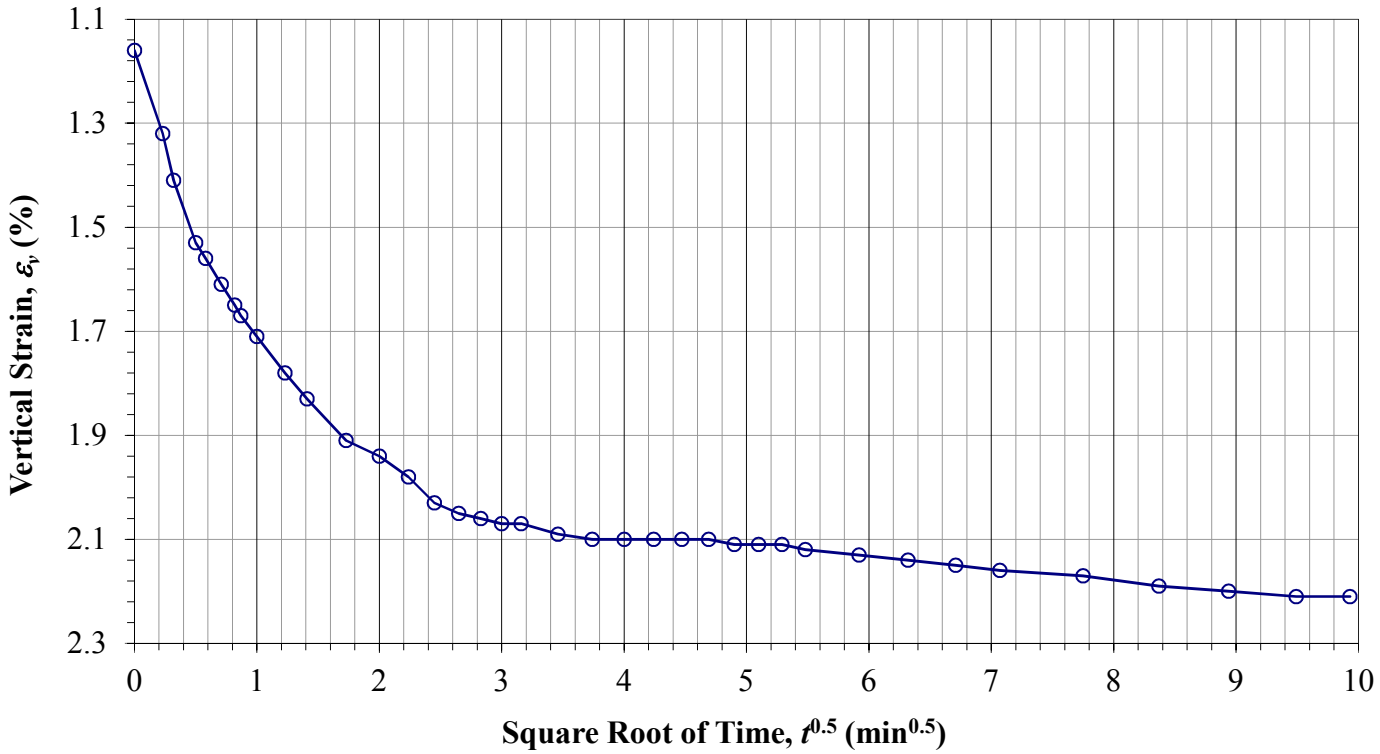
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 10
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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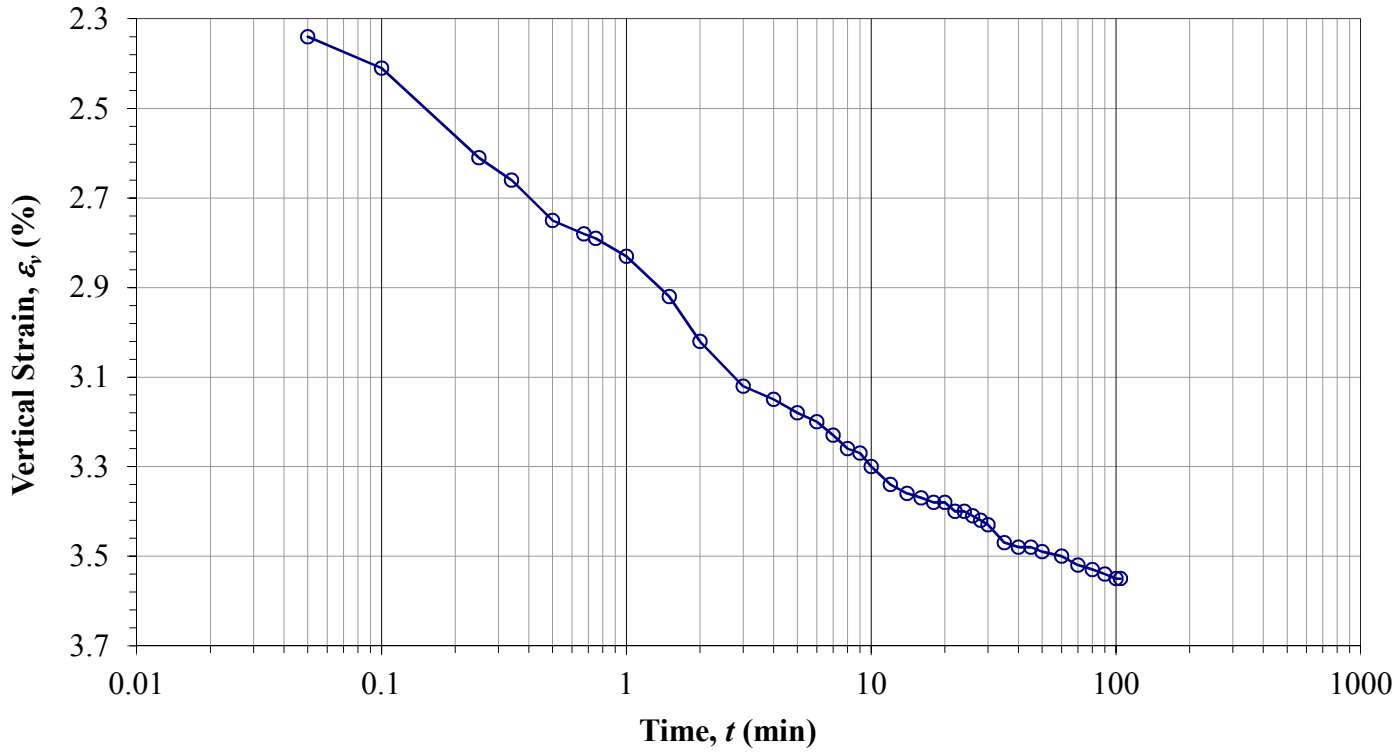
Project: AECOM **Boring No.:** BH19-ES-2

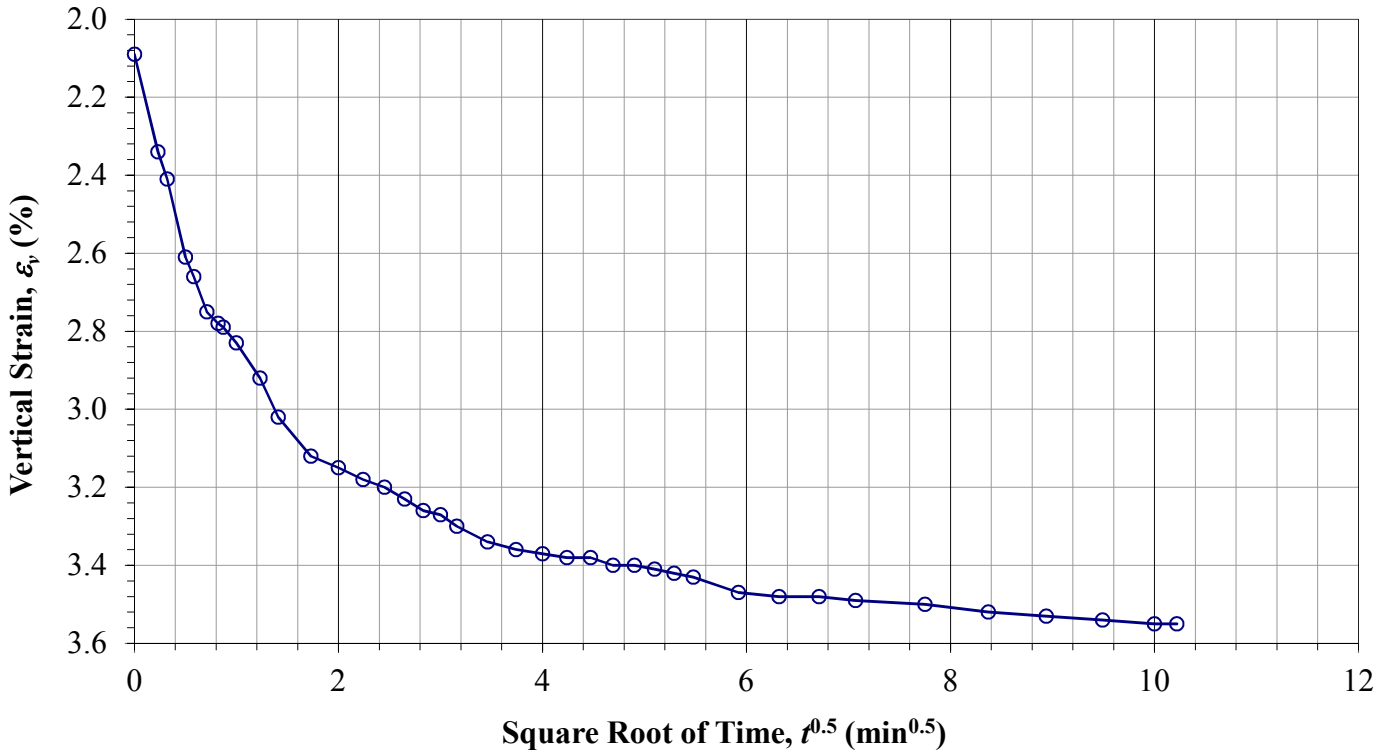
No: 00100-015, 3G2 (XIII) **Sample:** 10

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 5 of 14

Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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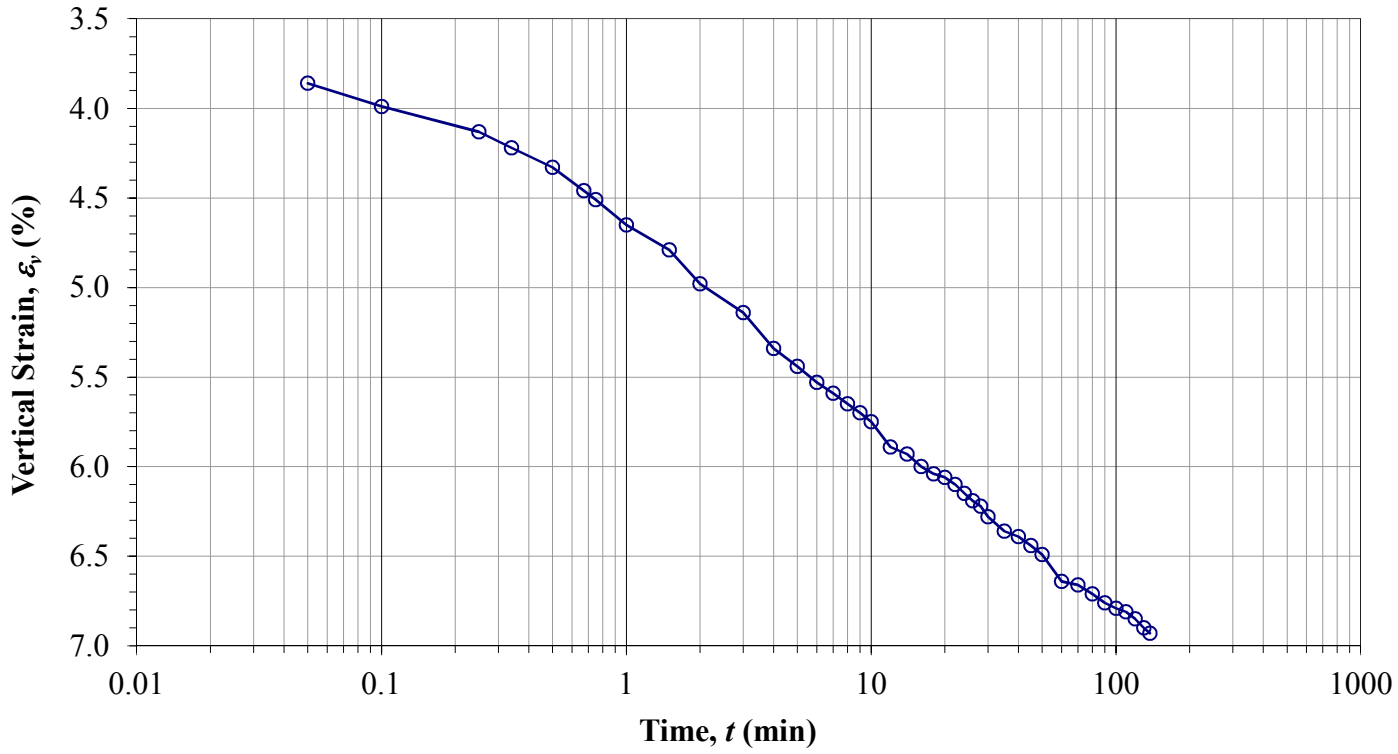
Project: AECOM **Boring No.:** BH19-ES-2

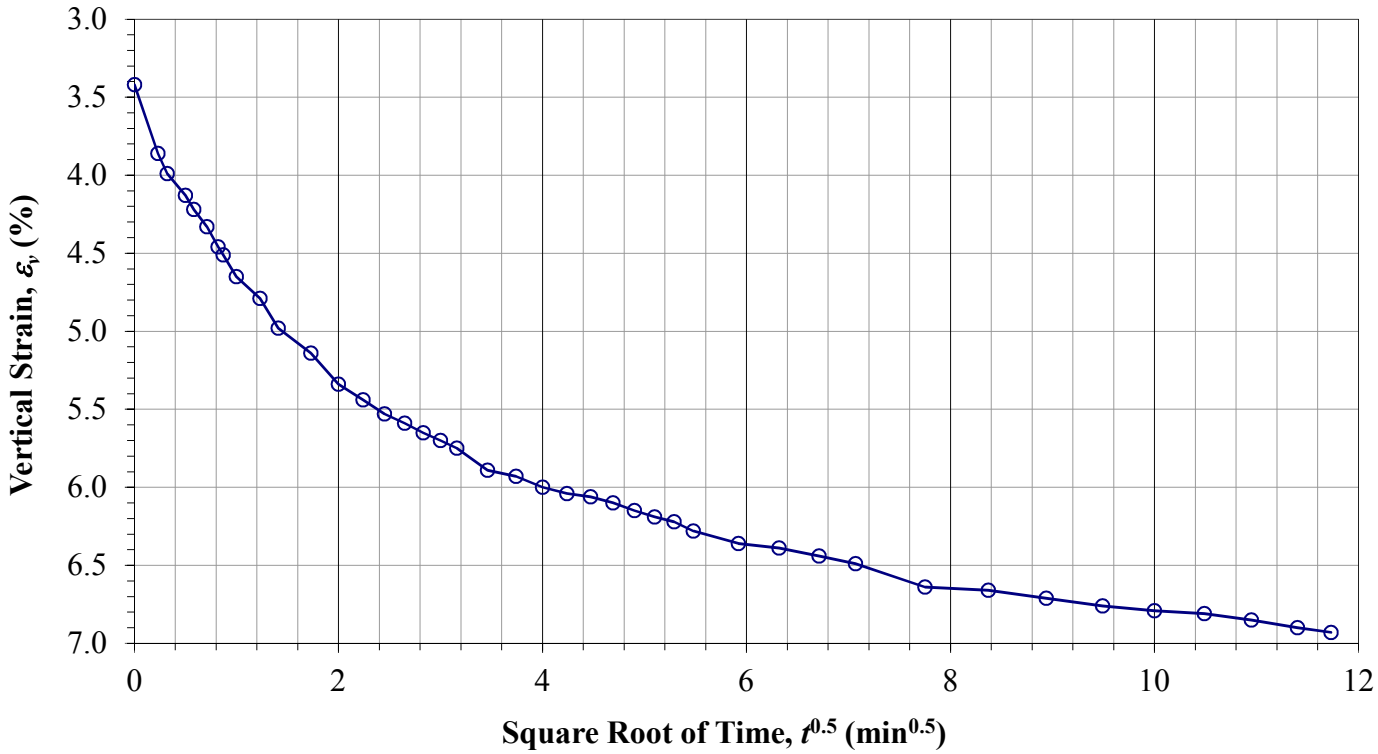
No: 00100-015, 3G2 (XIII) **Sample:** 10

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 6 of 14

Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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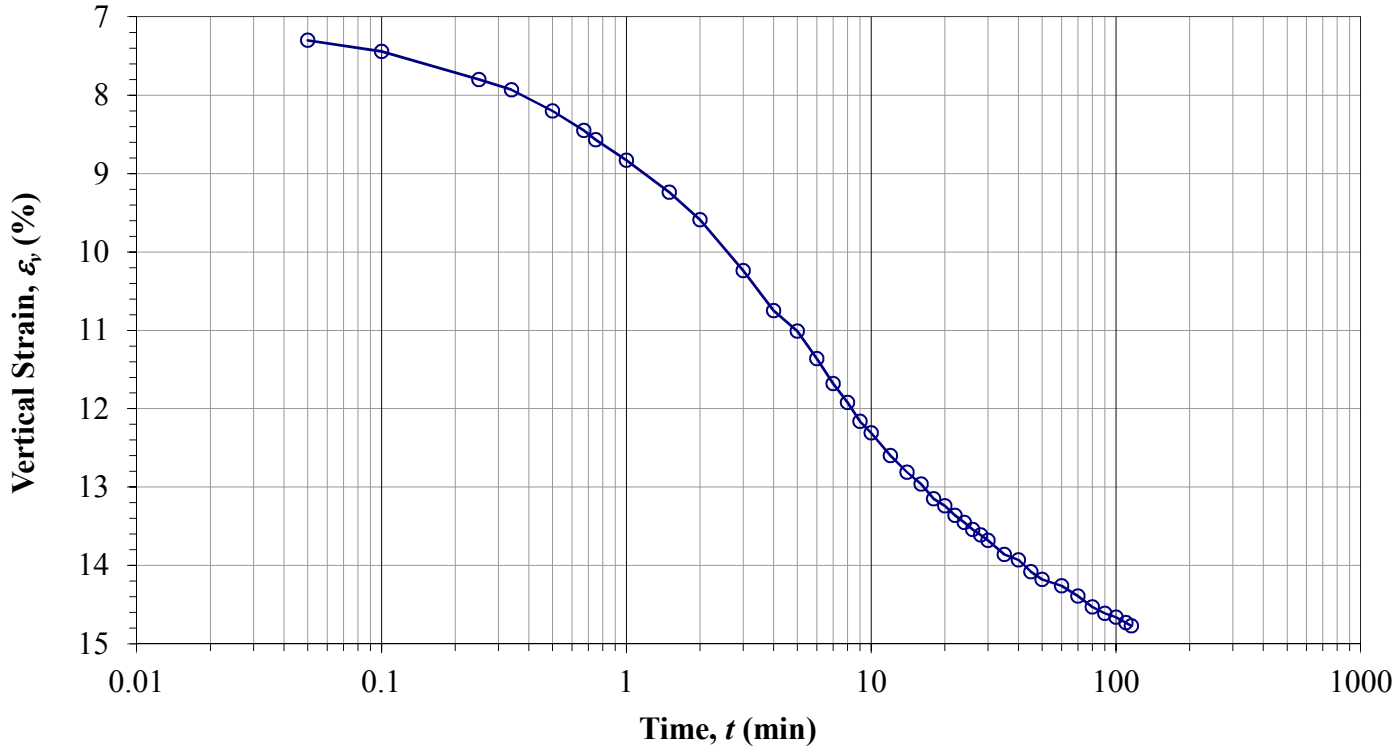
Project: AECOM **Boring No.:** BH19-ES-2

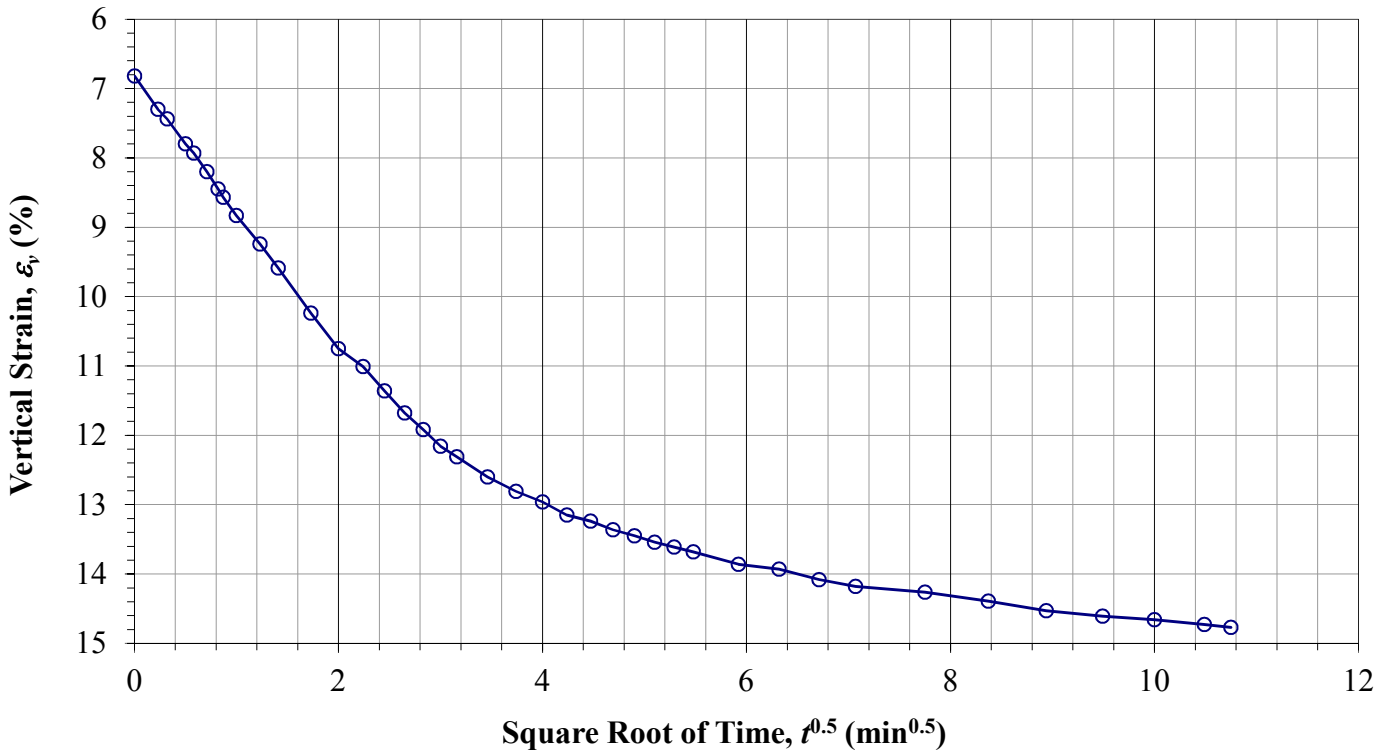
No: 00100-015, 3G2 (XIII) **Sample:** 10

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 7 of 14

Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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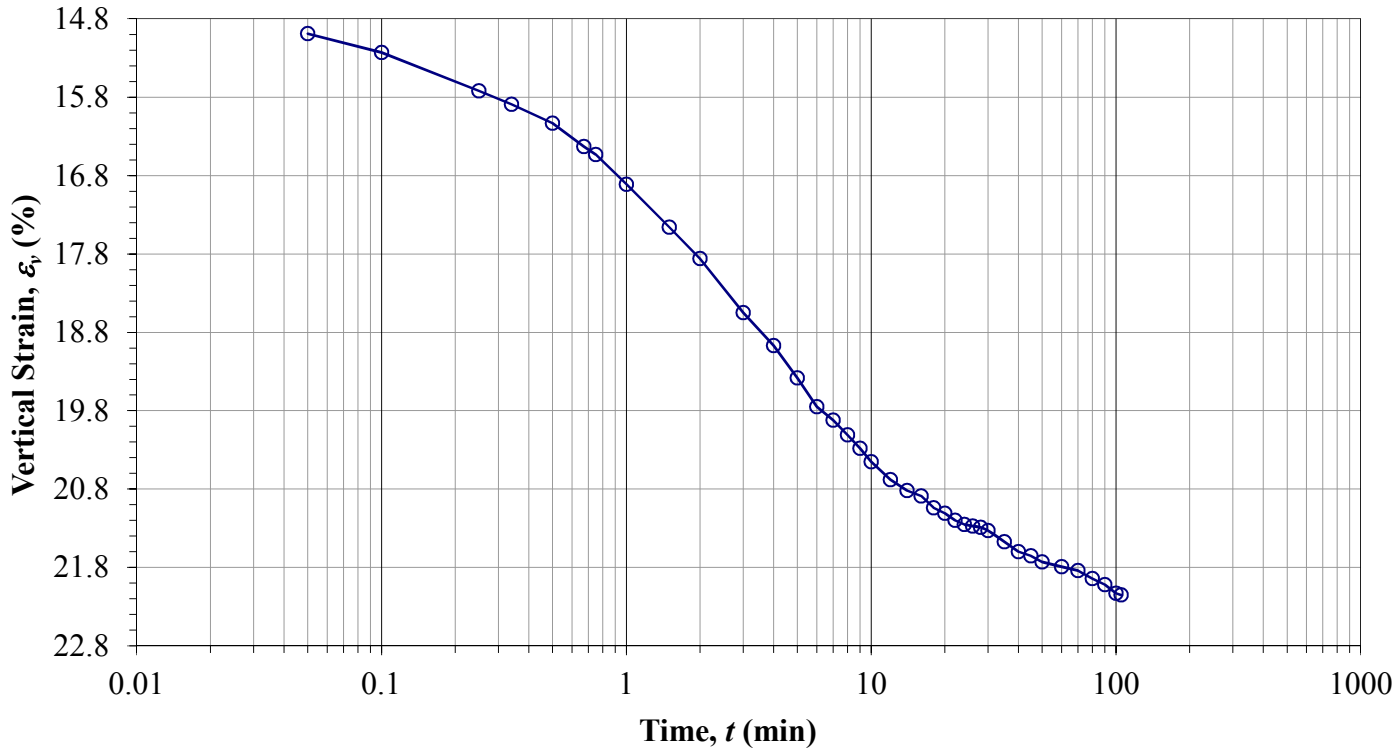
Project: AECOM **Boring No.:** BH19-ES-2

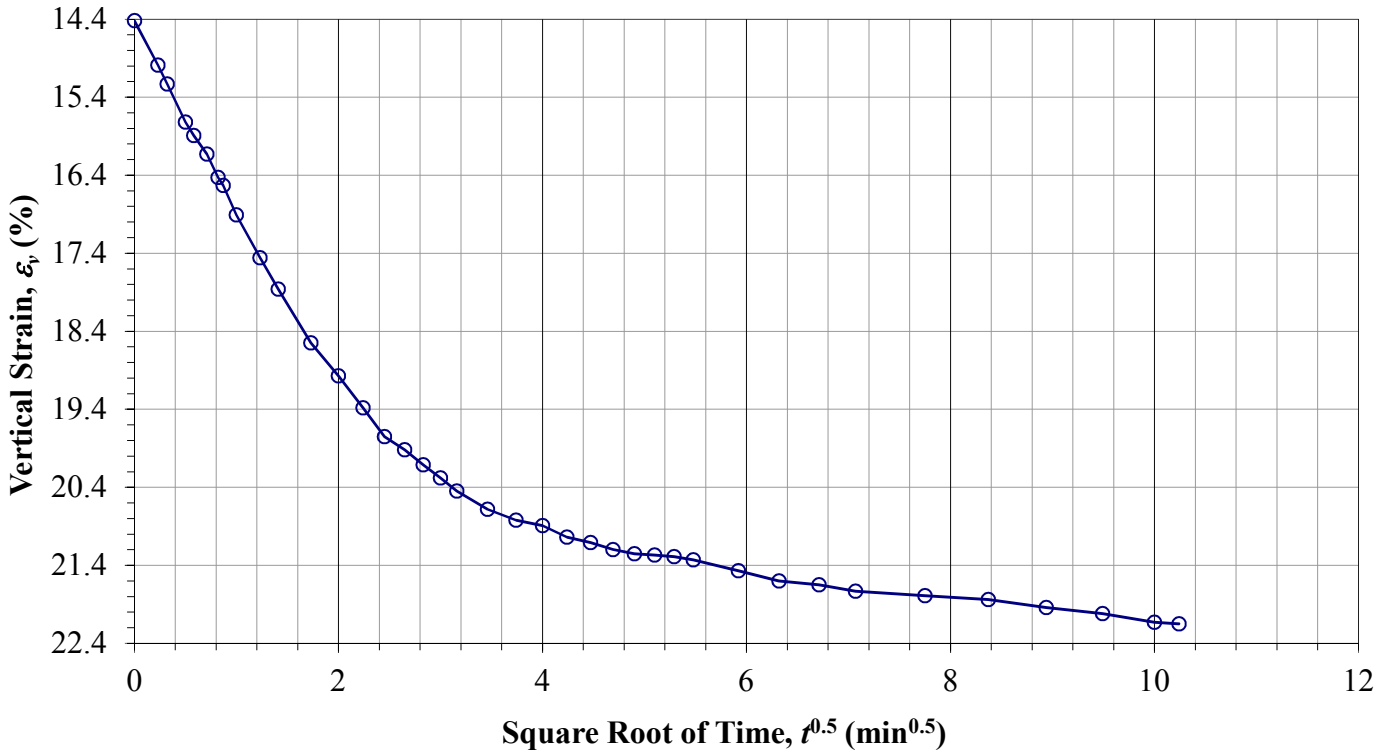
No: 00100-015, 3G2 (XIII) **Sample:** 10

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 8 of 14

Stress: 12800 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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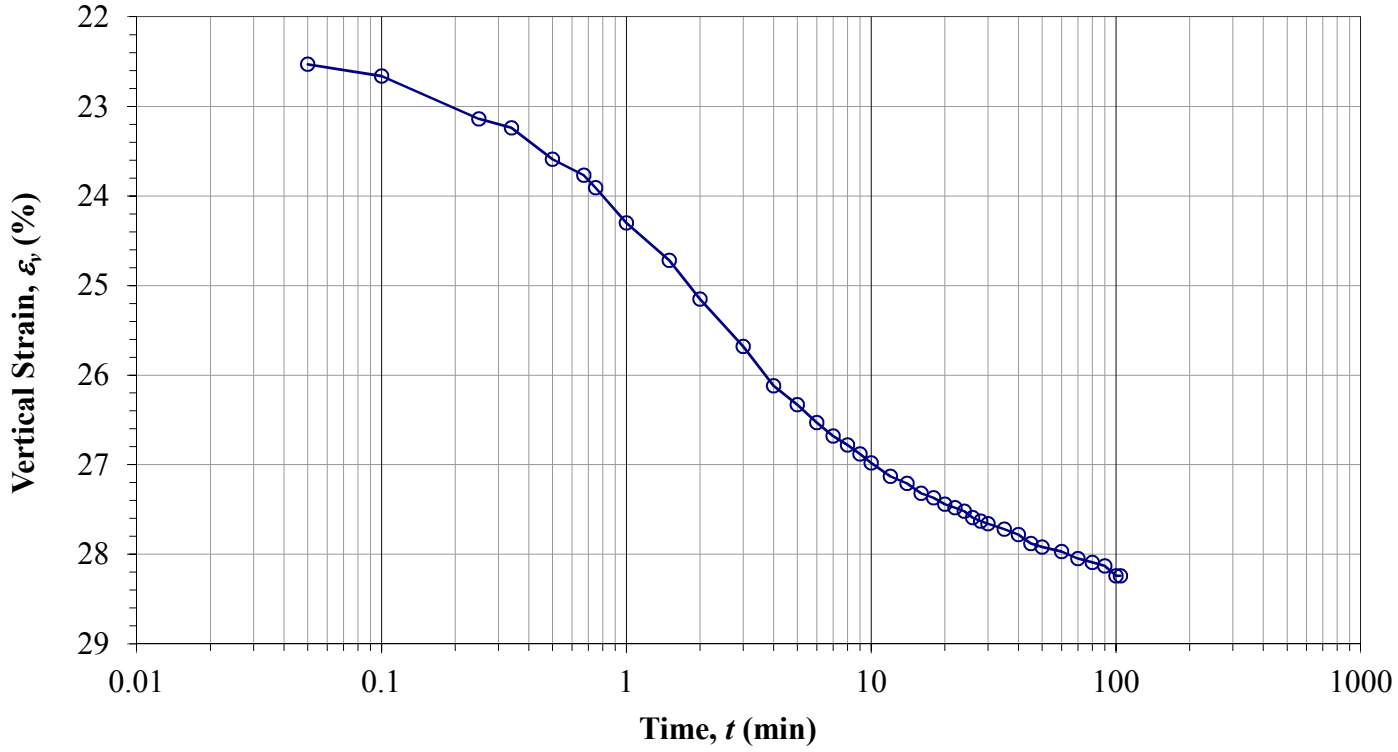
Project: AECOM **Boring No.:** BH19-ES-2

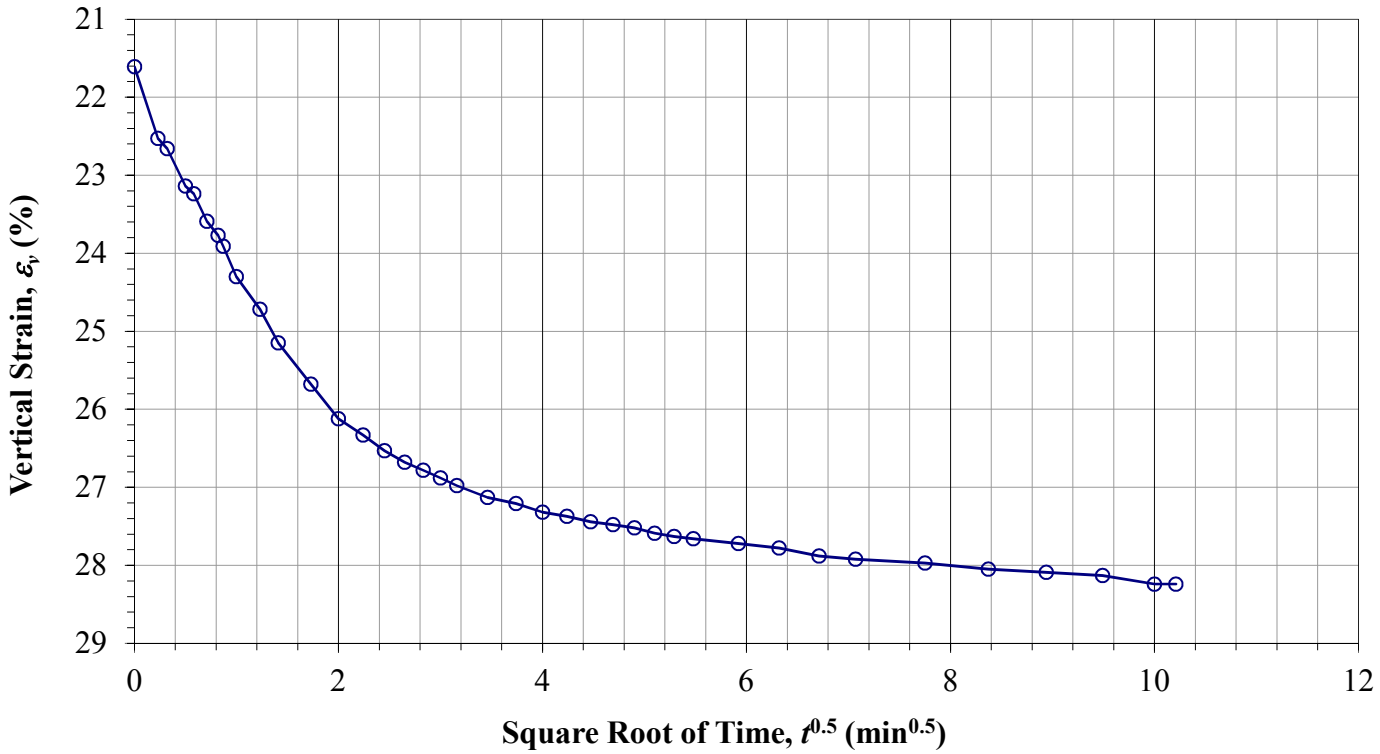
No: 00100-015, 3G2 (XIII) **Sample:** 10

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 9 of 14

Stress: 25600 psf



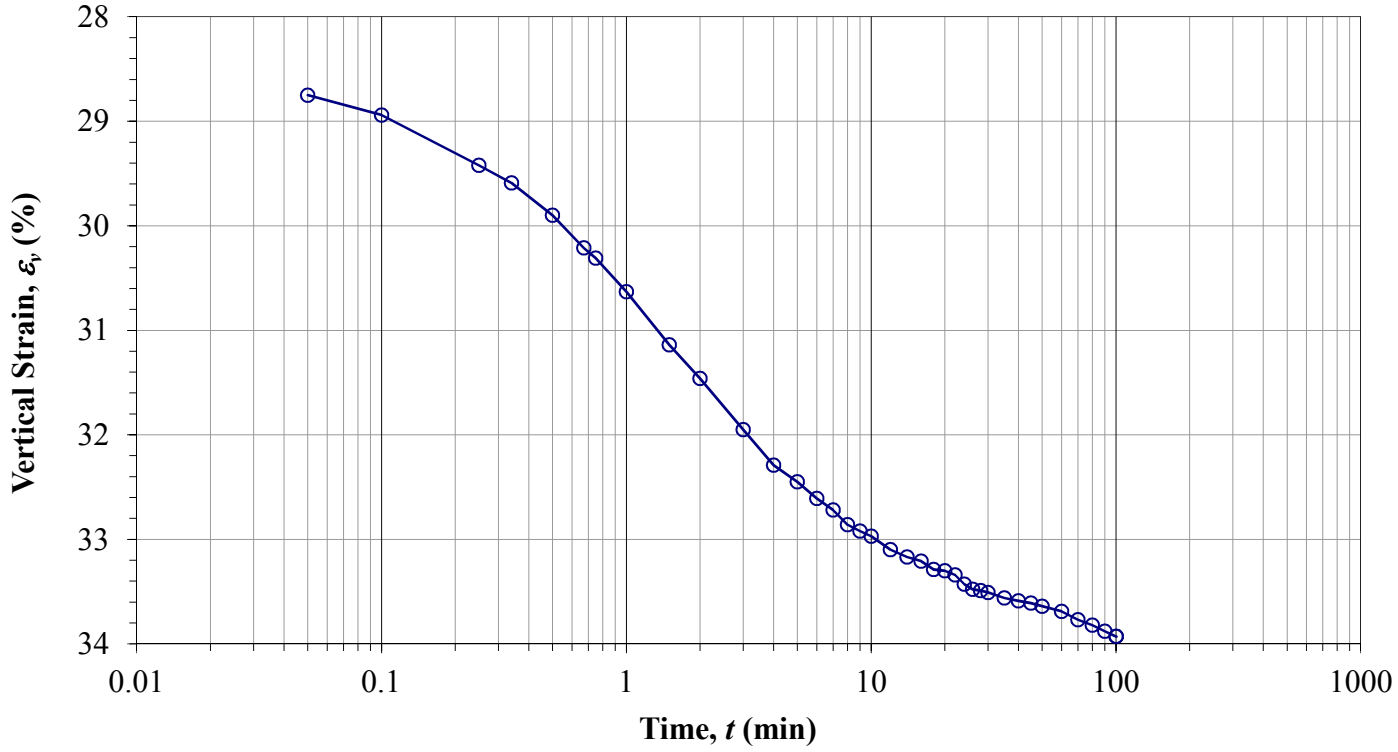


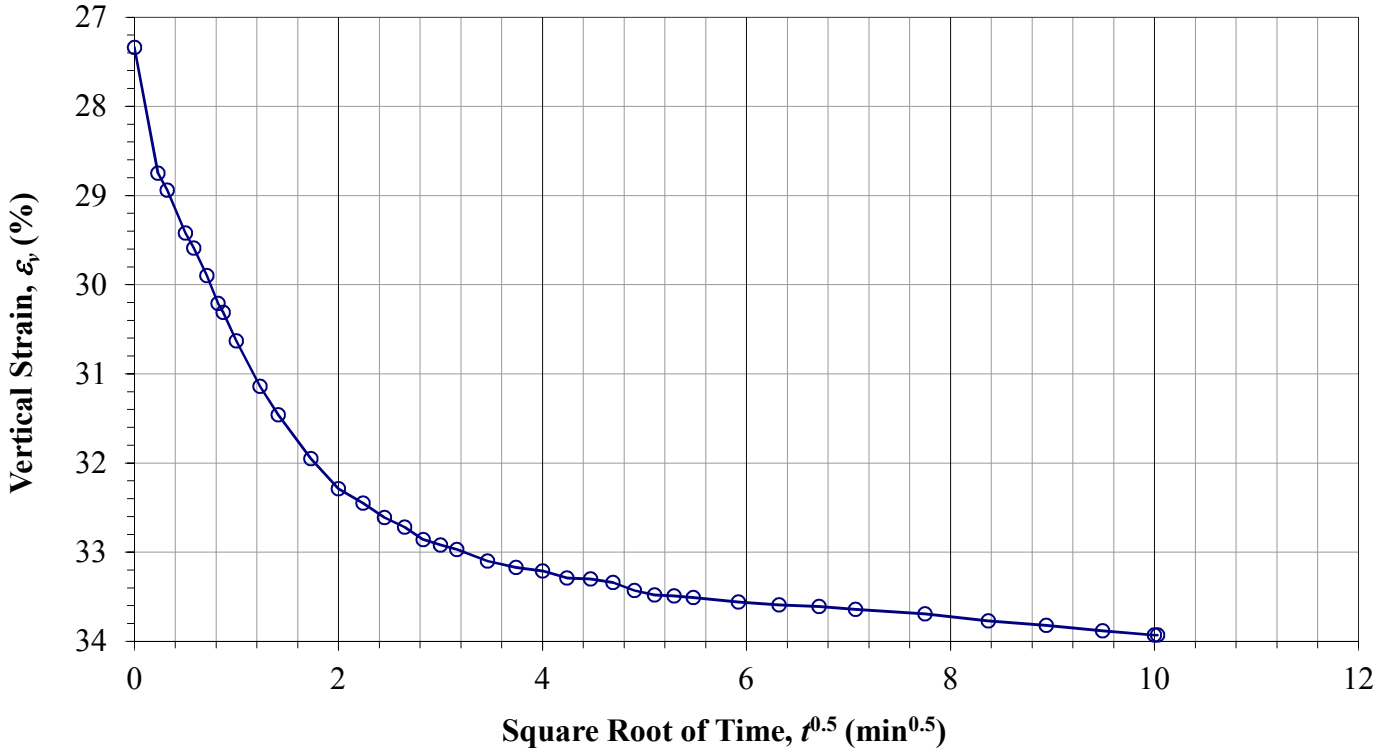
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 10
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 10 of 14
Stress: 51200 psf



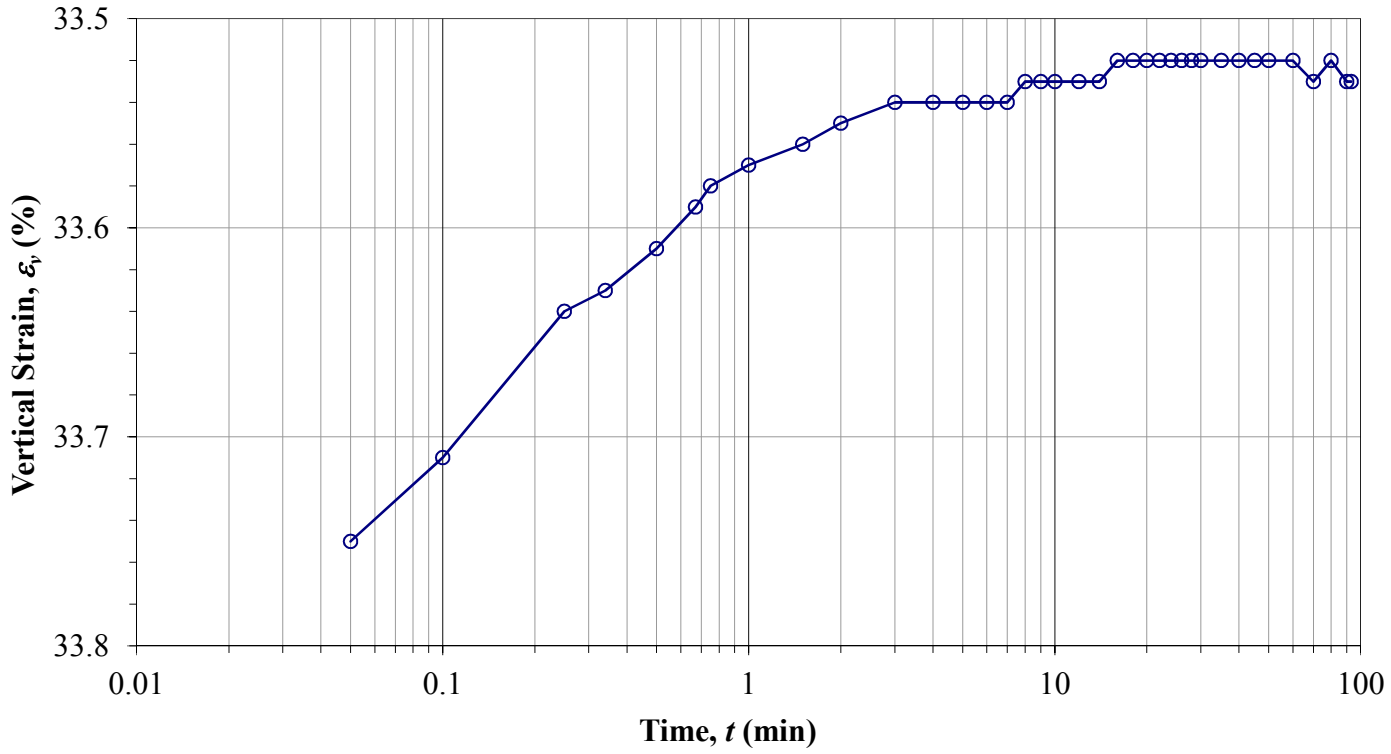


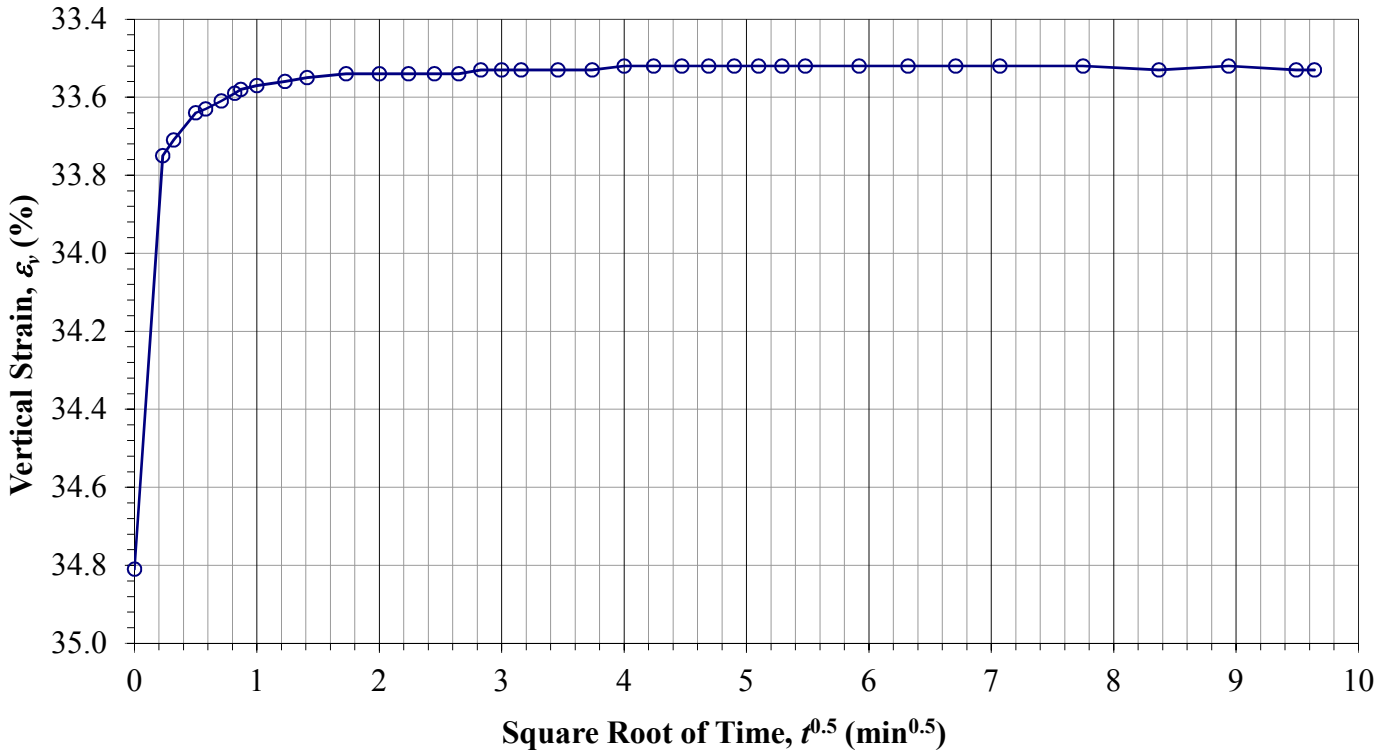
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 10
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 11 of 14
Stress: 25600 psf



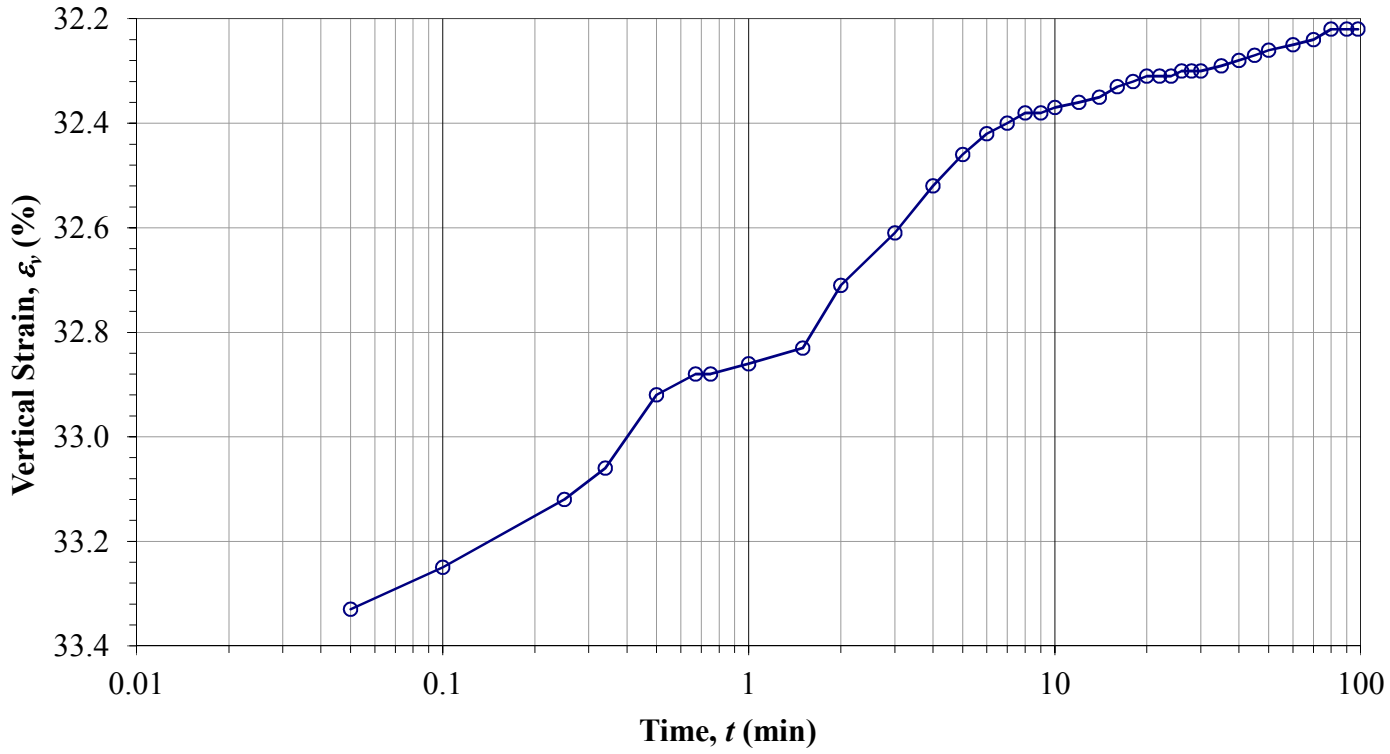


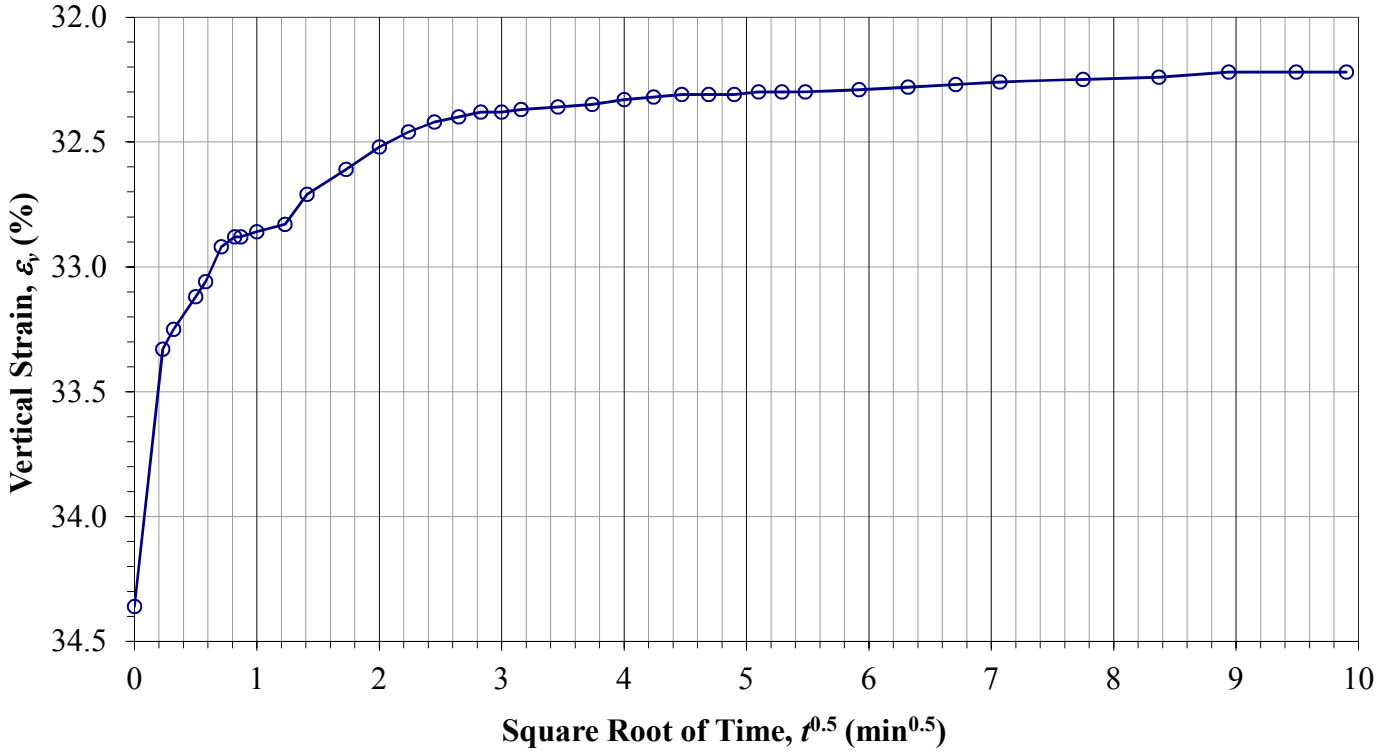
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 10
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 12 of 14
Stress: 6400 psf



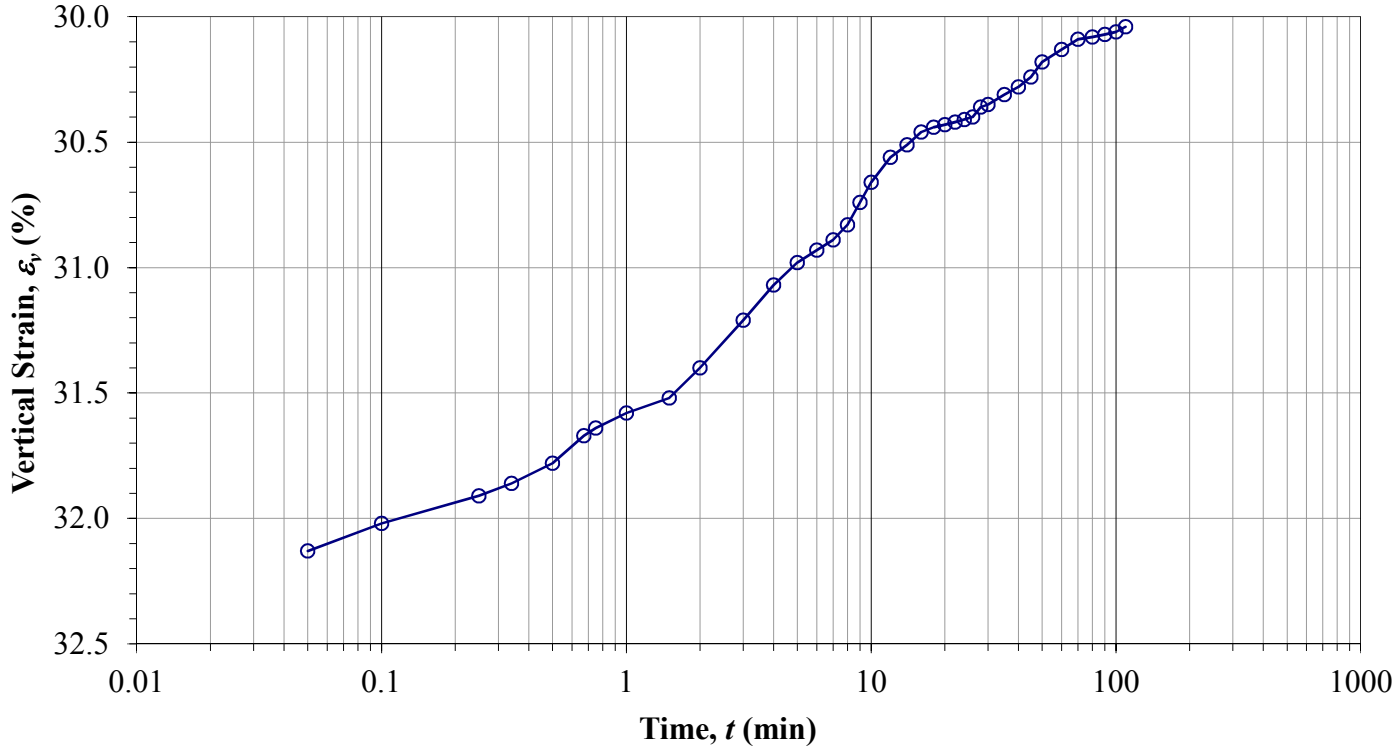


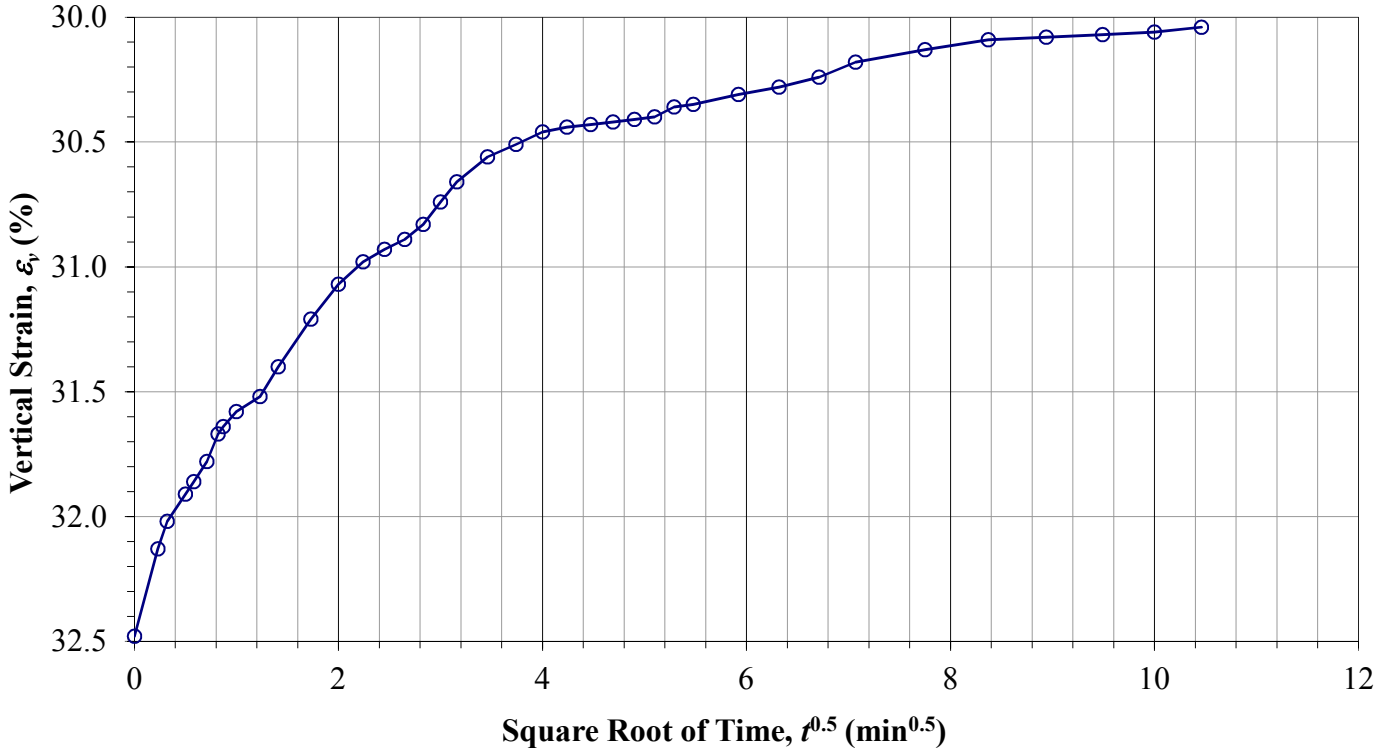
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 10
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 35'

Constant Load Step: 13 of 14
Stress: 1600 psf





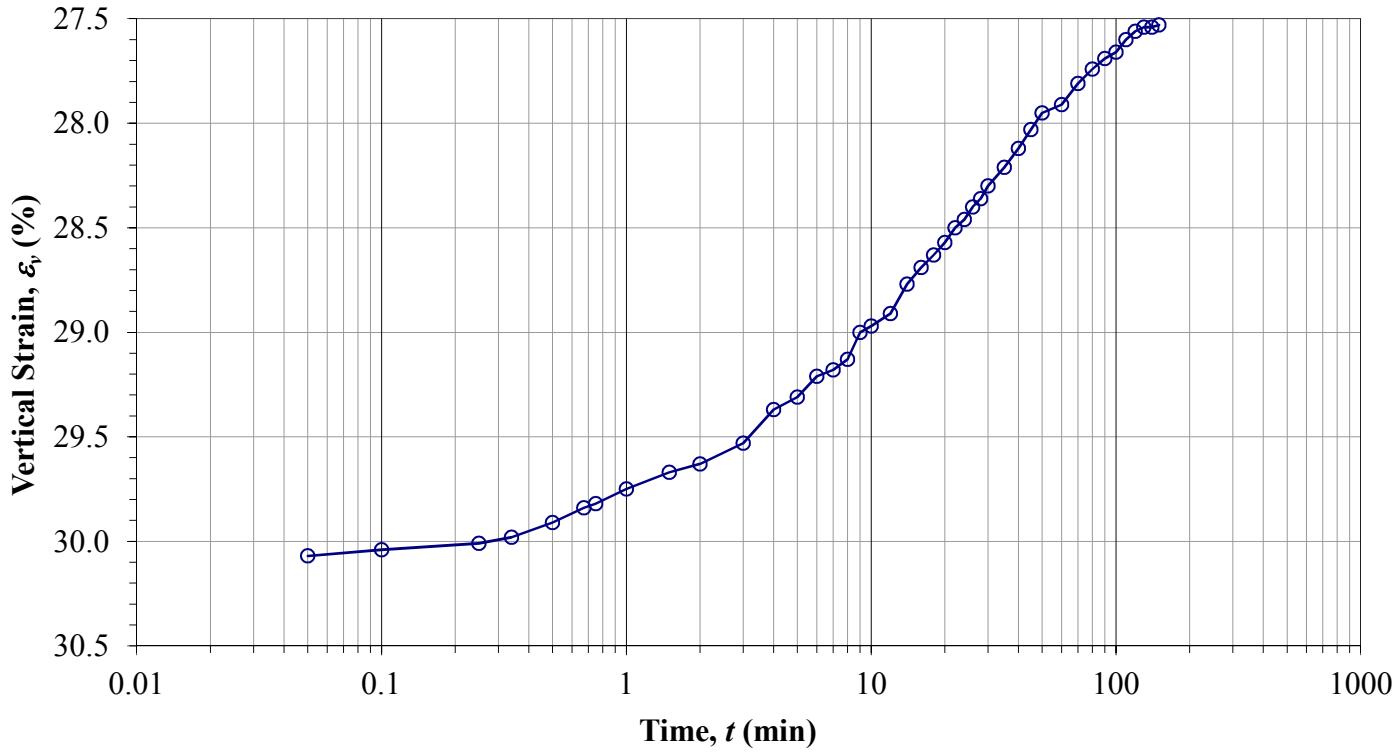
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

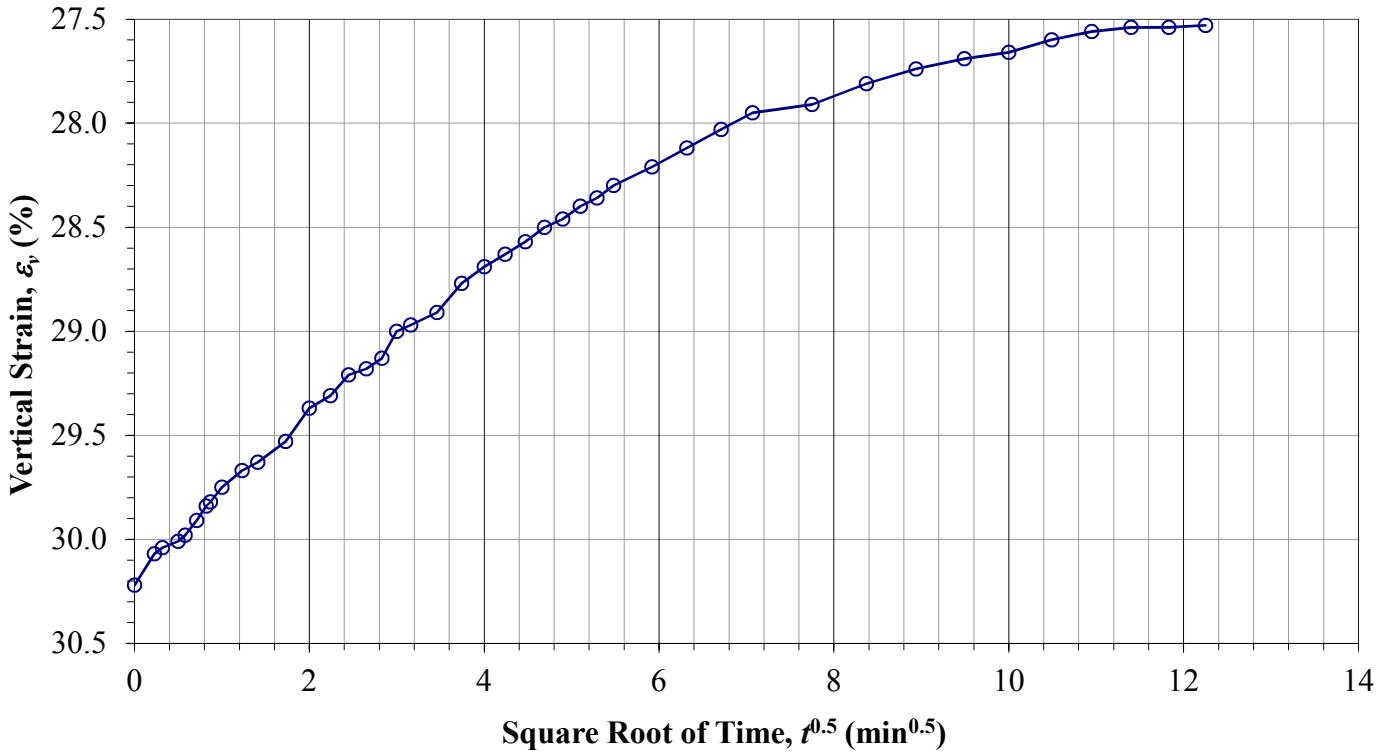
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 10
Depth: 35'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: JDF

Boring No.: BH19-ES-2
Sample: 14
Depth: 55'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

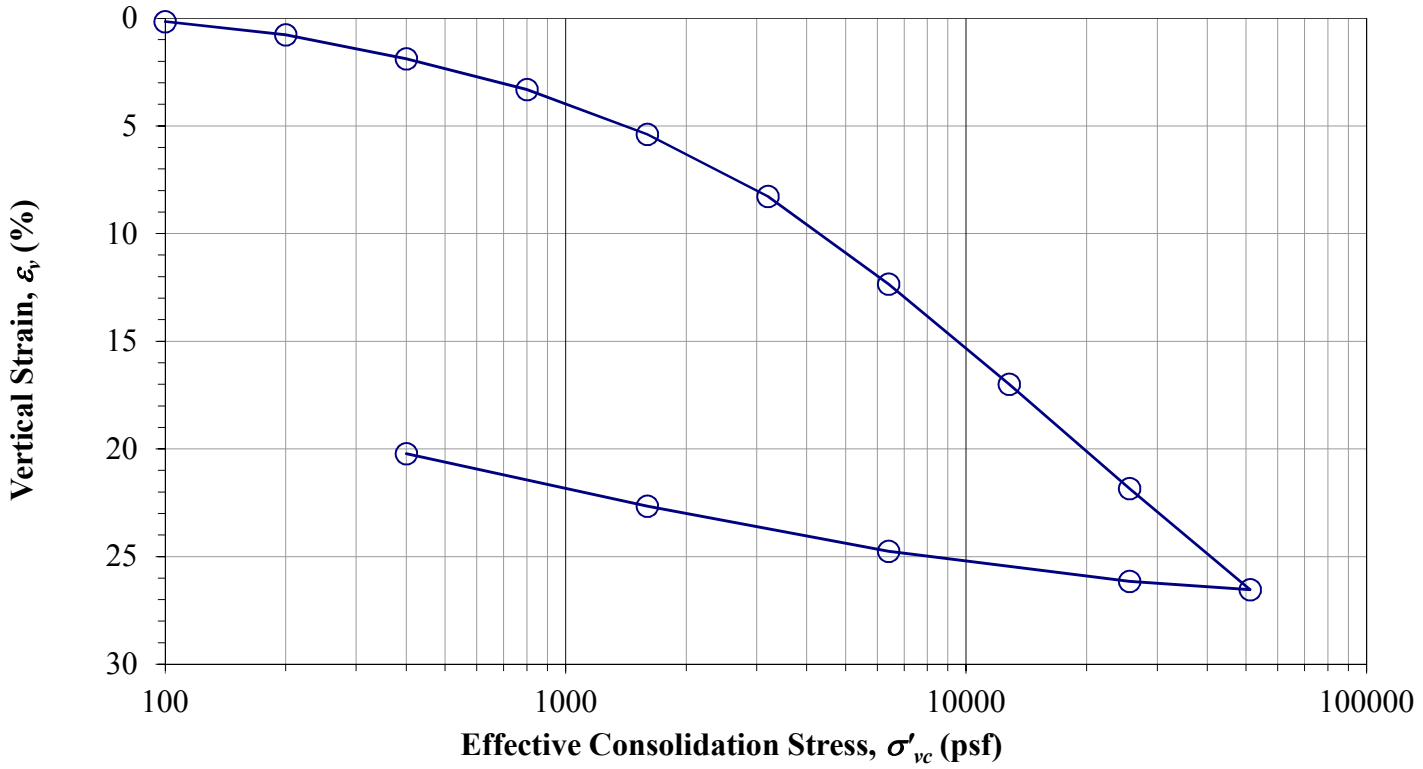
Test method:	B	
Inundation stress (psf), timing:	Seating	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation: Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.924	0.737
Sample diameter, D (in.)	2.413	2.413
Wt. rings + wet soil (g)	168.88	158.34
Wt. rings/tare (g)	45.33	45.33
Total unit wt., γ (pcf)	111.4	127.72
Wet soil + tare (g)	487.93	237.89
Dry soil + tare (g)	399.81	213.09
Tare (g)	185.02	127.57
Water content, ω (%)	41.0	29.0
Dry unit wt., γ_d (pcf)	79.0	99.0
Saturation, S	0.98	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9240	1.1340
100	0.0015	0.16	0.9225	1.1306
200	0.0071	0.77	0.9169	1.1177
400	0.0174	1.89	0.9066	1.0938
800	0.0306	3.31	0.8934	1.0634
1600	0.0498	5.39	0.8742	1.0189
3200	0.0764	8.27	0.8476	0.9575
6400	0.1141	12.35	0.8099	0.8705
12800	0.1571	17.00	0.7669	0.7712
25600	0.2018	21.84	0.7222	0.6680
51200	0.2452	26.54	0.6788	0.5677
25600	0.2416	26.15	0.6824	0.5760
6400	0.2287	24.75	0.6953	0.6058
1600	0.2093	22.65	0.7147	0.6506
400	0.1869	20.23	0.7371	0.7024



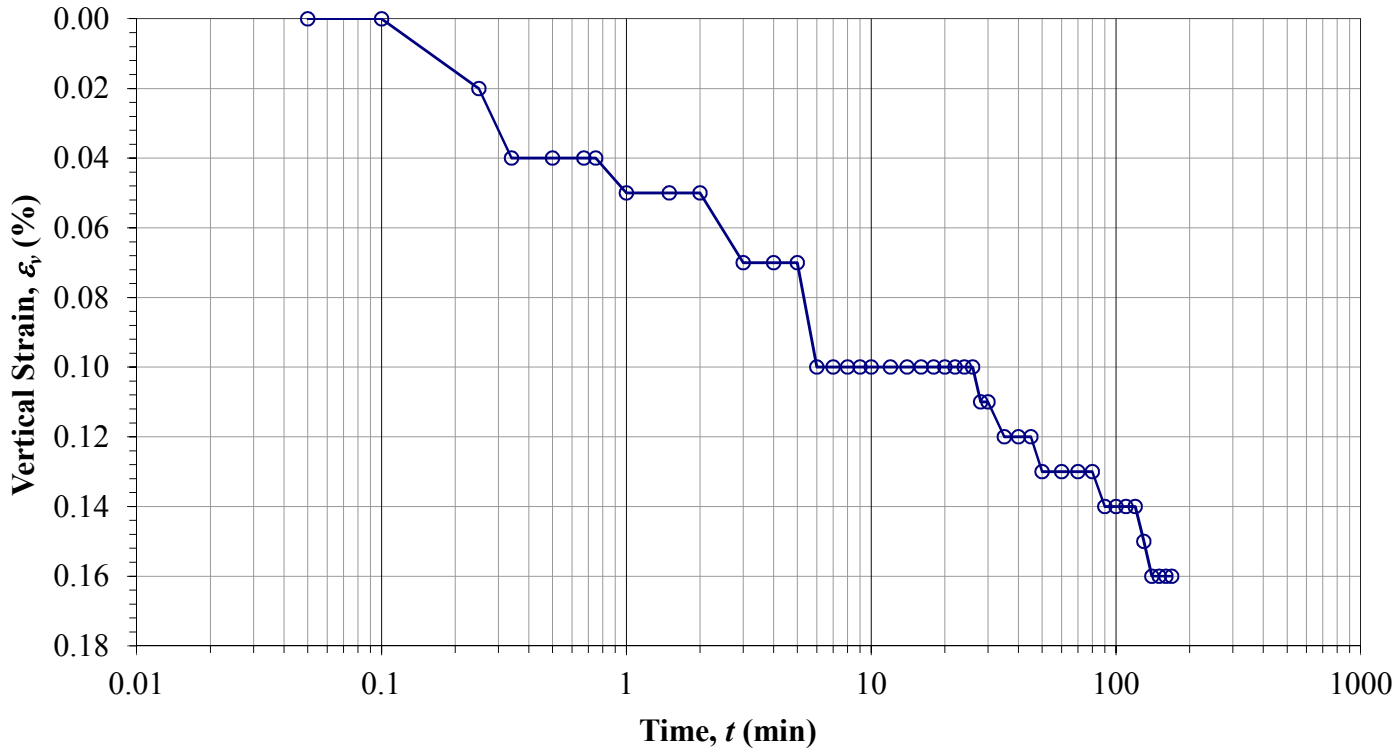
Entered: _____
Reviewed: _____

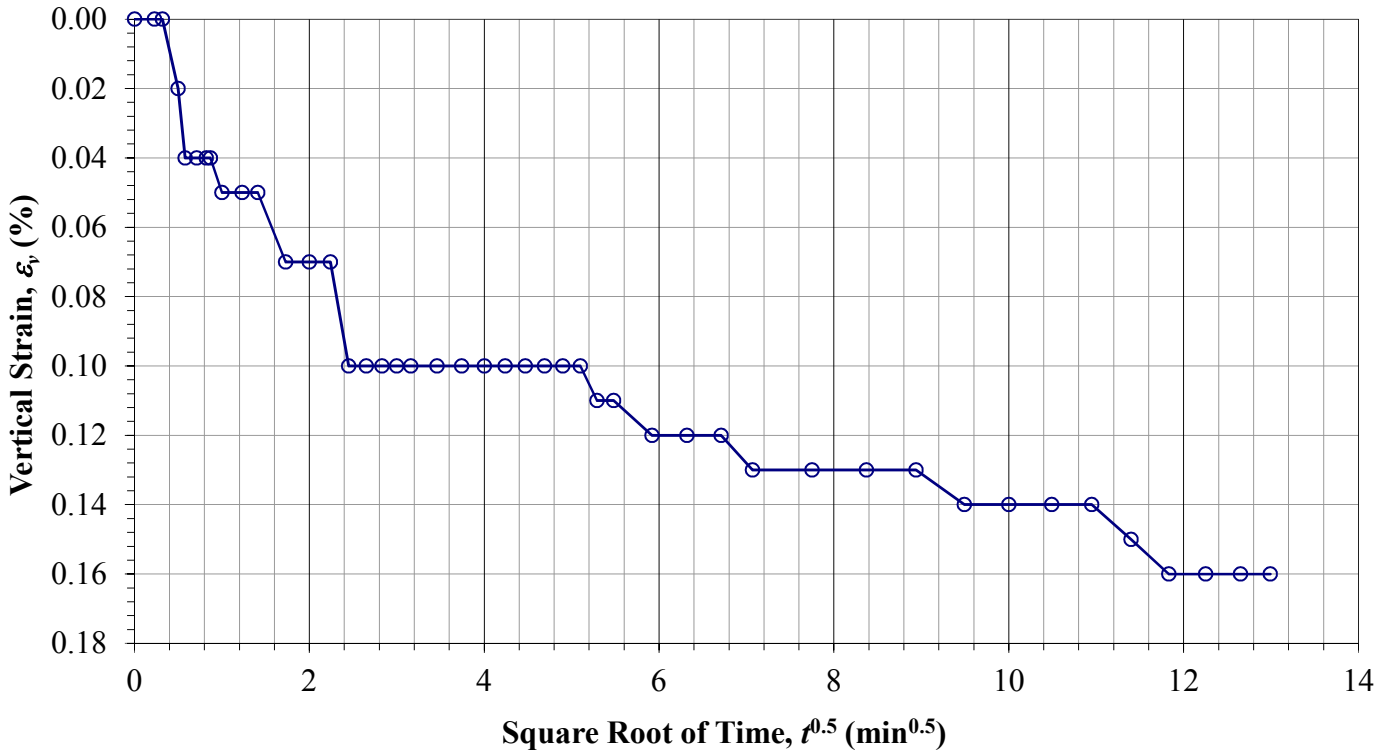
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 14
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 55'

Constant Load Step: 1 of 14
Stress: 100 psf





One-Dimensional Consolidation Properties of Soils

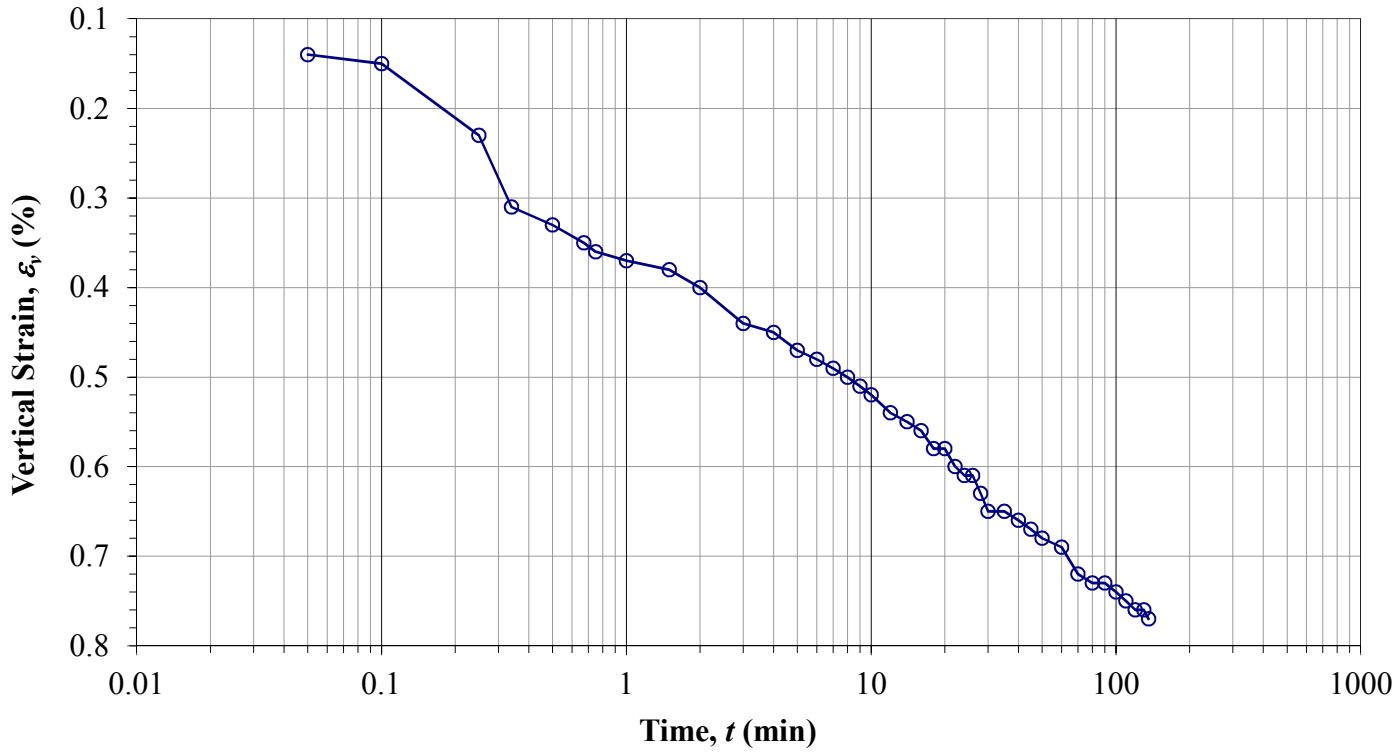
(ASTM D2435)

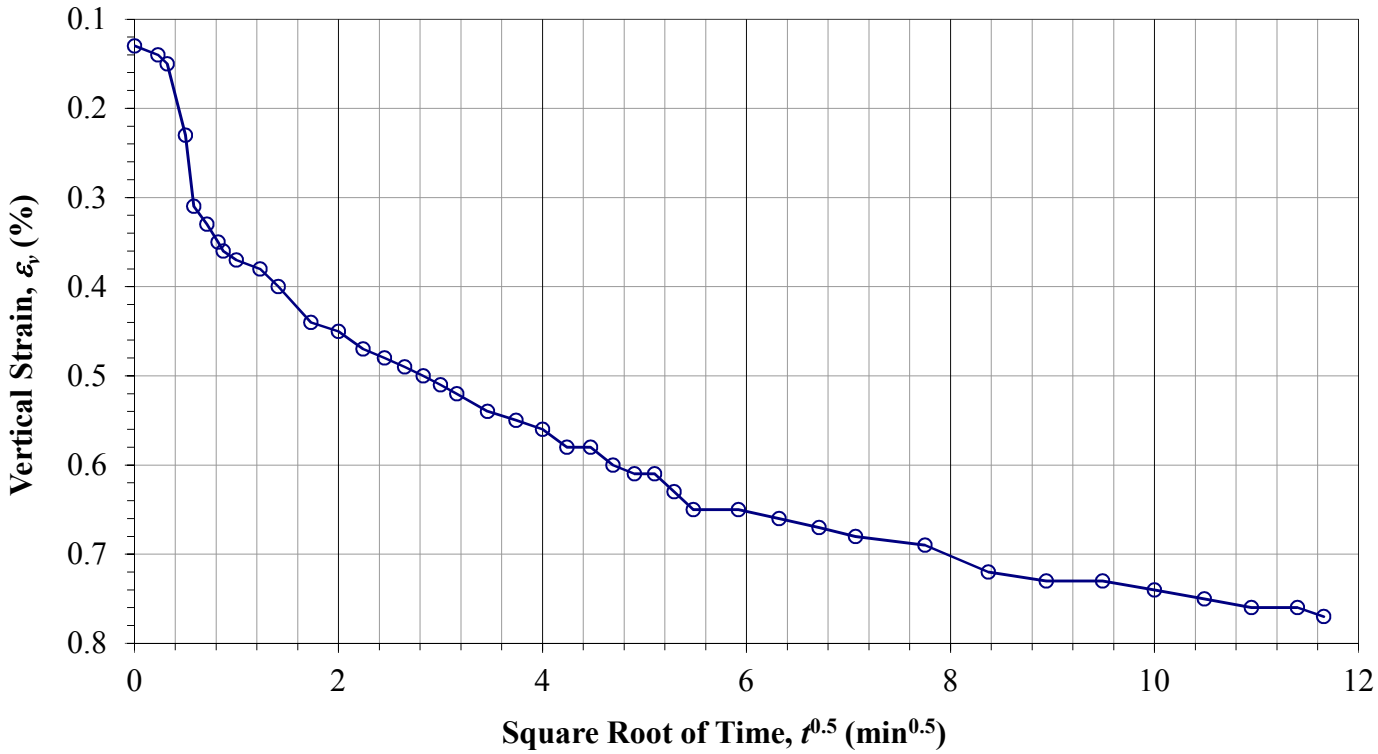
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 14
Depth: 55'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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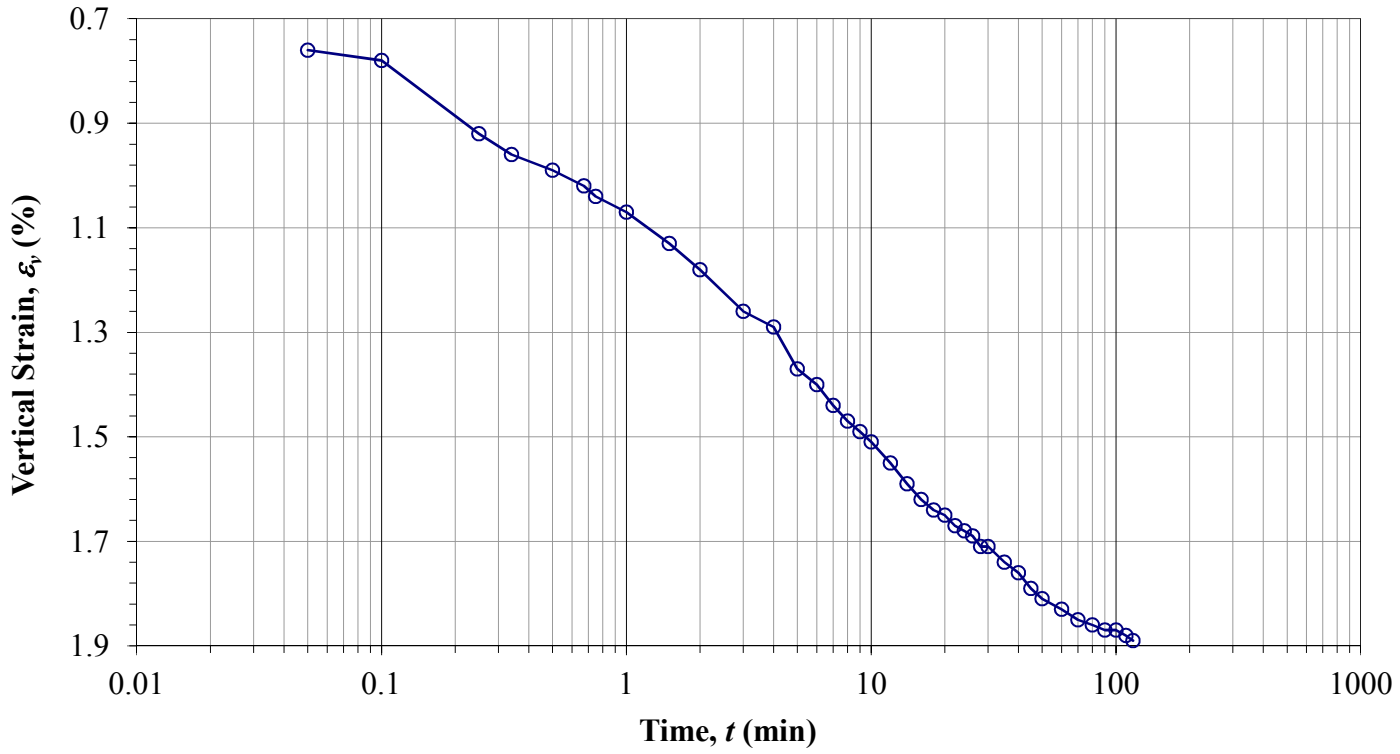
Project: AECOM **Boring No.:** BH19-ES-2

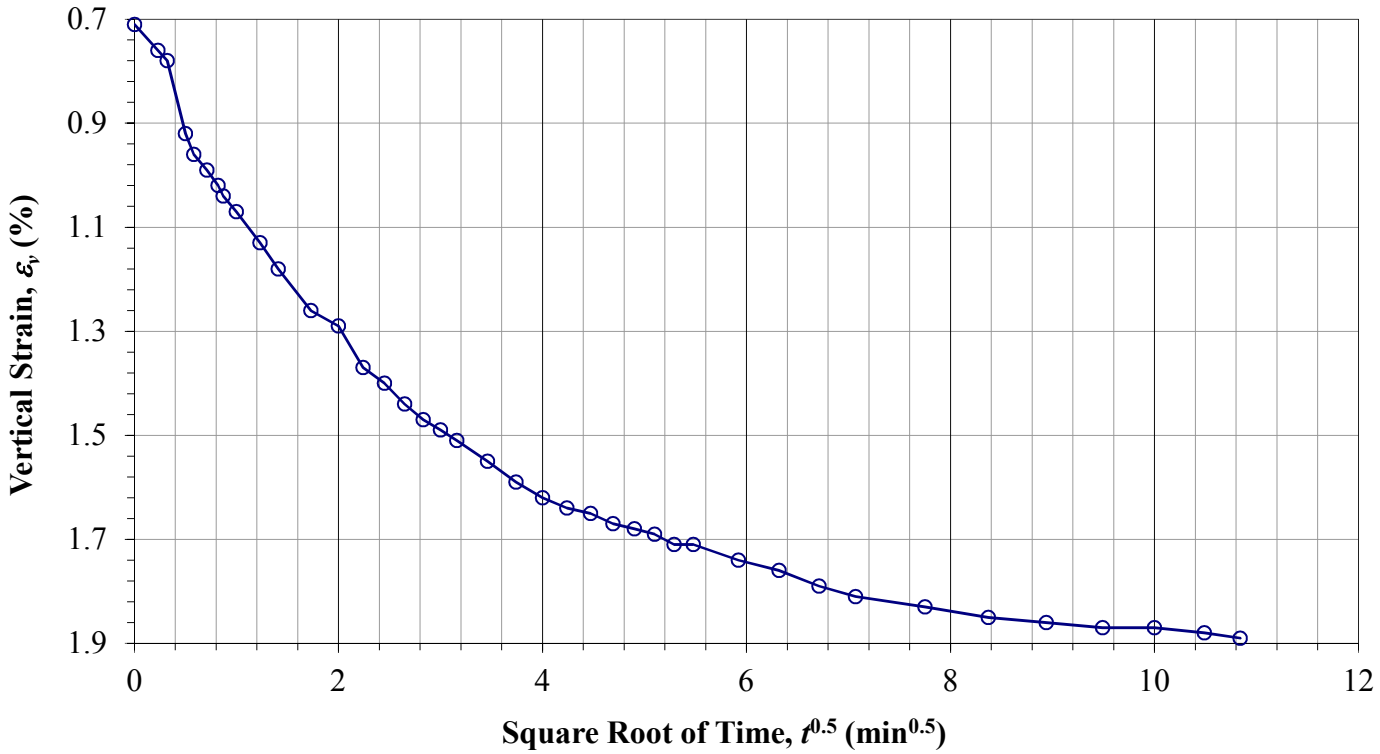
No: 00100-015, 3G2 (XIII) **Sample:** 14

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 55'

Constant Load Step: 3 of 14

Stress: 400 psf





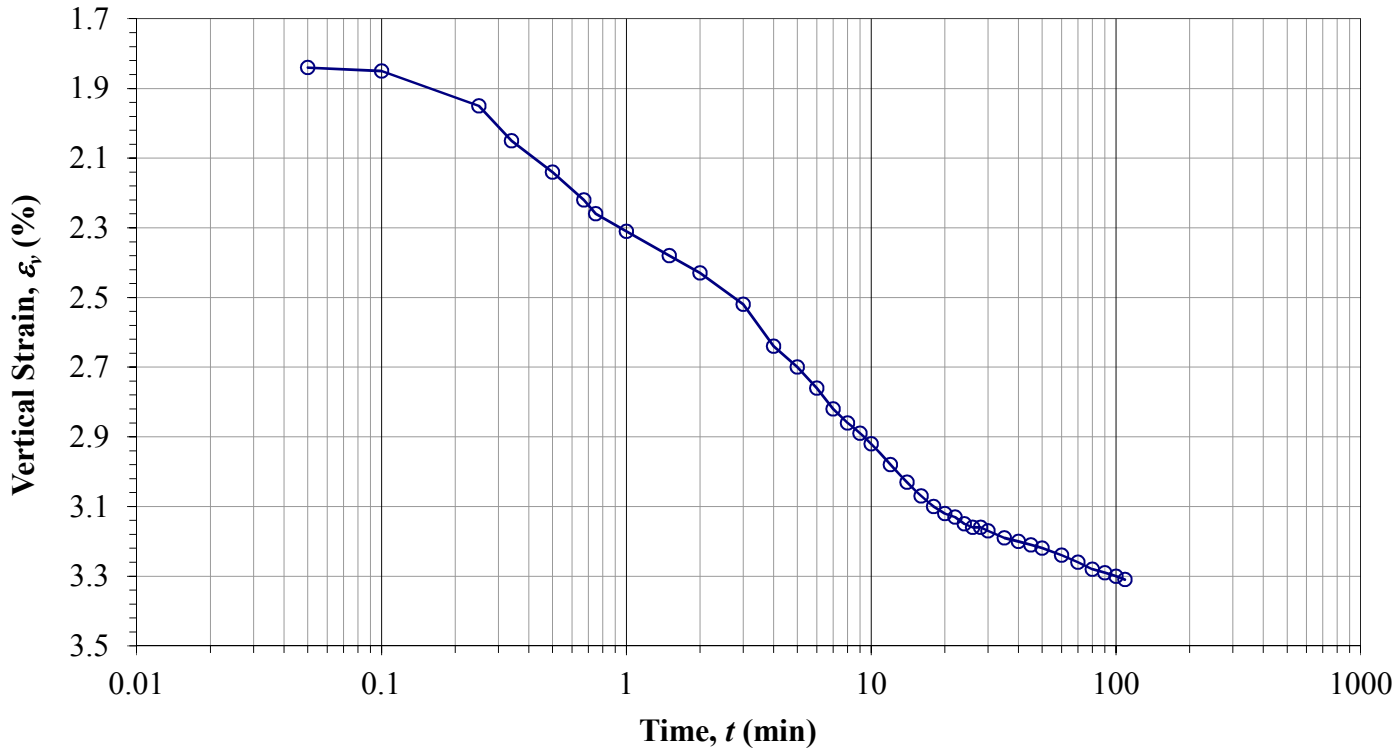
One-Dimensional Consolidation Properties of Soils

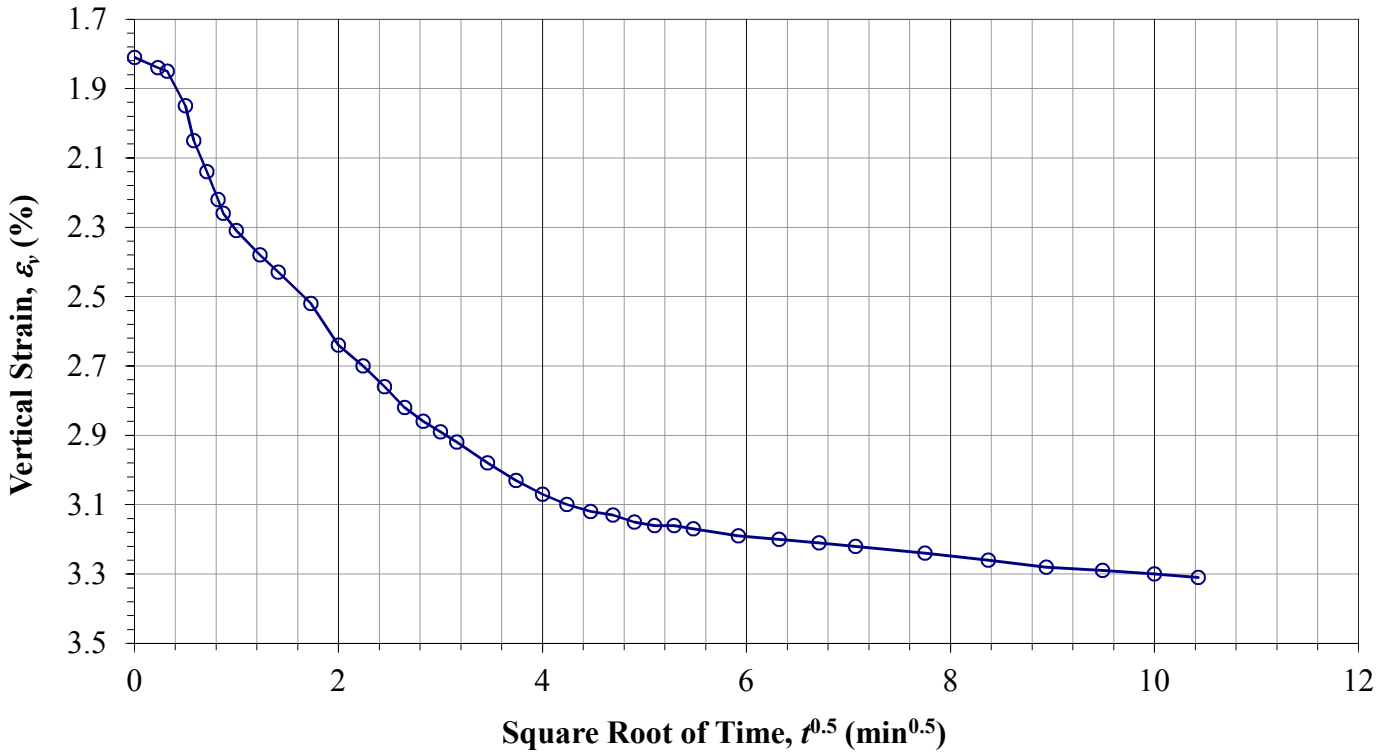
(ASTM D2435)

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Project: AECOM
Boring No.: BH19-ES-2
No: 00100-015, 3G2 (XIII)
Sample: 14
Location: SLCity Public Utilities Waste Water Reclamation Facility
Depth: 55'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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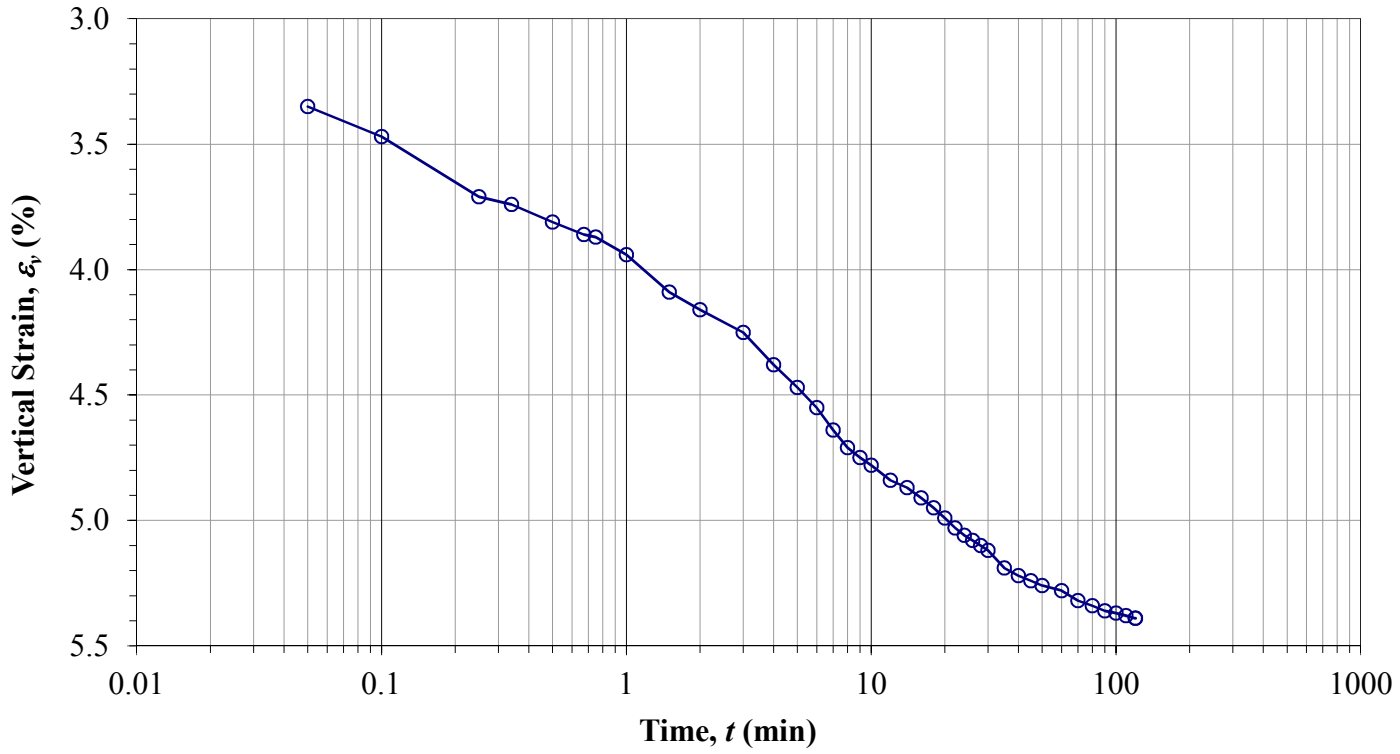
Project: AECOM **Boring No.:** BH19-ES-2

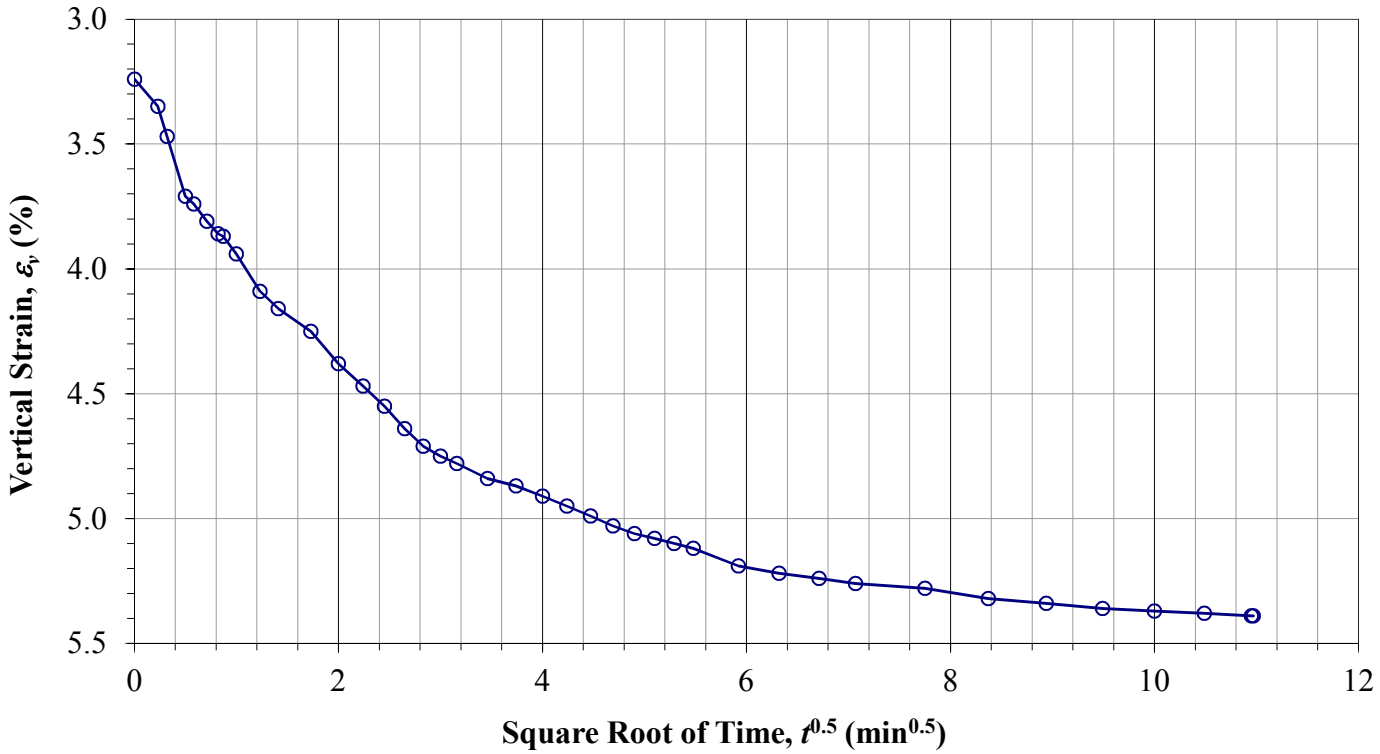
No: 00100-015, 3G2 (XIII) **Sample:** 14

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 55'

Constant Load Step: 5 of 14

Stress: 1600 psf





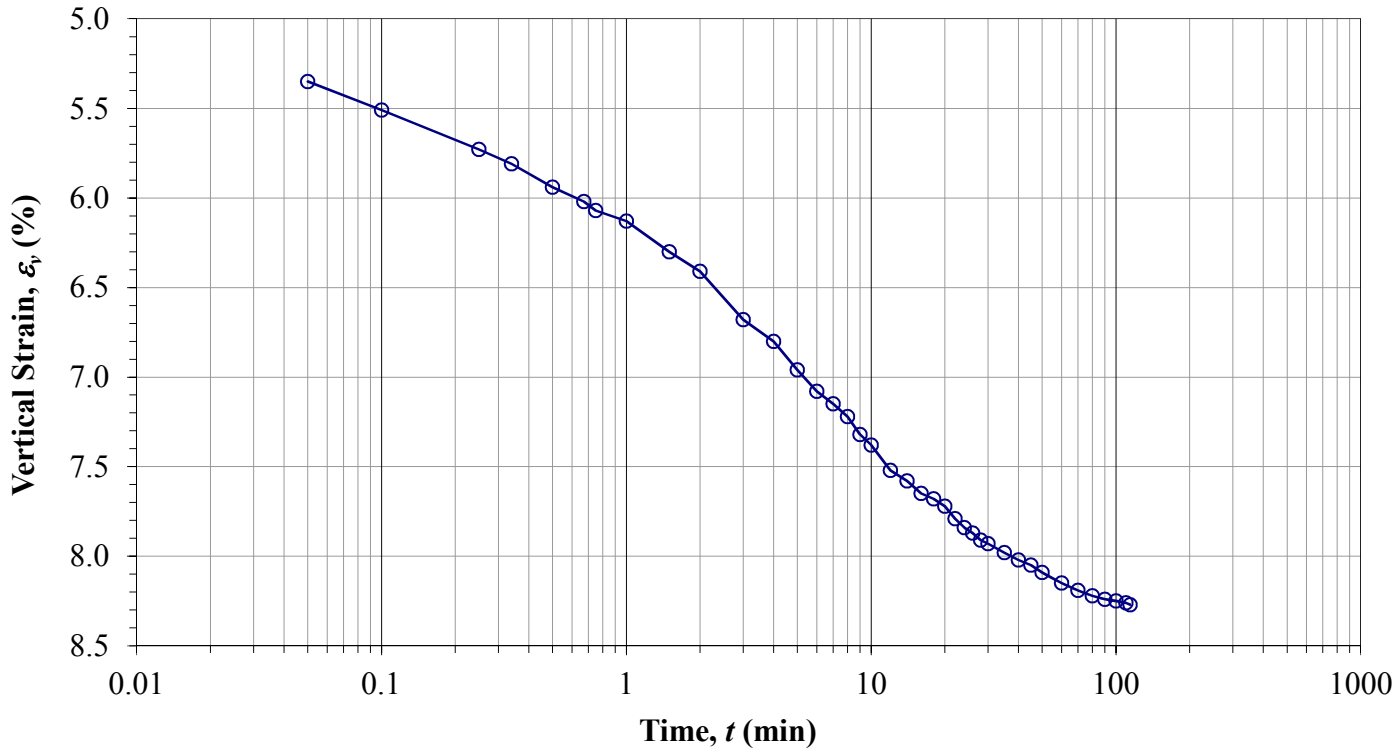
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

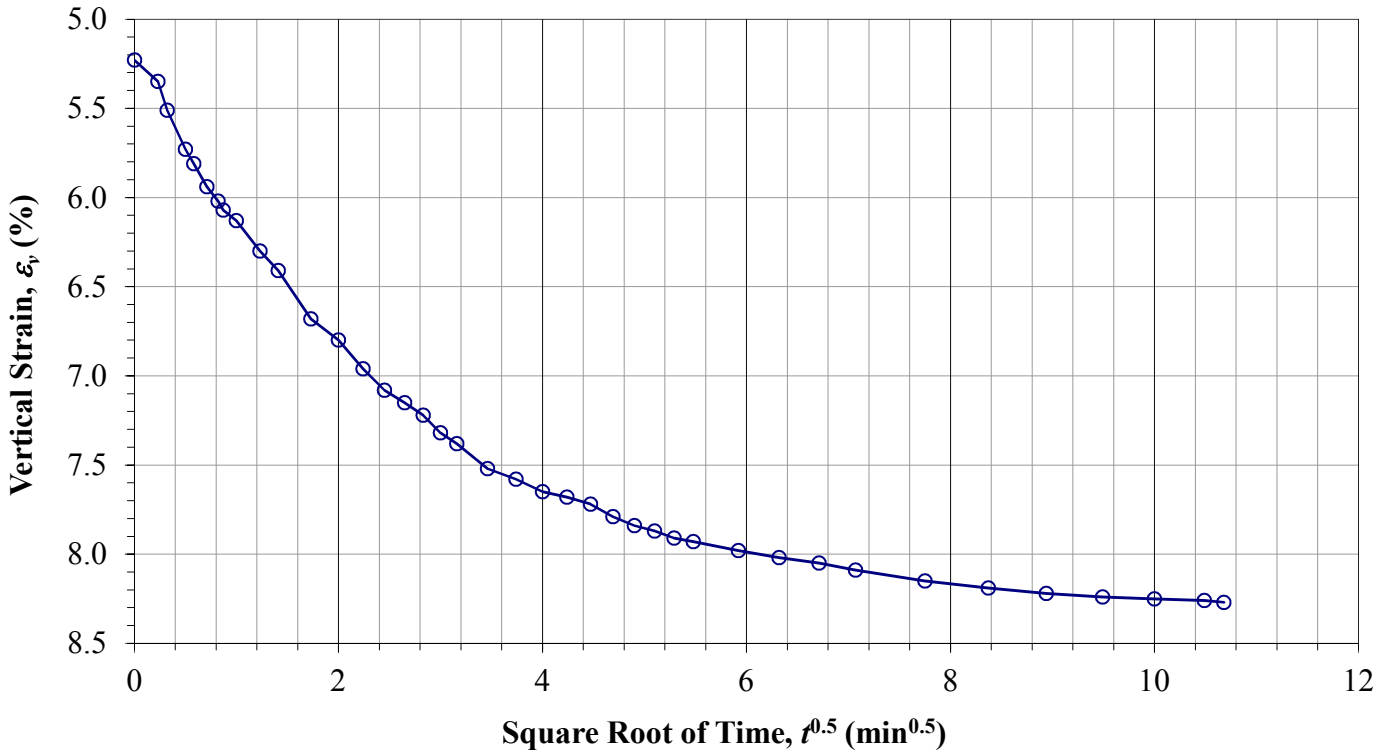
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 14
Depth: 55'

Constant Load Step: 6 of 14
Stress: 3200 psf





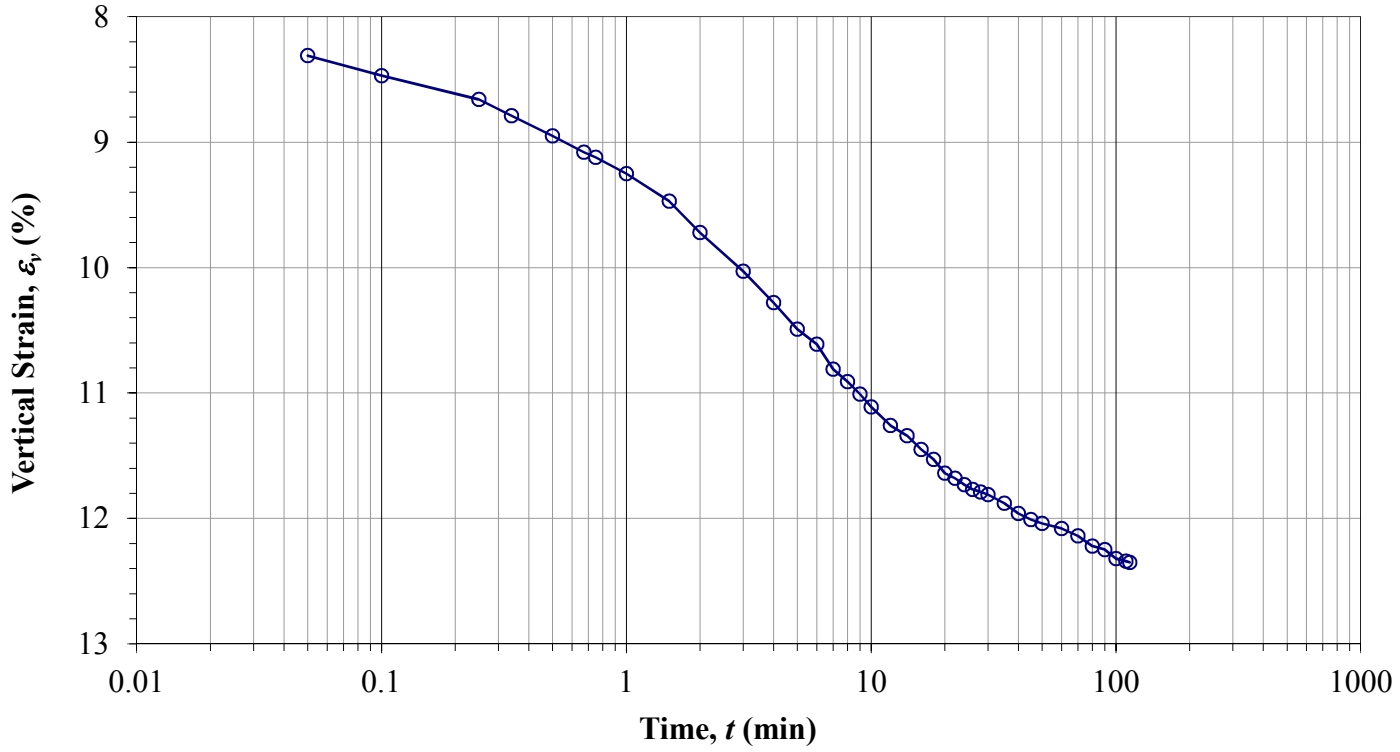
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

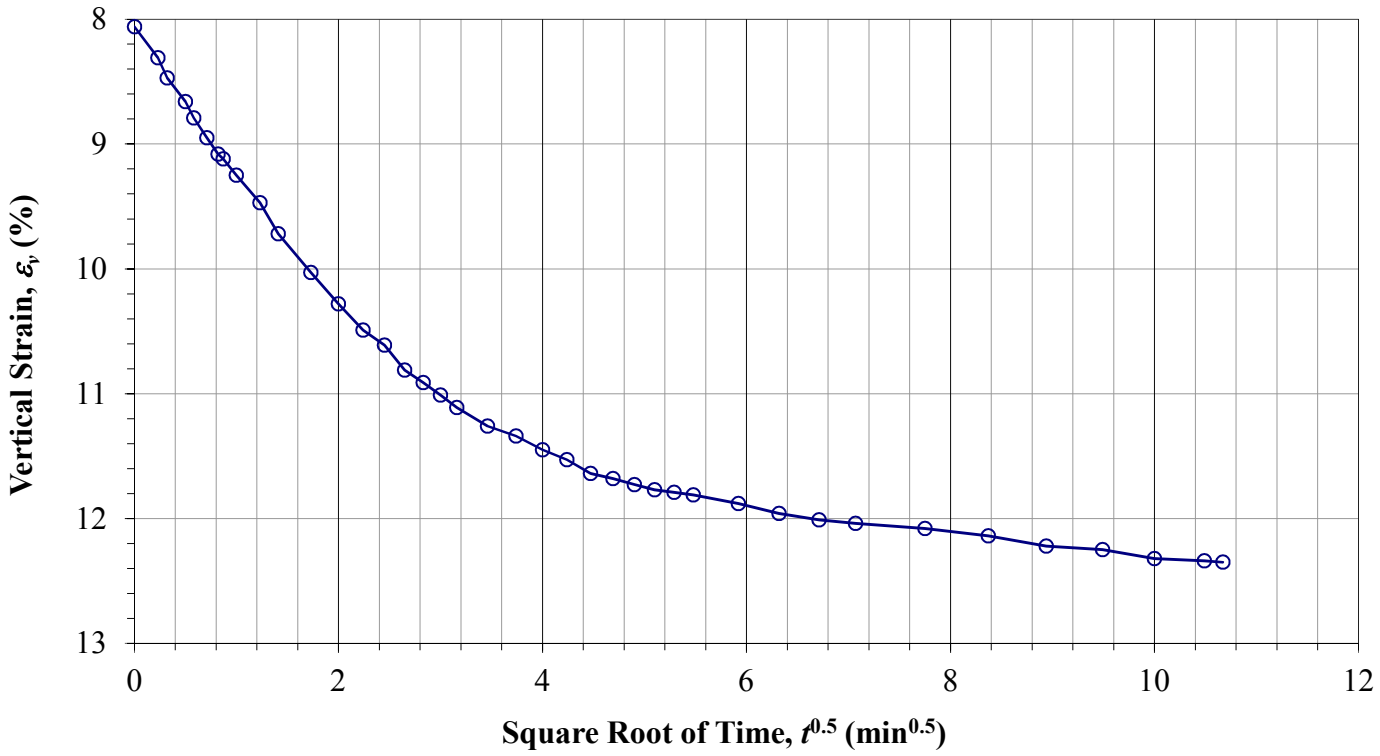
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 14
Depth: 55'

Constant Load Step: 7 of 14
Stress: 6400 psf





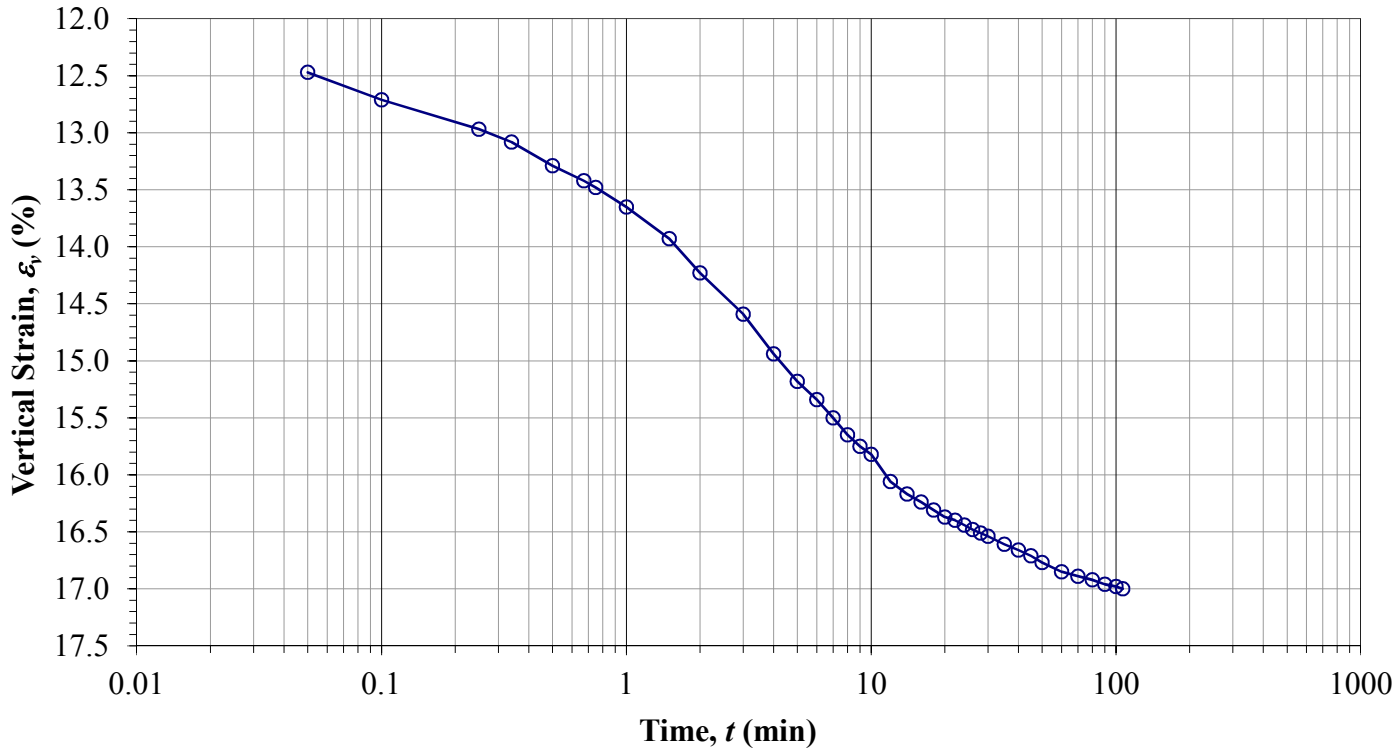
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

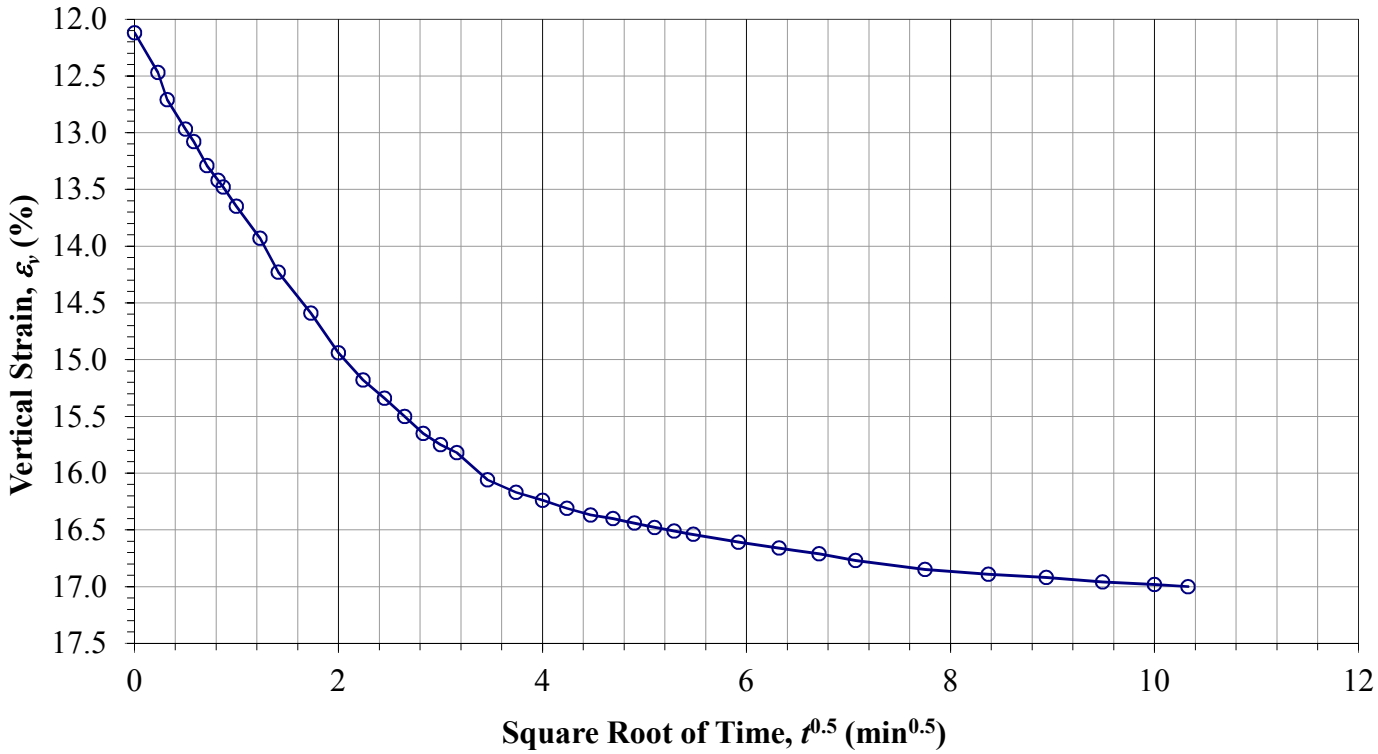
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 14
Depth: 55'

Constant Load Step: 8 of 14
Stress: 12800 psf





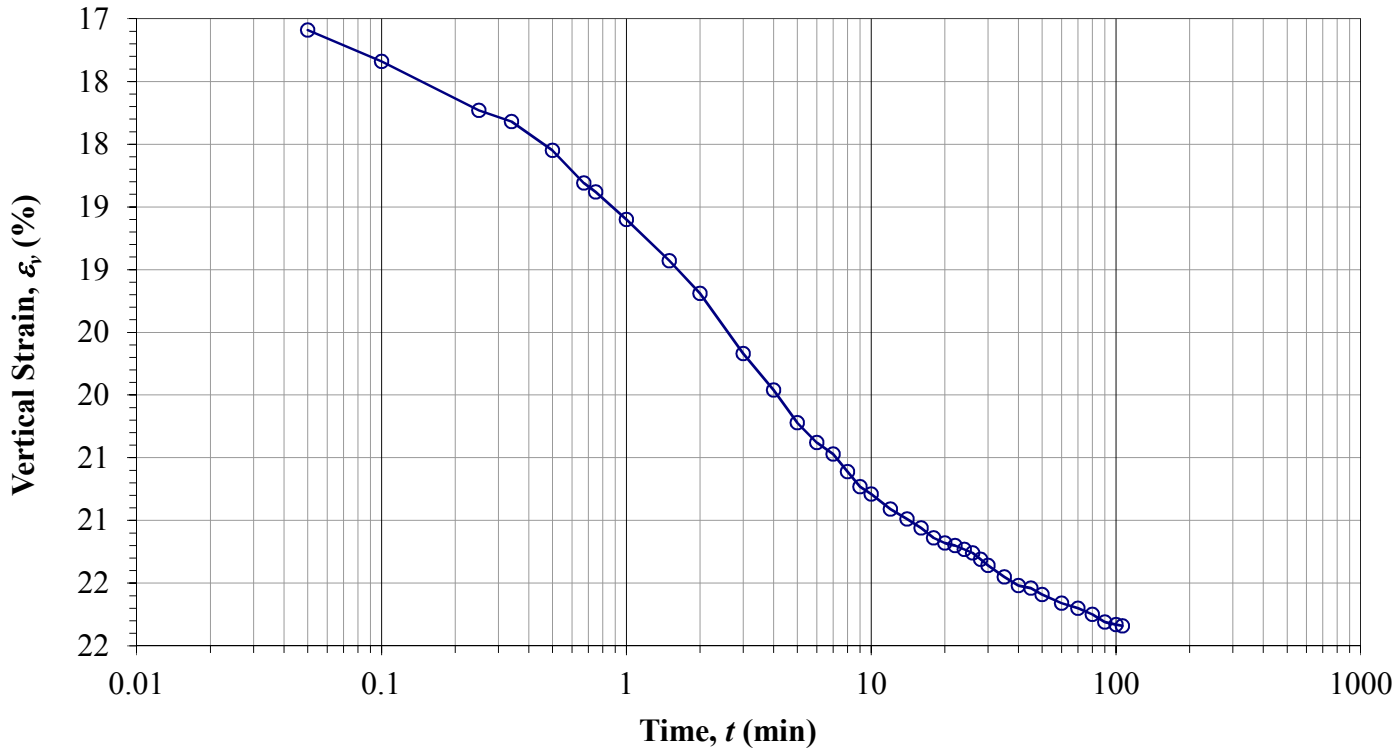
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

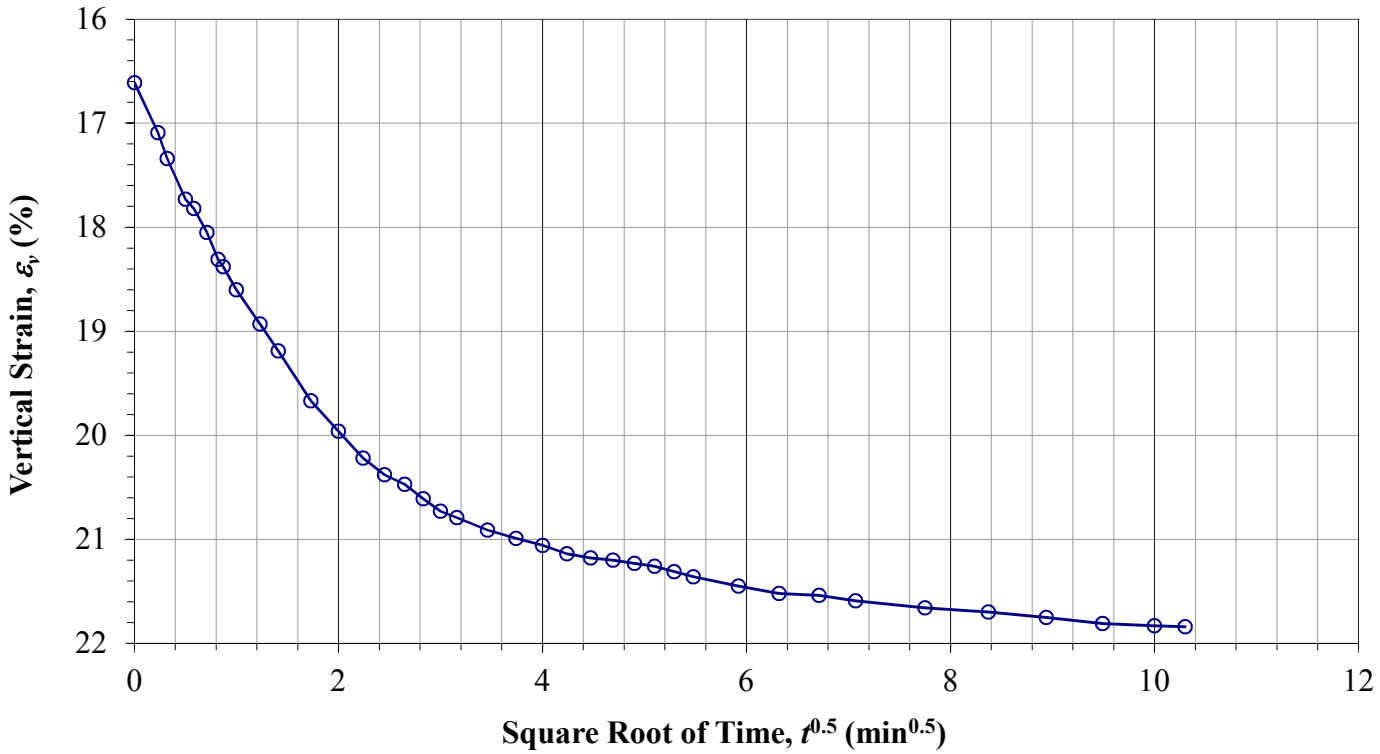
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 14
Depth: 55'

Constant Load Step: 9 of 14
Stress: 25600 psf





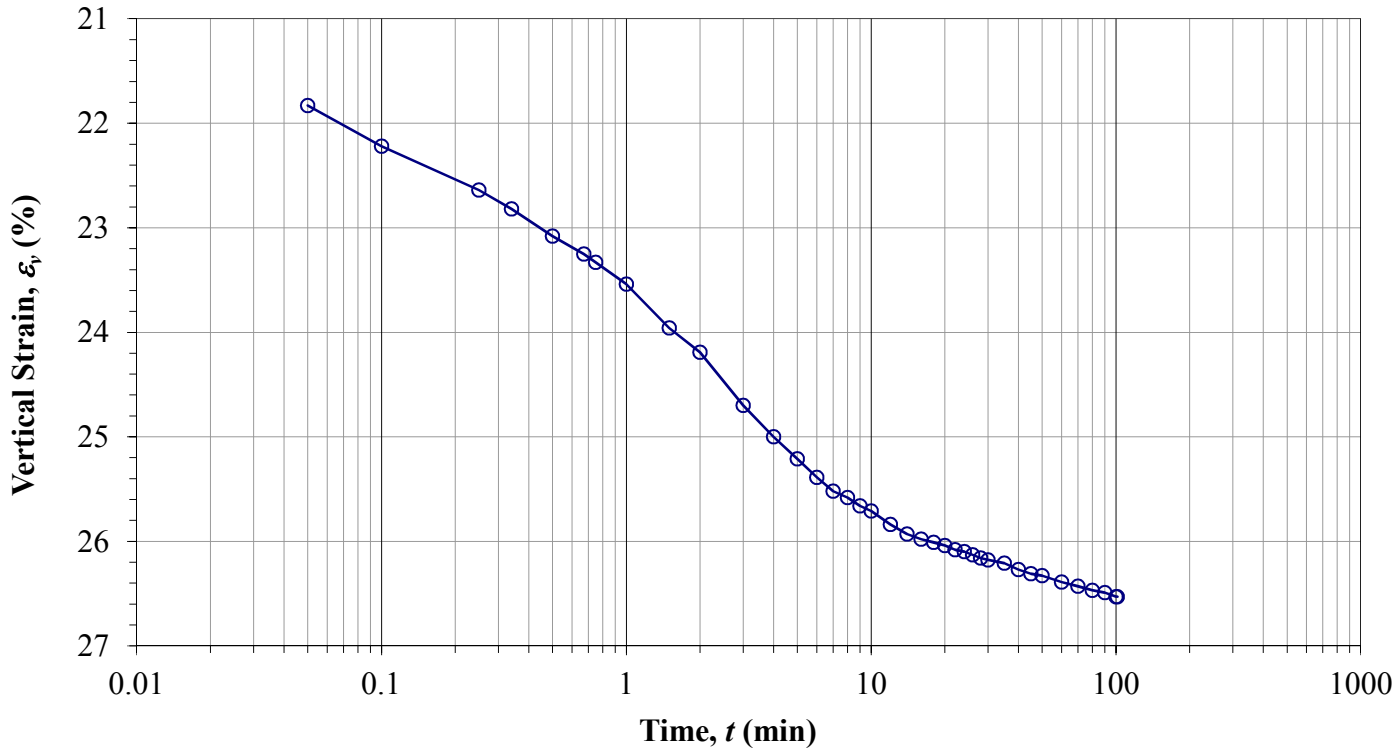
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

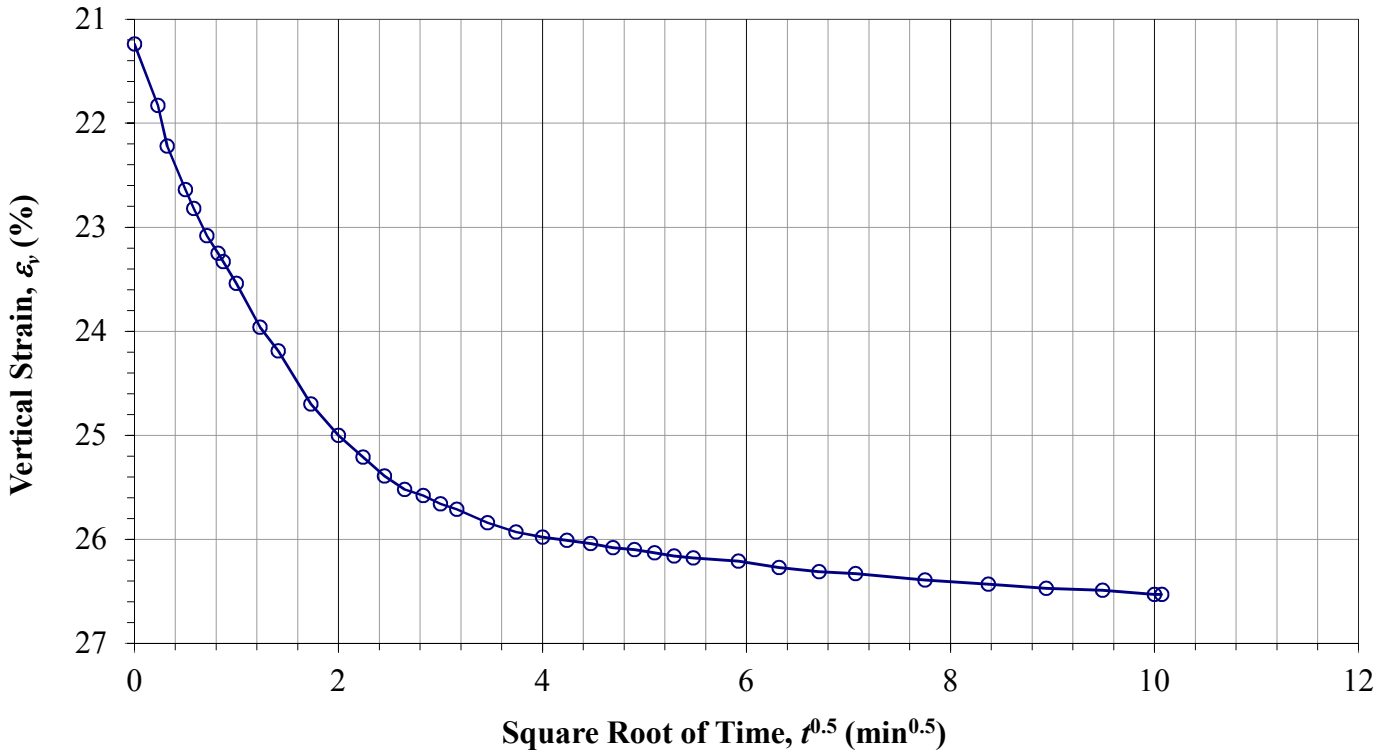
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 14
Depth: 55'

Constant Load Step: 10 of 14
Stress: 51200 psf



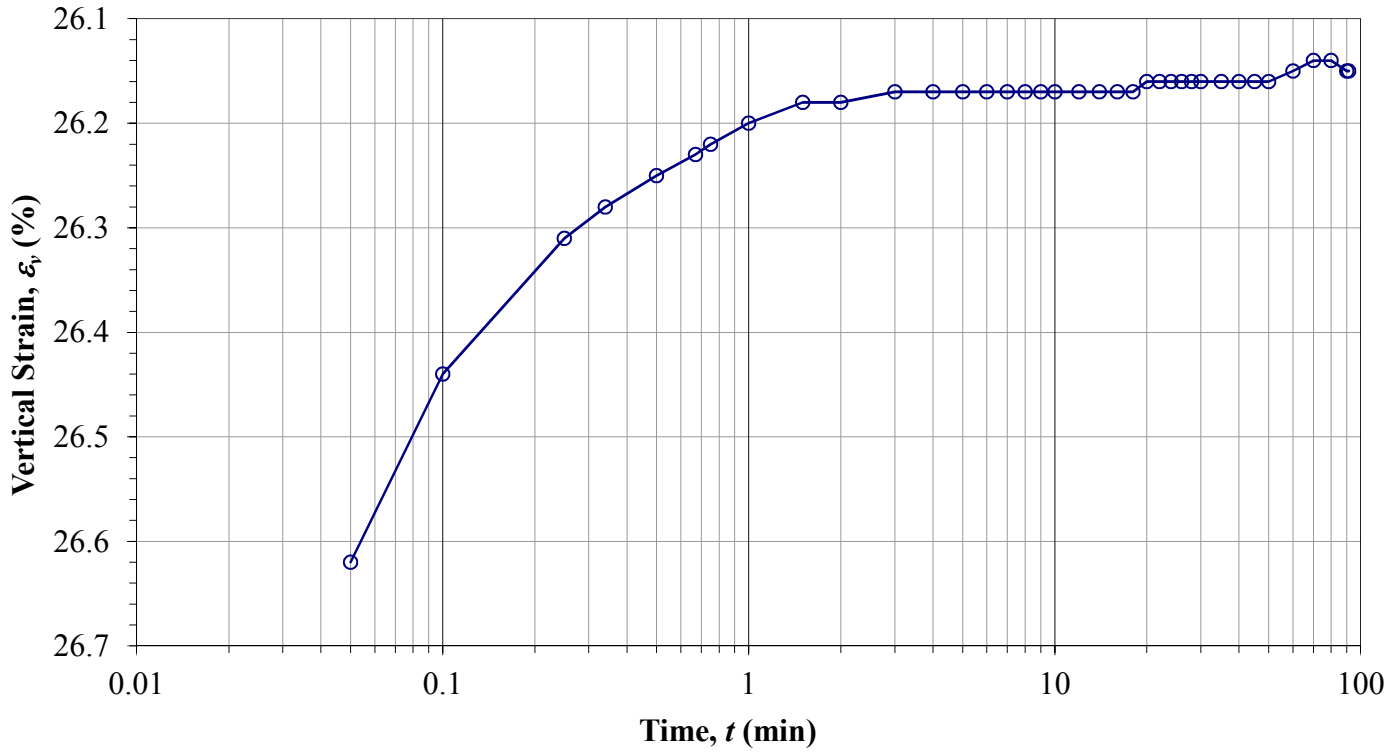


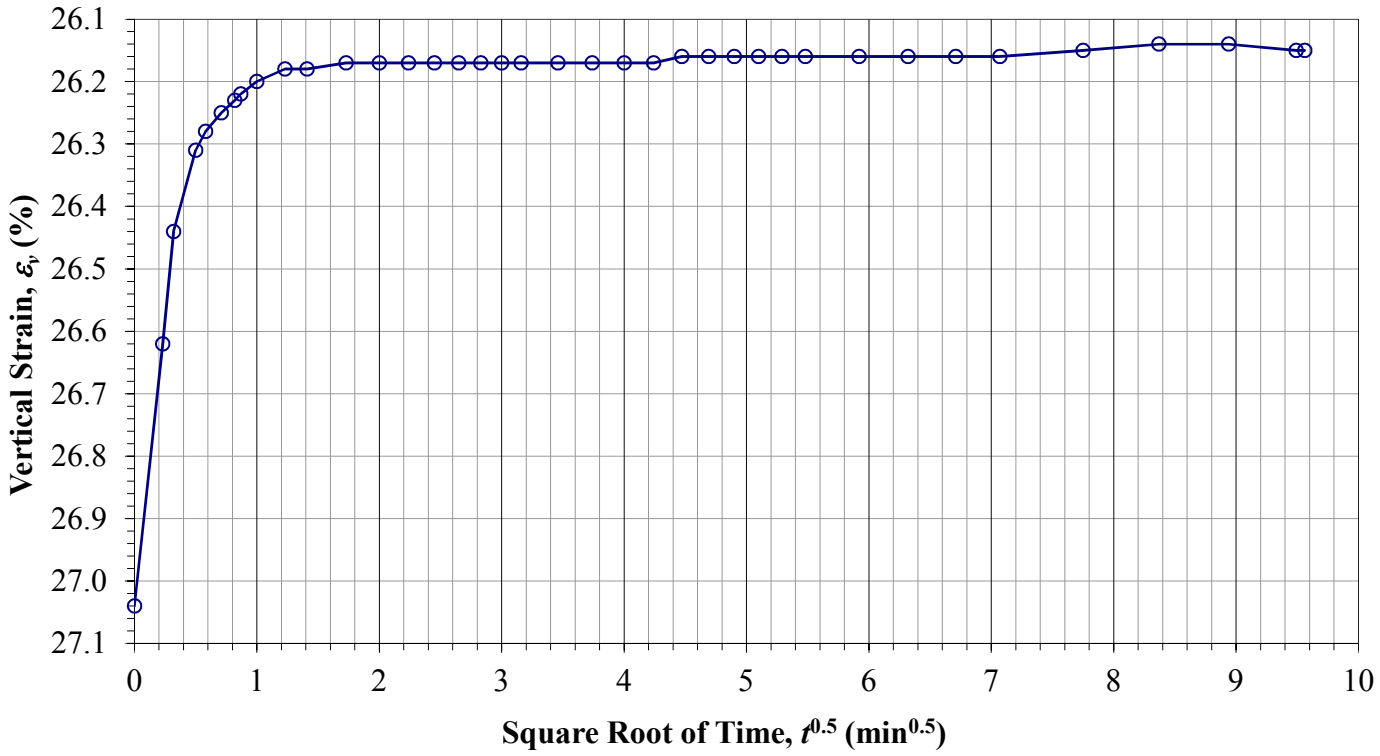
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 14
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 55'

Constant Load Step: 11 of 14
Stress: 25600 psf



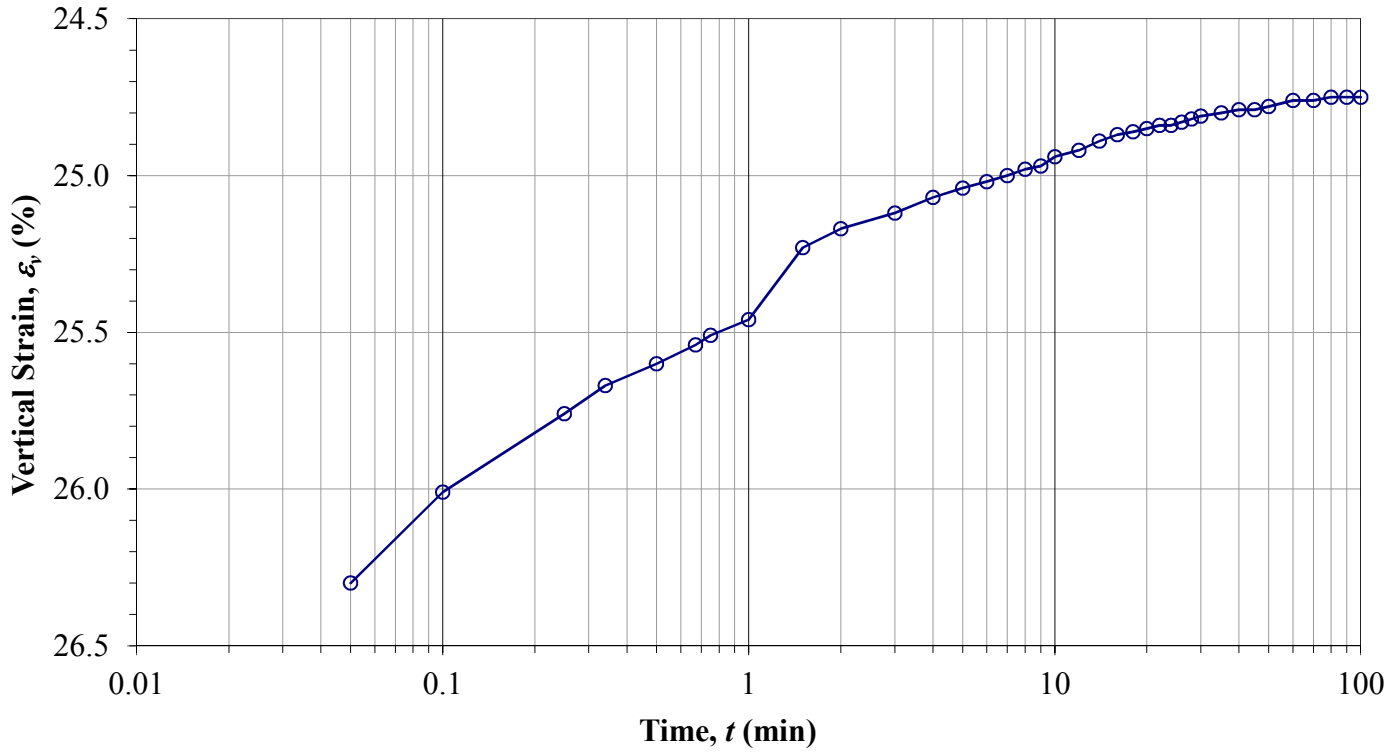


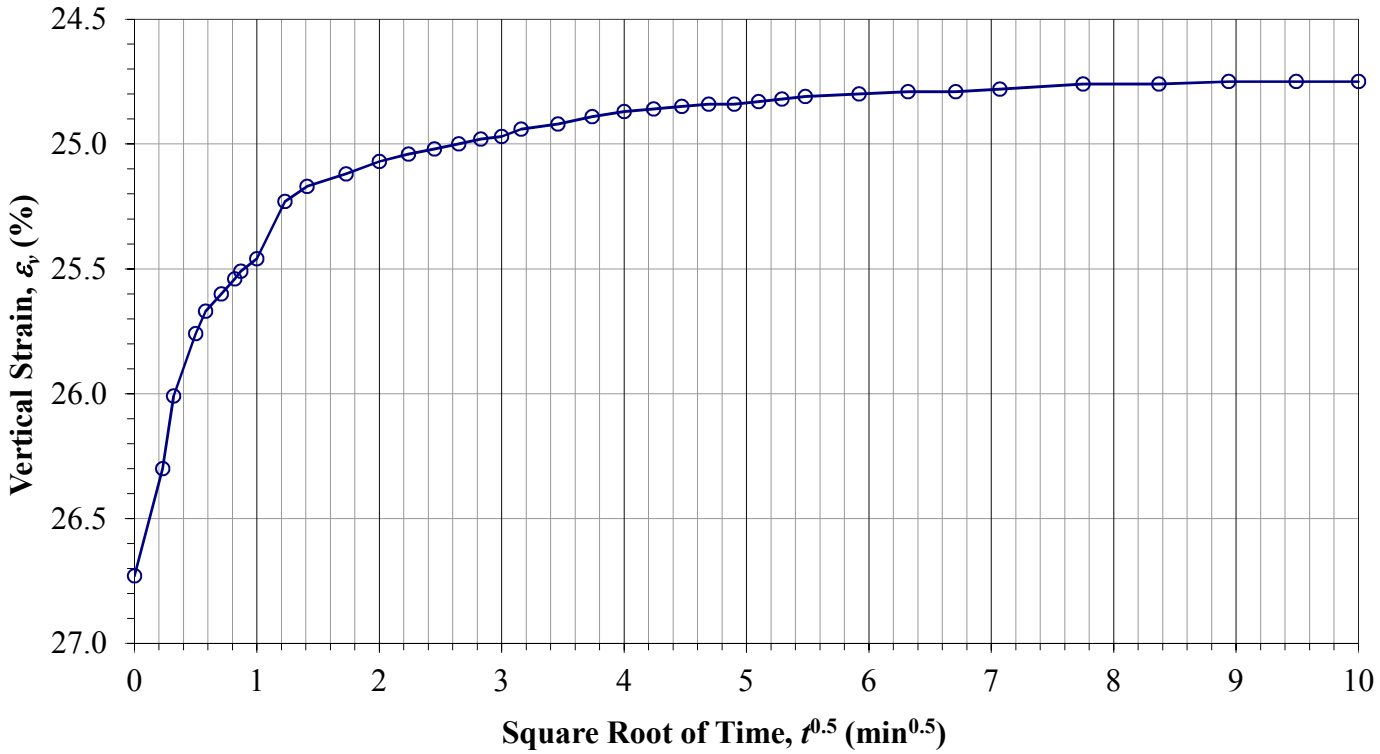
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 14
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 55'

Constant Load Step: 12 of 14
Stress: 6400 psf



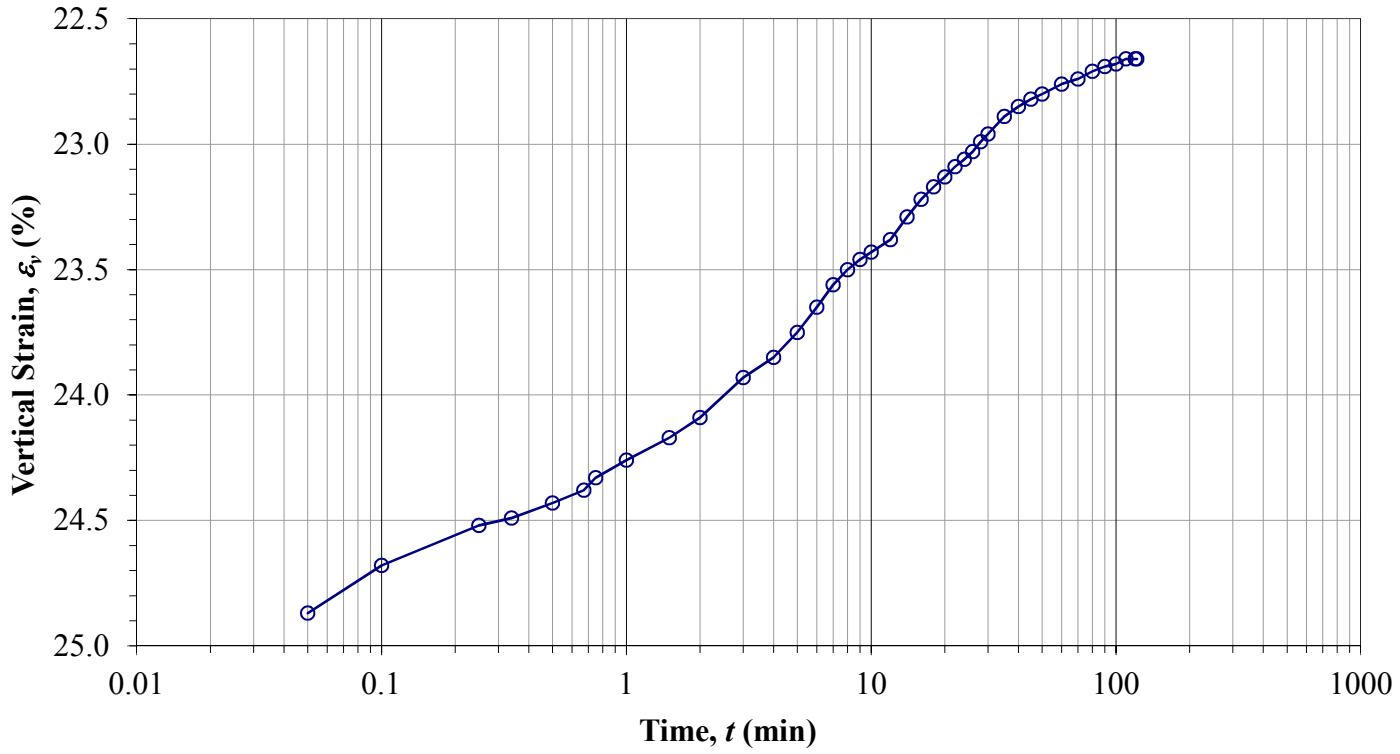


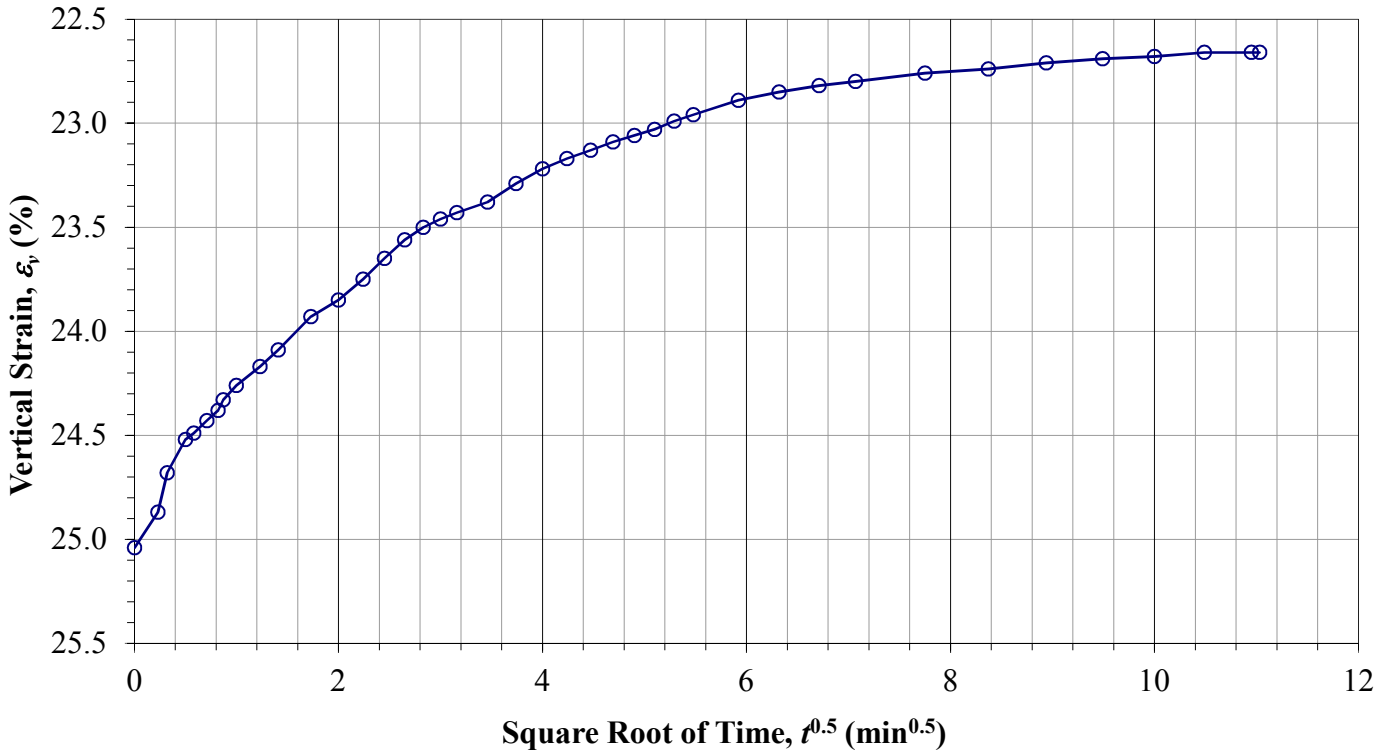
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 14
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 55'

Constant Load Step: 13 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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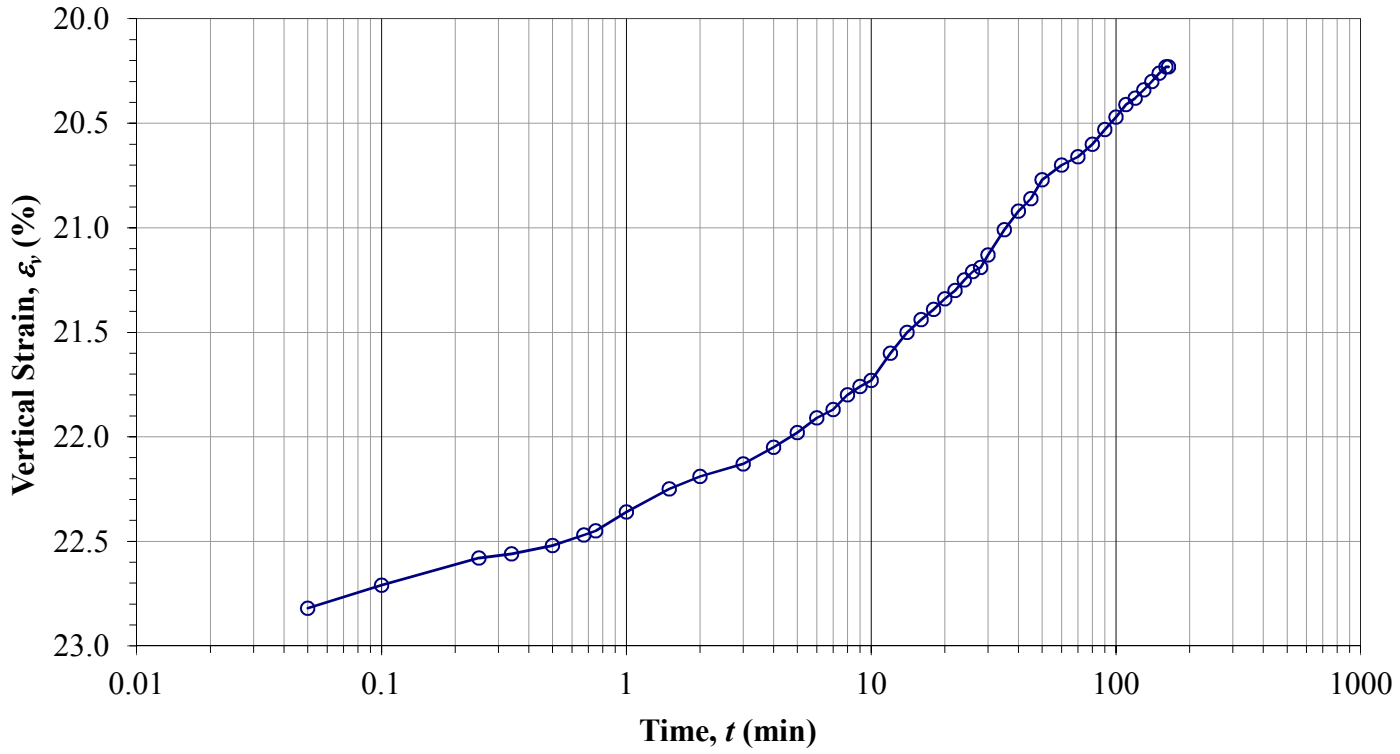
Project: AECOM **Boring No.:** BH19-ES-2

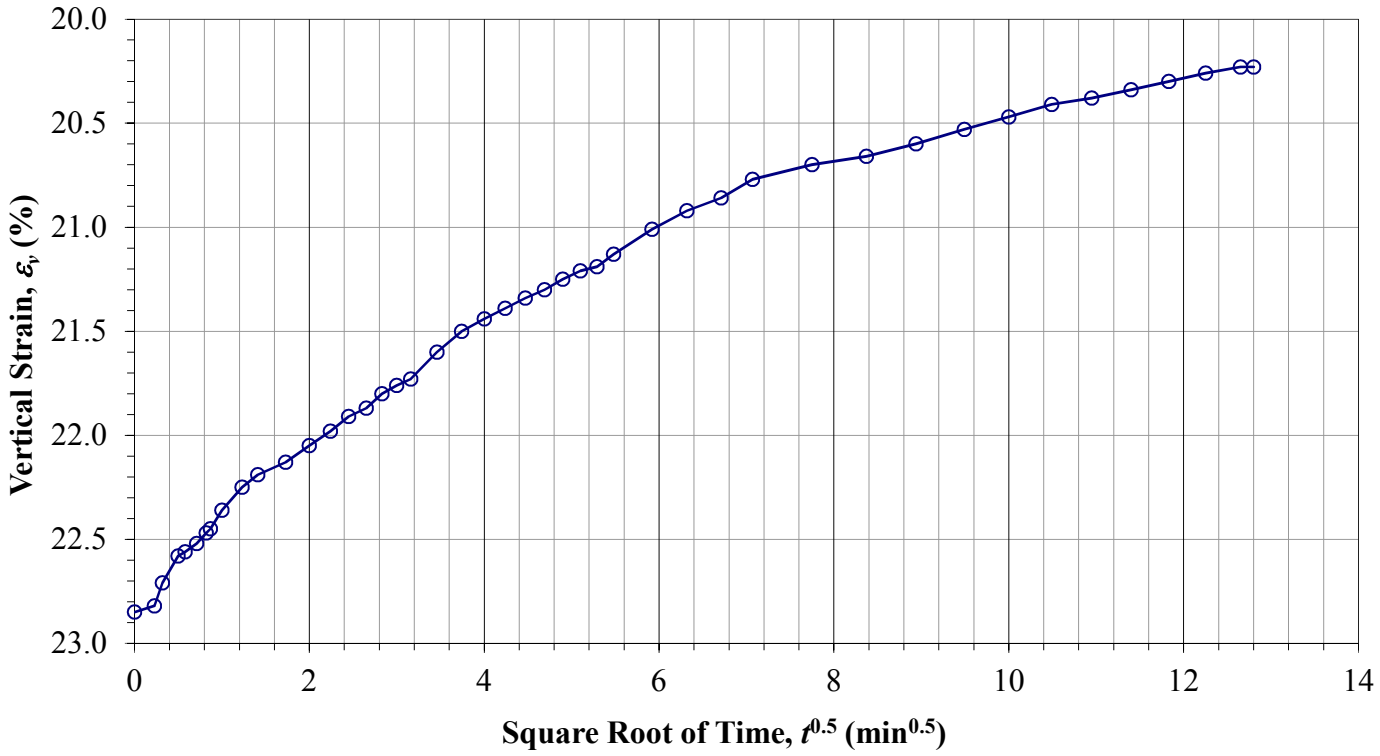
No: 00100-015, 3G2 (XIII) **Sample:** 14

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 55'

Constant Load Step: 14 of 14

Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/2/2019
By: JDF

Boring No.: BH19-ES-2
Sample: 23
Depth: 100'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

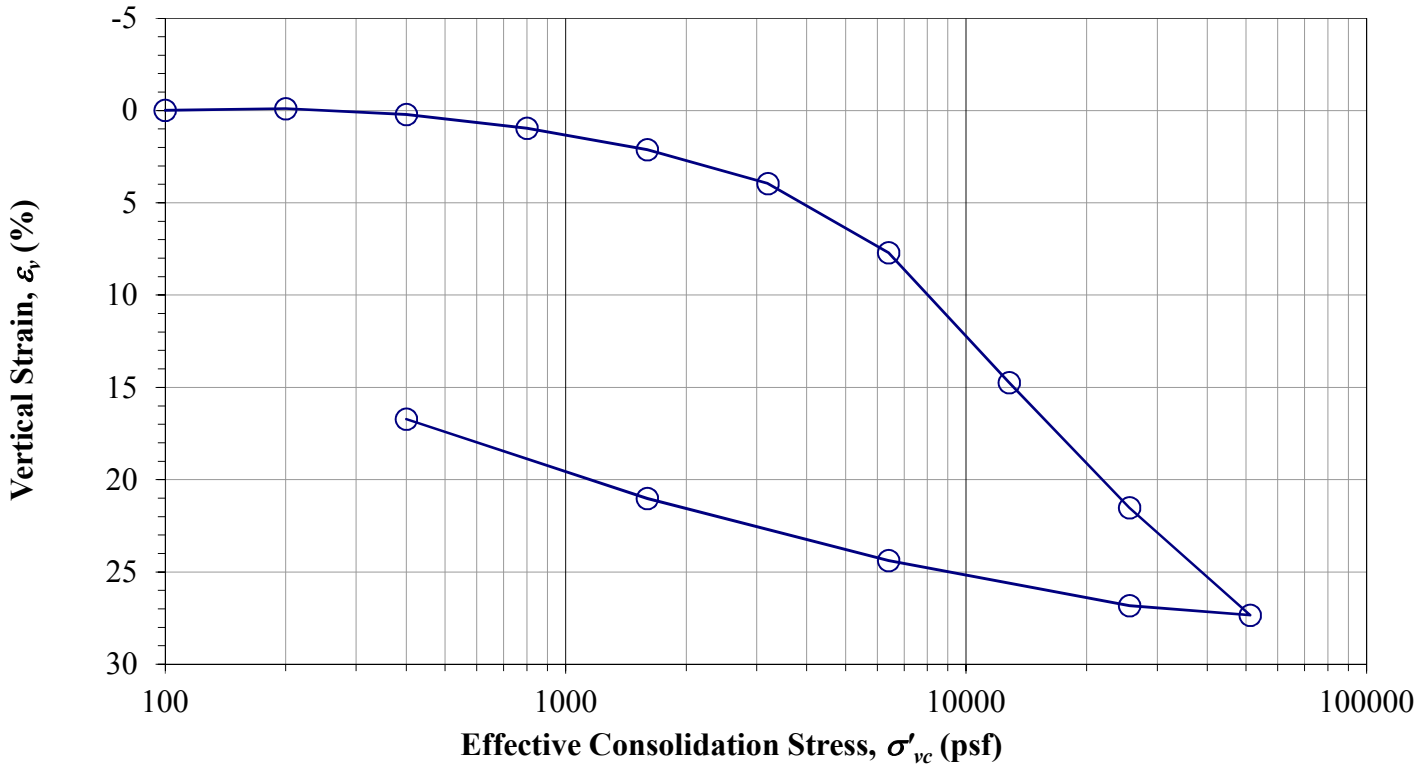
Test method:	B	
Inundation stress (psf), timing:	Seating	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation: Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.918	0.765
Sample diameter, D (in.)	2.412	2.412
Wt. rings + wet soil (g)	167.69	165.55
Wt. rings/tare (g)	44.80	44.80
Total unit wt., γ (pcf)	111.6	131.69
Wet soil + tare (g)	431.86	234.96
Dry soil + tare (g)	350.46	206.48
Tare (g)	127.02	122.85
Water content, ω (%)	36.4	34.1
Dry unit wt., γ_d (pcf)	81.8	98.2
Saturation, S	0.93	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9180	1.0604
100	0.0000	0.00	0.9180	1.0604
200	-0.0010	-0.11	0.9190	1.0625
400	0.0020	0.22	0.9160	1.0558
800	0.0089	0.97	0.9091	1.0405
1600	0.0196	2.13	0.8985	1.0165
3200	0.0363	3.96	0.8817	0.9788
6400	0.0707	7.70	0.8474	0.9018
12800	0.1353	14.74	0.7827	0.7567
25600	0.1975	21.51	0.7205	0.6171
51200	0.2510	27.34	0.6670	0.4970
25600	0.2462	26.82	0.6718	0.5078
6400	0.2238	24.38	0.6942	0.5581
1600	0.1929	21.01	0.7251	0.6274
400	0.1535	16.72	0.7645	0.7159



Comments: Specimen swelled upon inundation, and at the 100 and 200 psf loadings.

Entered: _____
Reviewed: _____

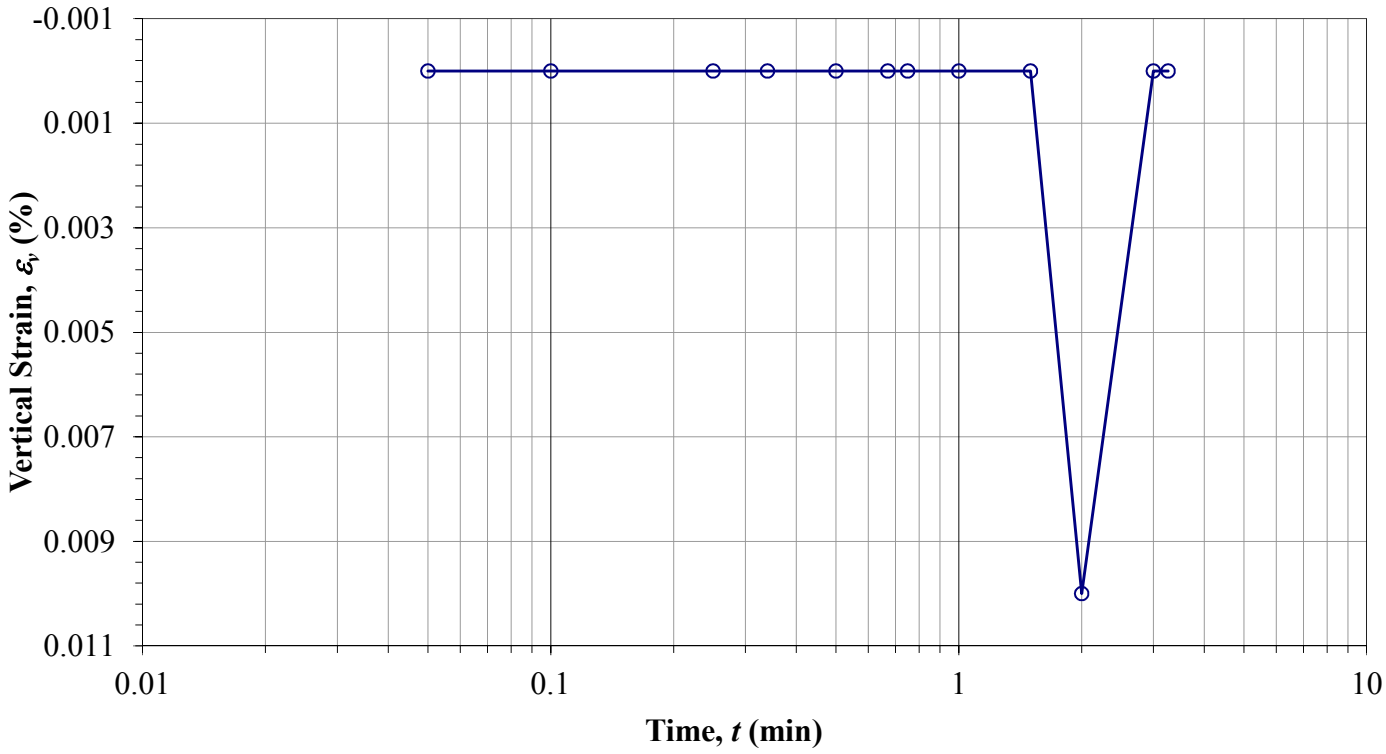
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

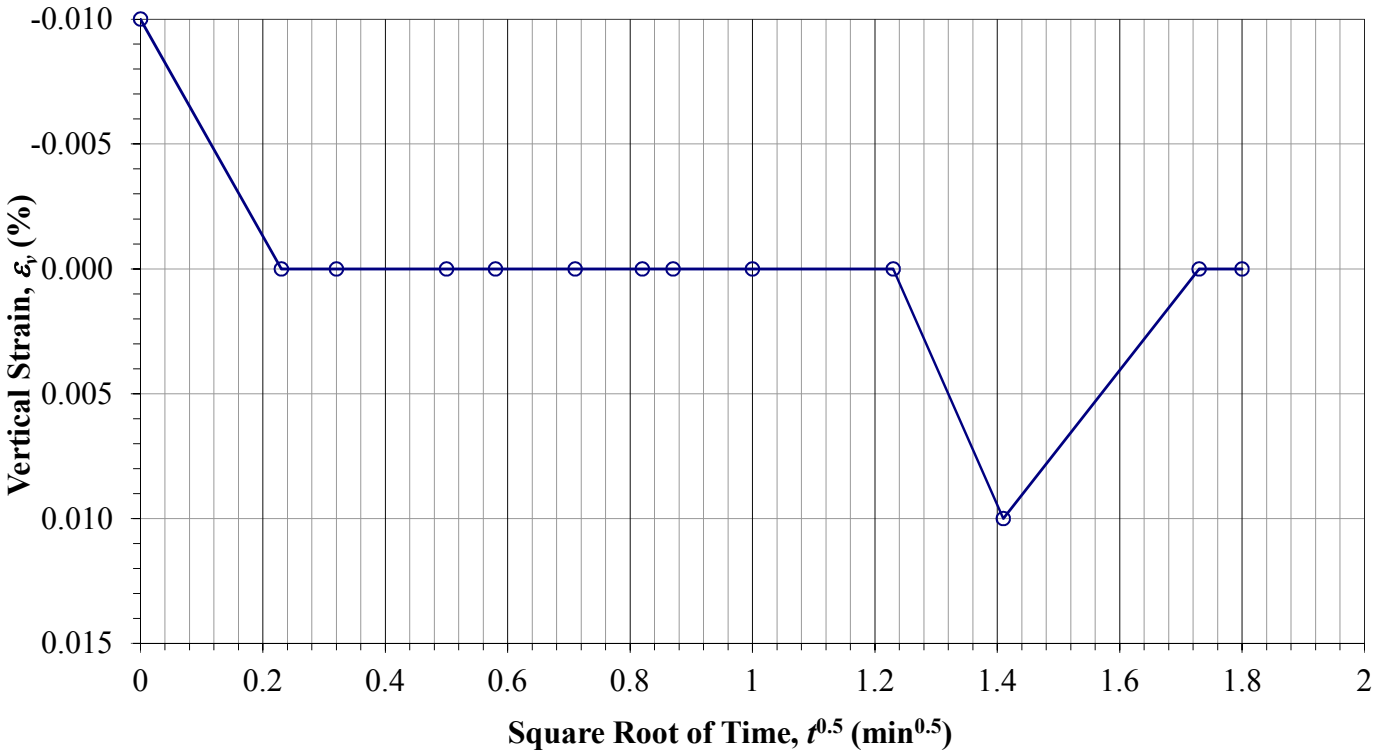
© IGES 2011, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 23
Depth: 100'

Constant Load Step: 1 of 14
Stress: 100 psf





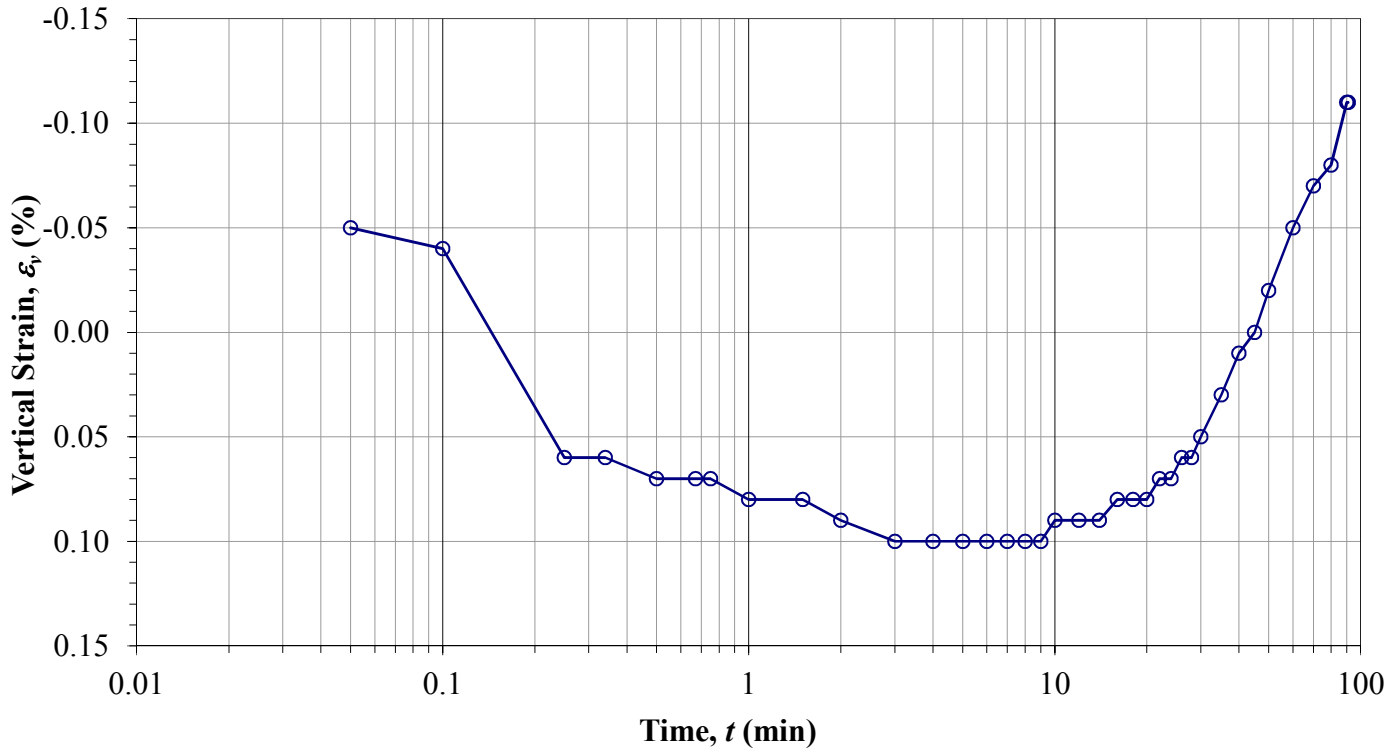
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

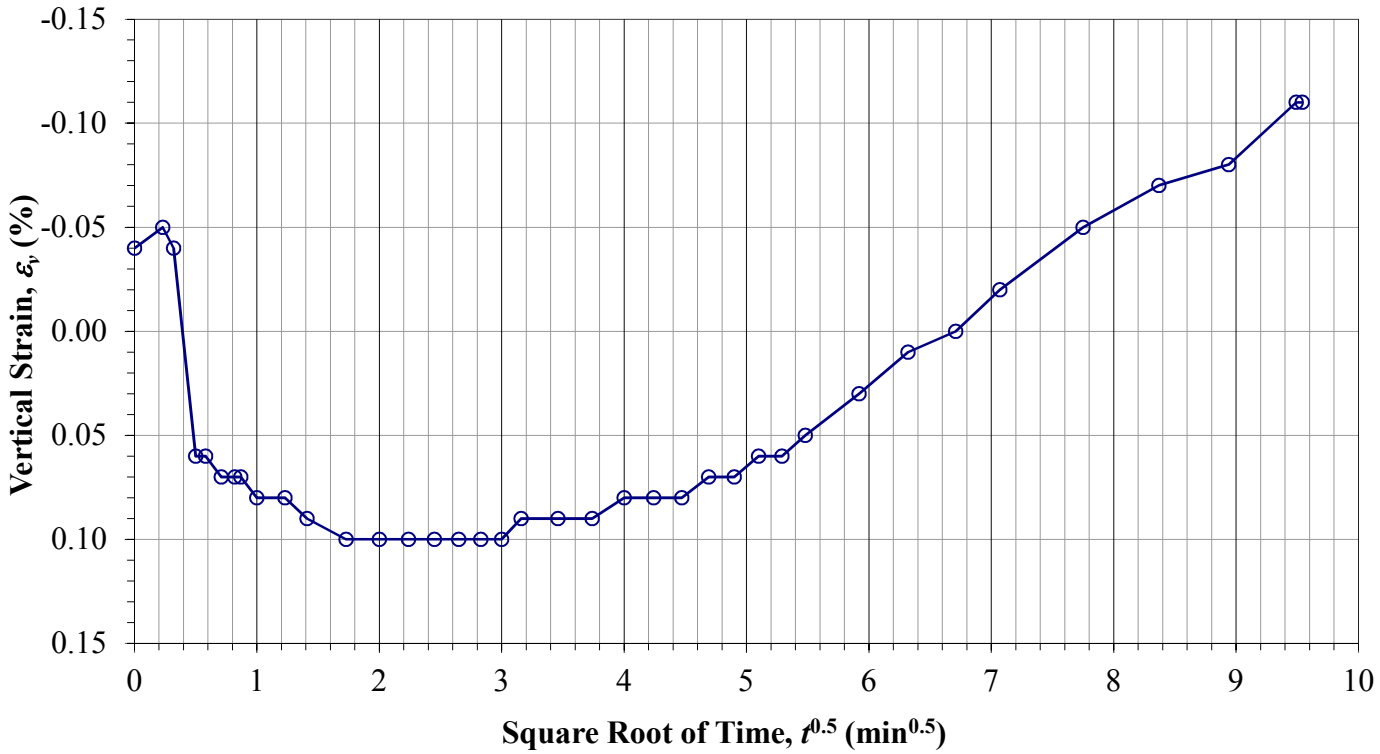
© IGES 2011, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 23
Depth: 100'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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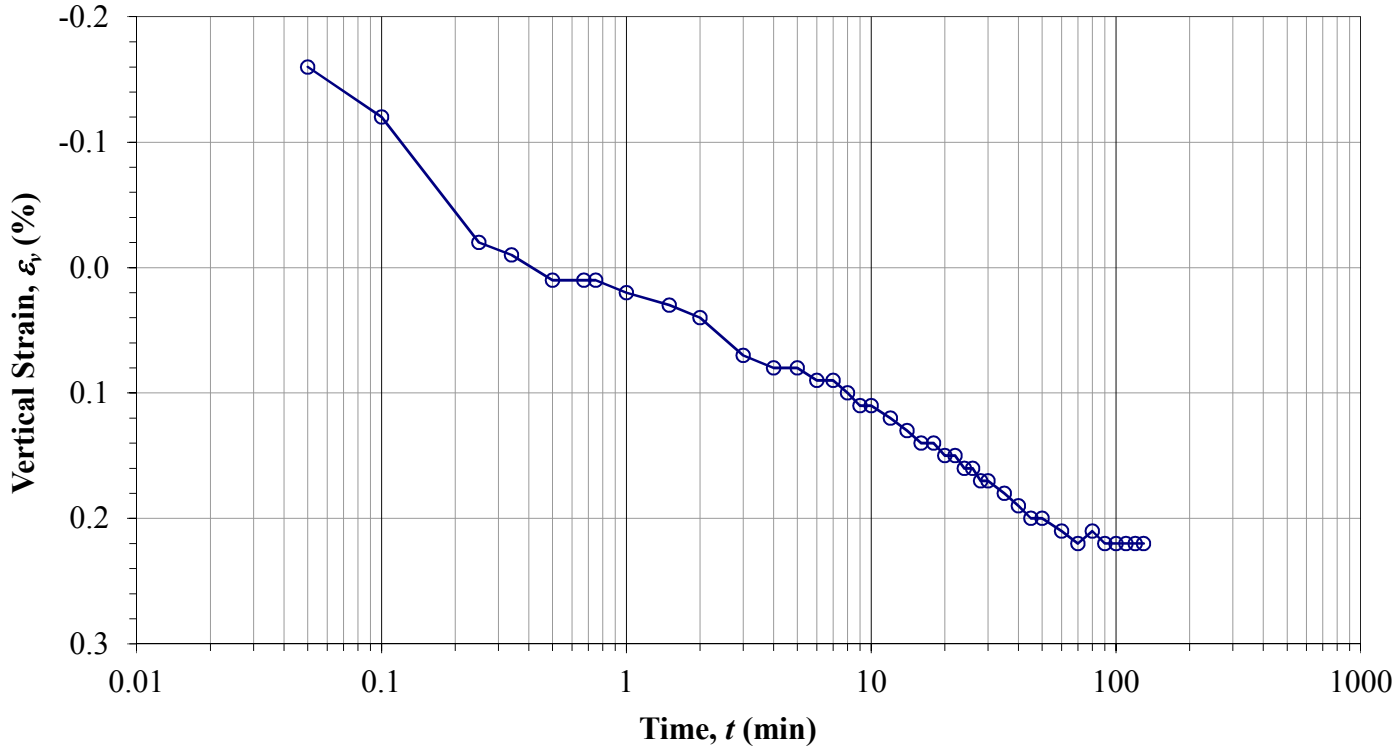
Project: AECOM **Boring No.:** BH19-ES-2

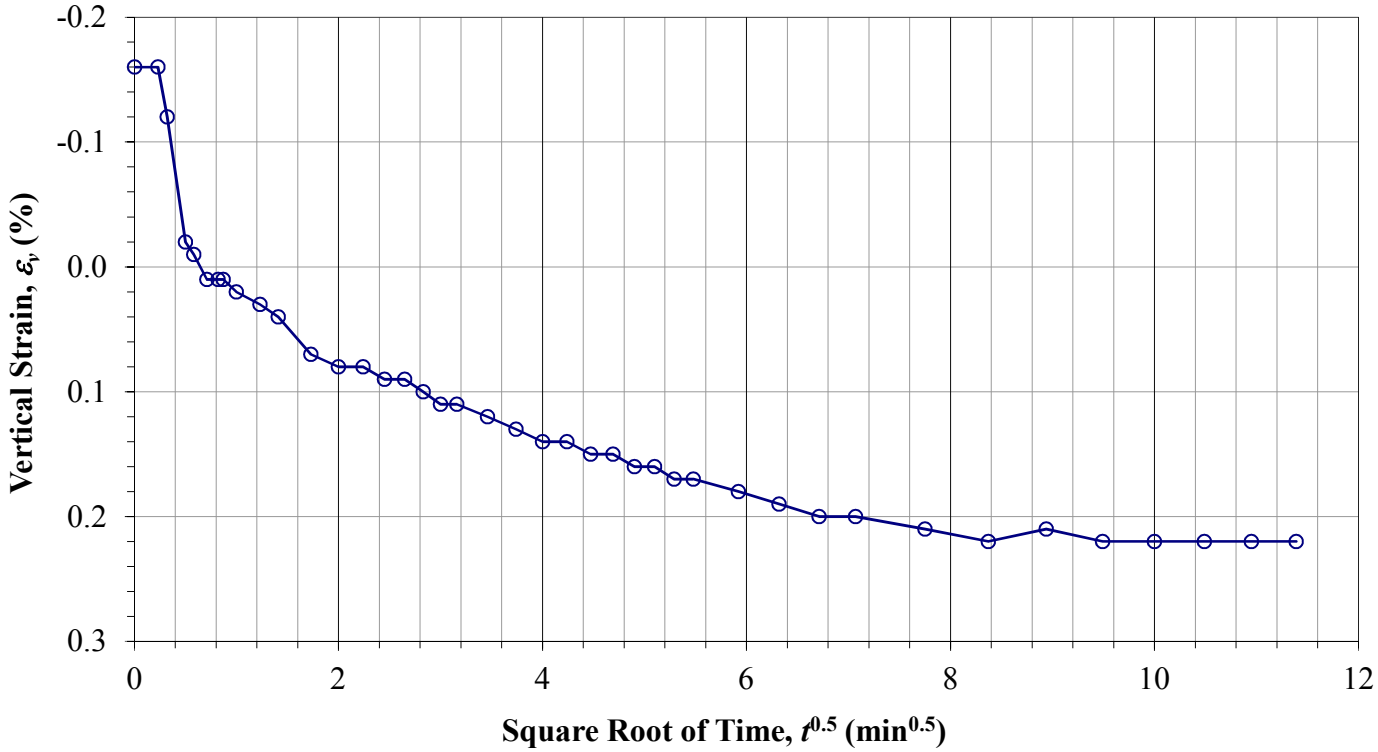
No: 00100-015, 3G2 (XIII) **Sample:** 23

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 3 of 14

Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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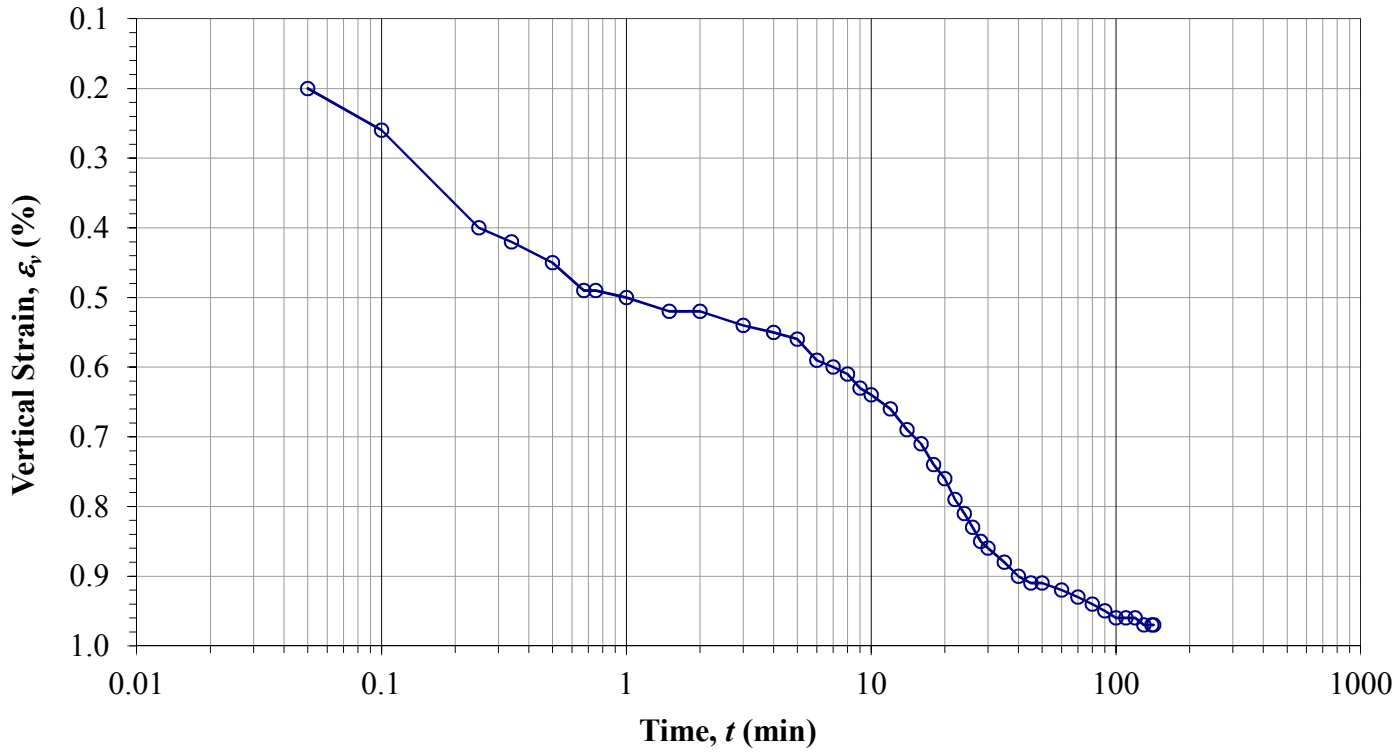
Project: AECOM **Boring No.:** BH19-ES-2

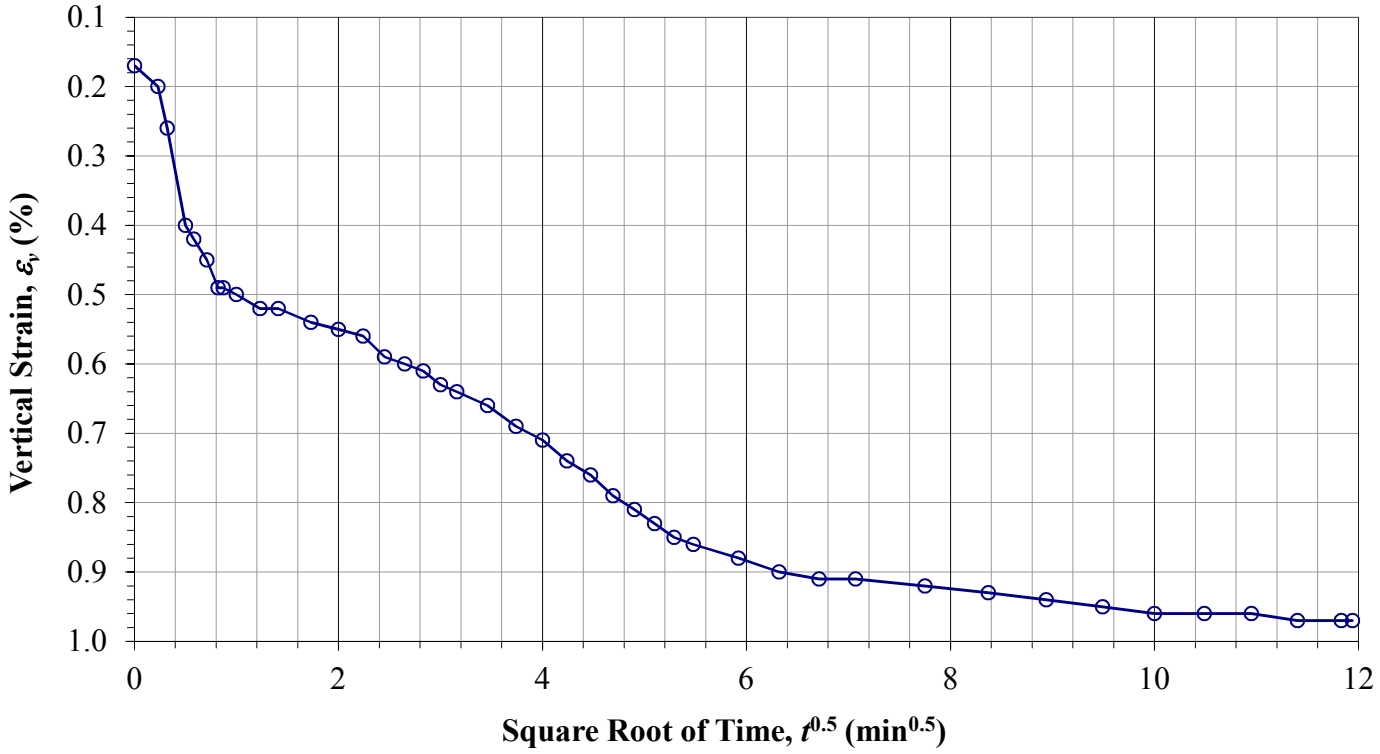
No: 00100-015, 3G2 (XIII) **Sample:** 23

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 4 of 14

Stress: 800 psf





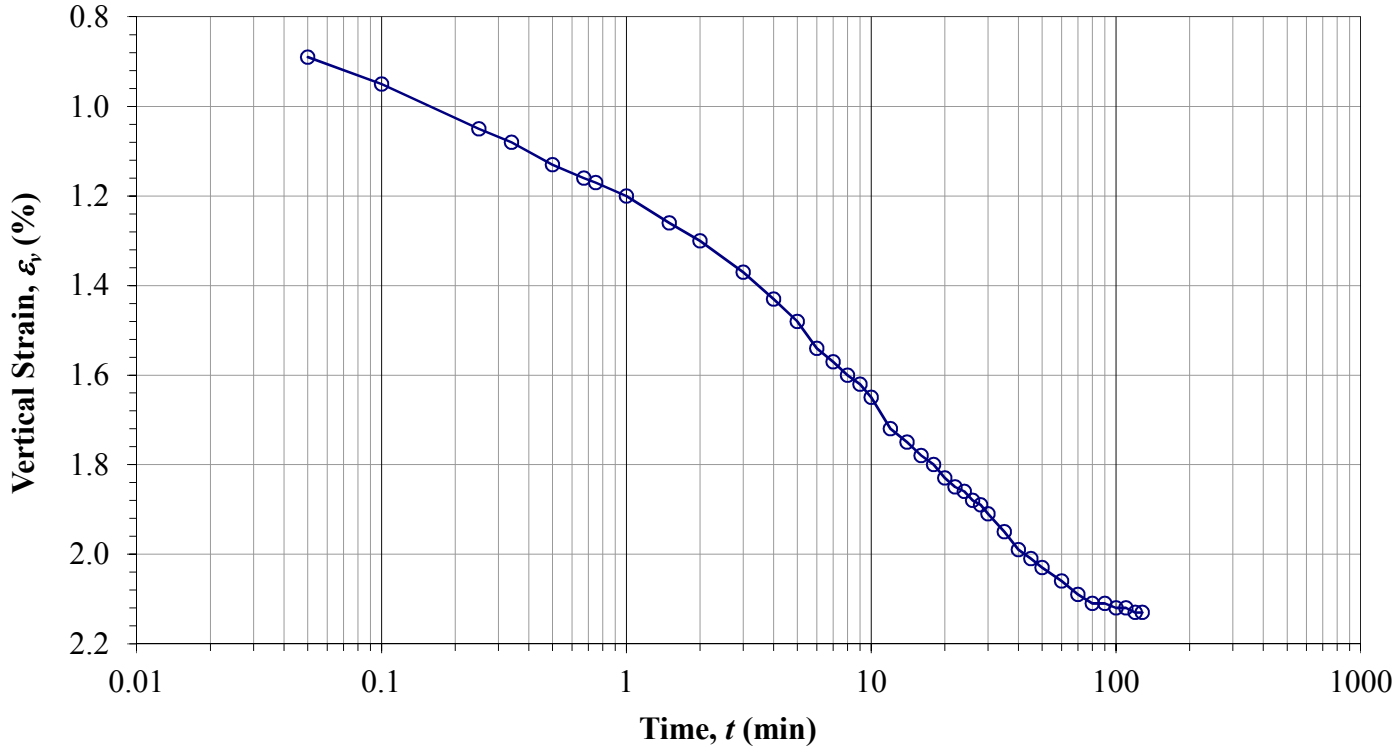
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

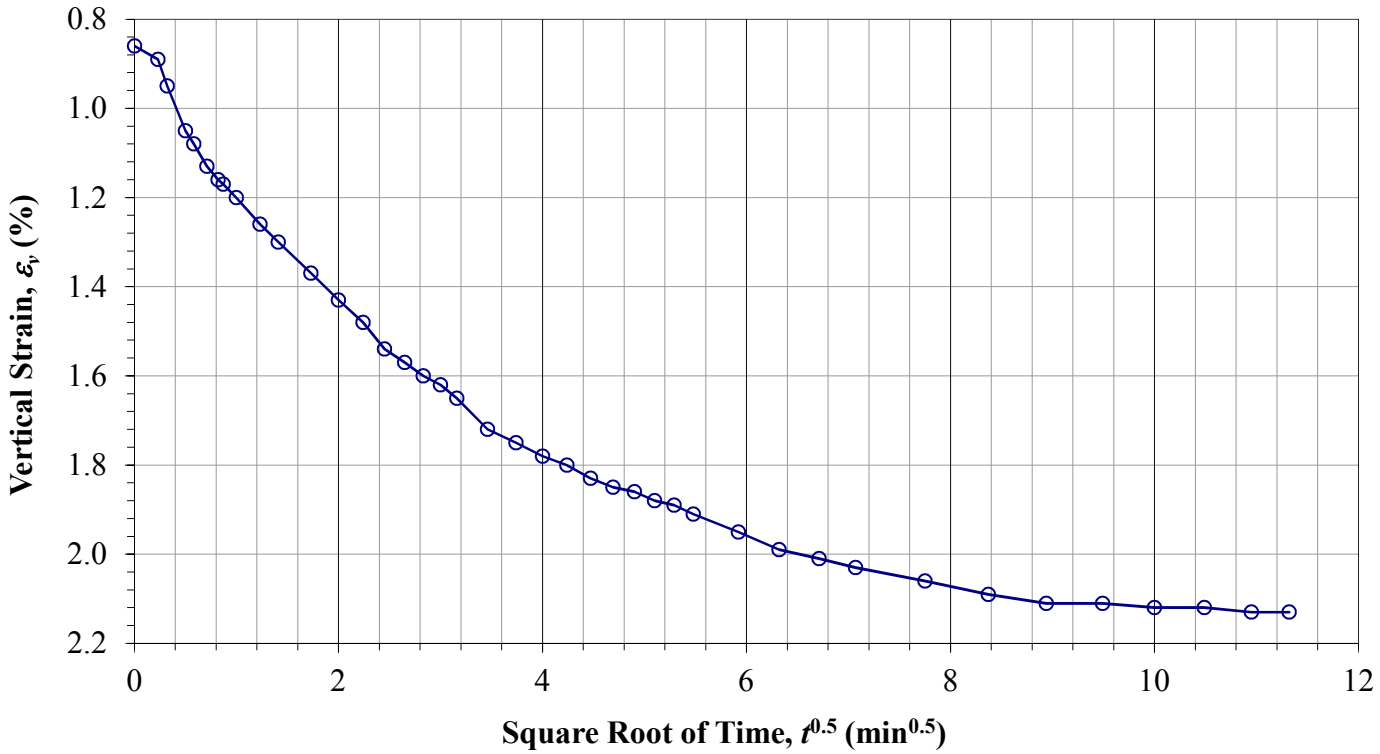
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 23
Depth: 100'

Constant Load Step: 5 of 14
Stress: 1600 psf





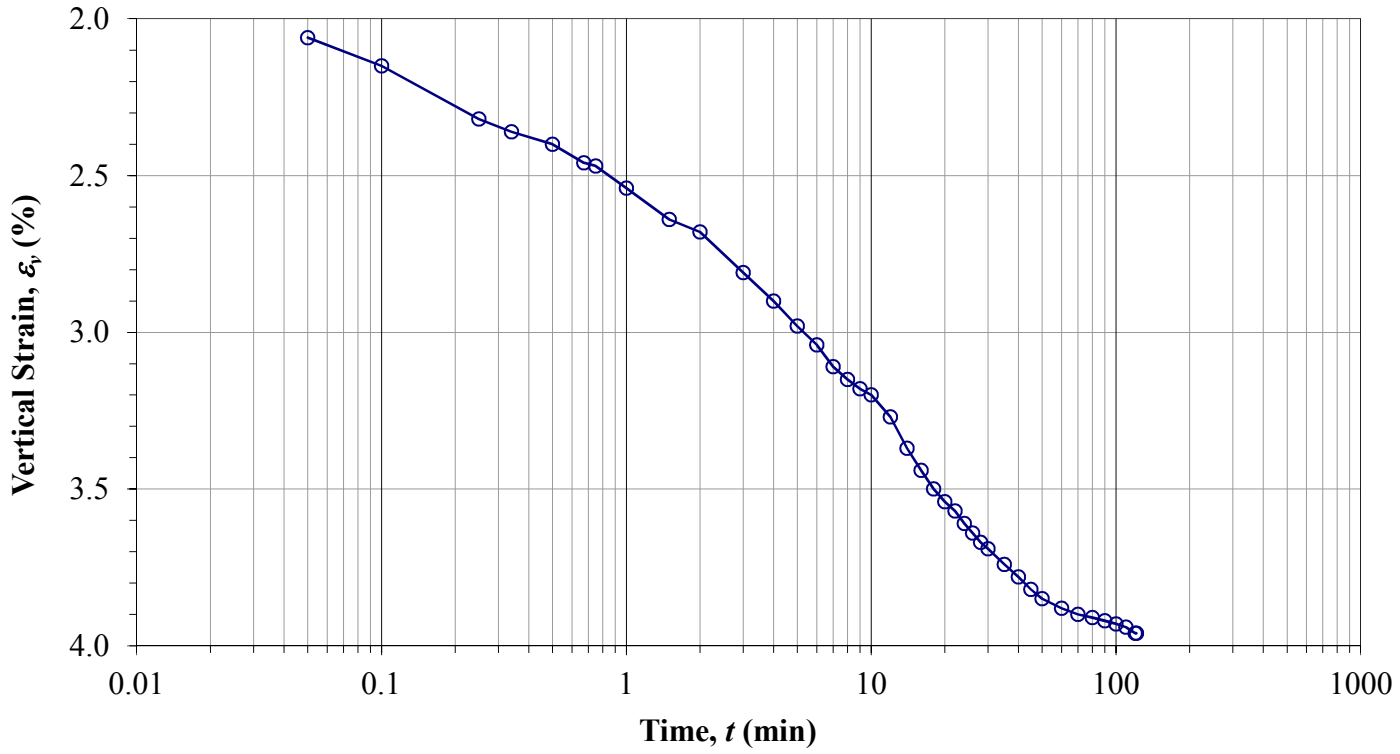
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

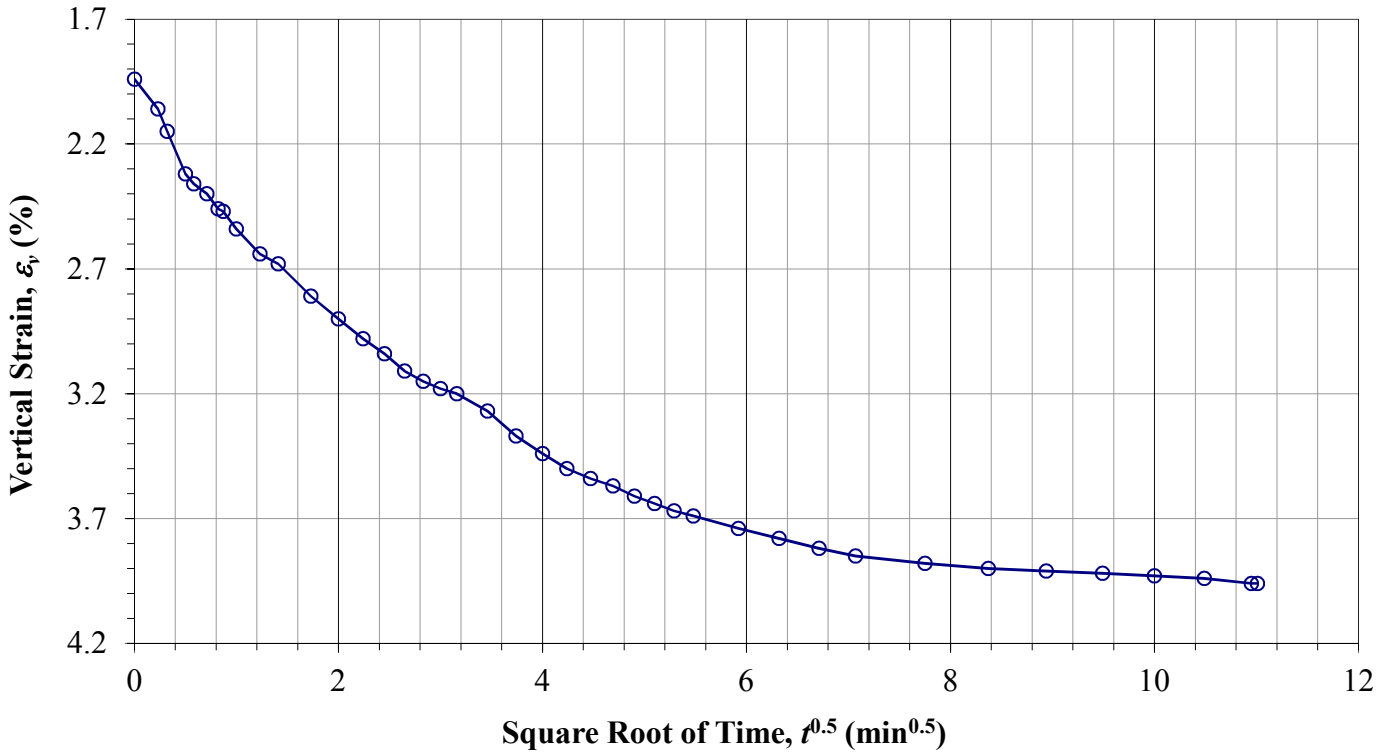
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Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 23
Depth: 100'

Constant Load Step: 6 of 14
Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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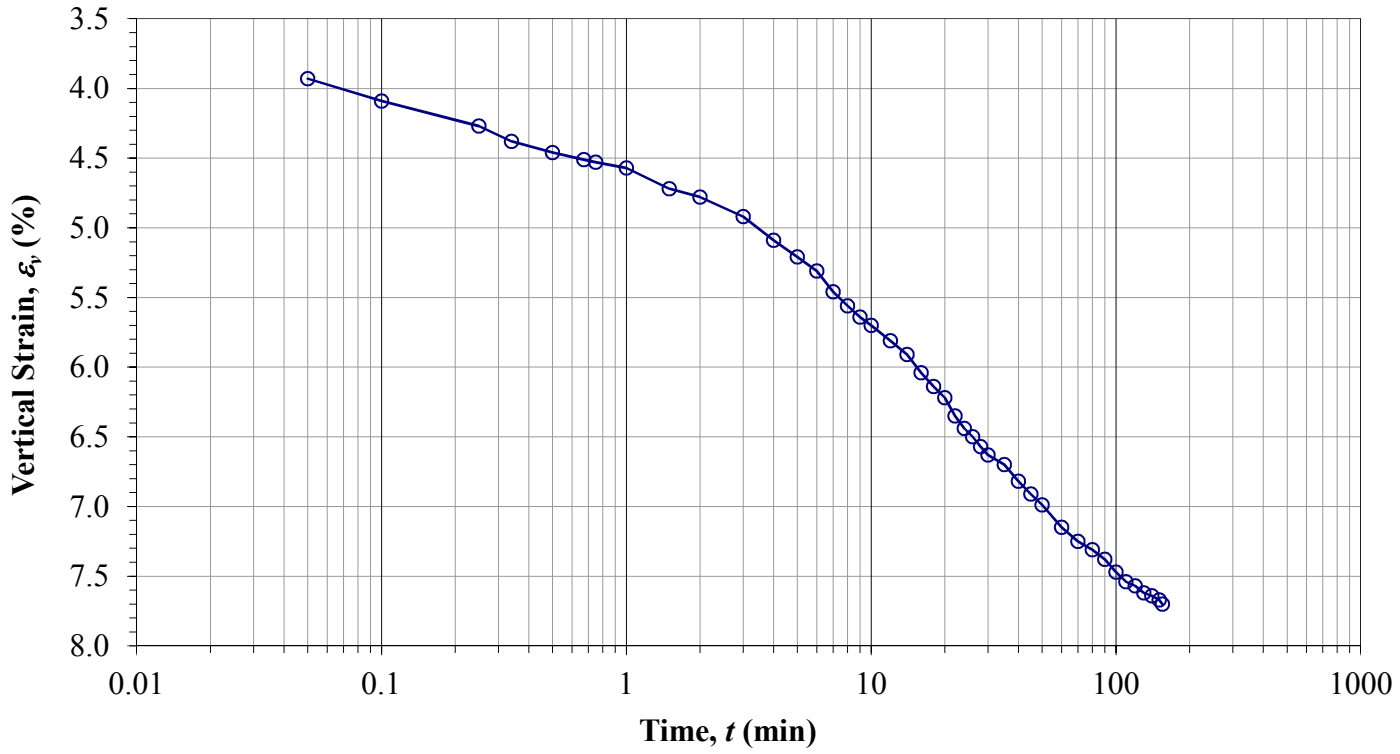
Project: AECOM **Boring No.:** BH19-ES-2

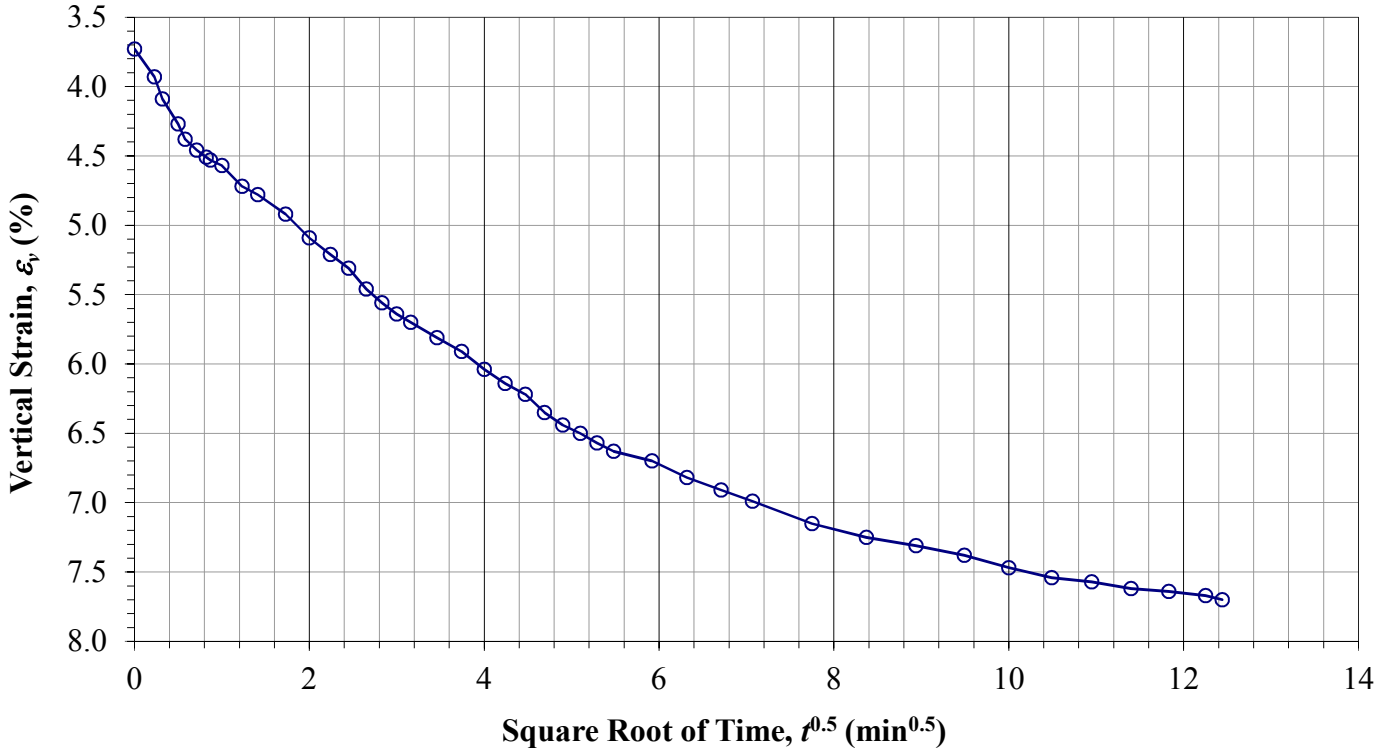
No: 00100-015, 3G2 (XIII) **Sample:** 23

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 7 of 14

Stress: 6400 psf





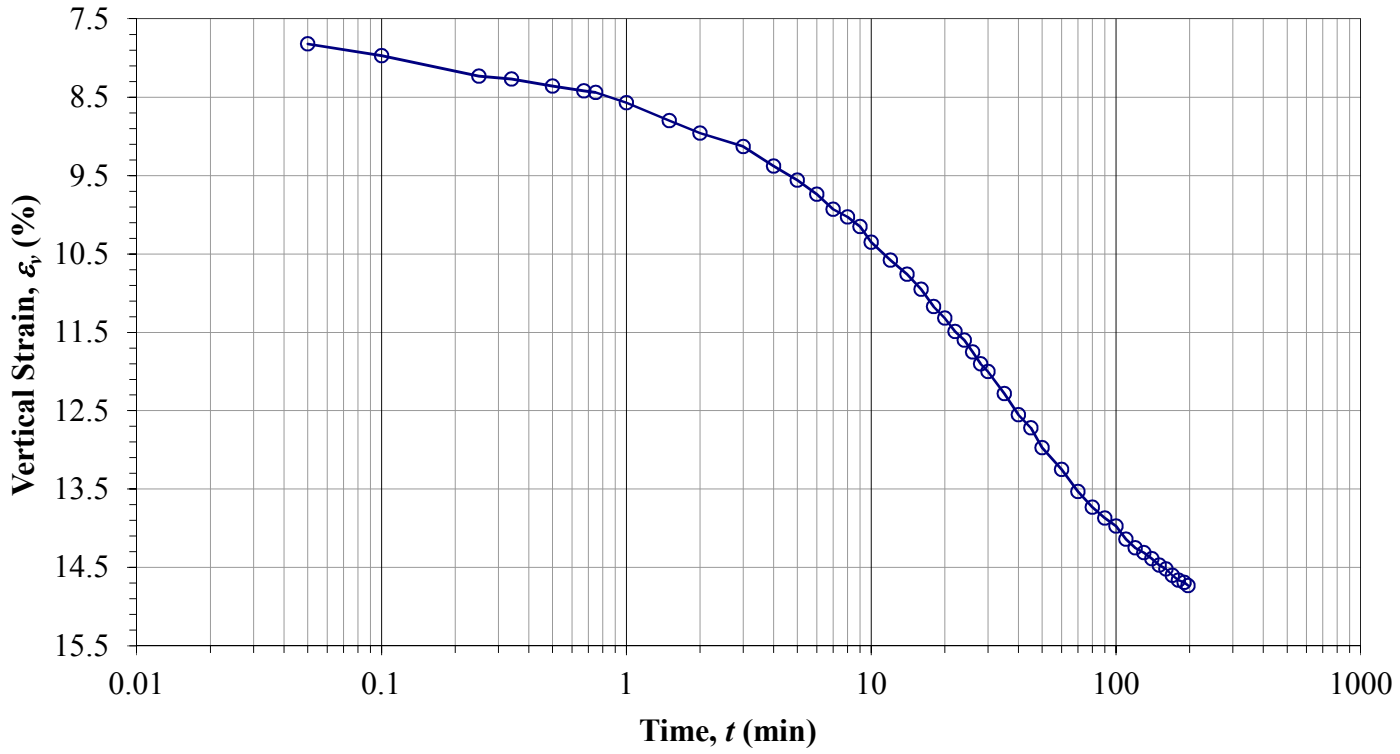
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

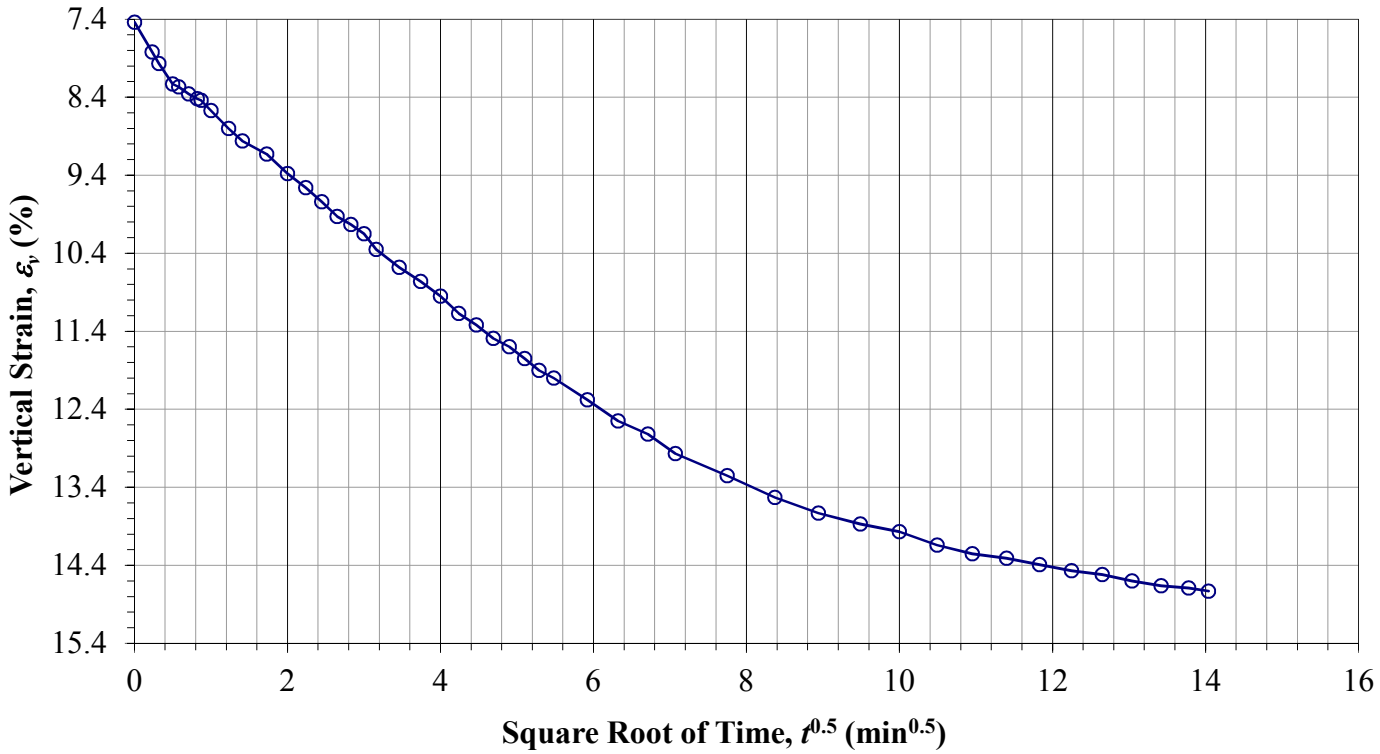
© IGES 2011, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 23
Depth: 100'

Constant Load Step: 8 of 14
Stress: 12800 psf





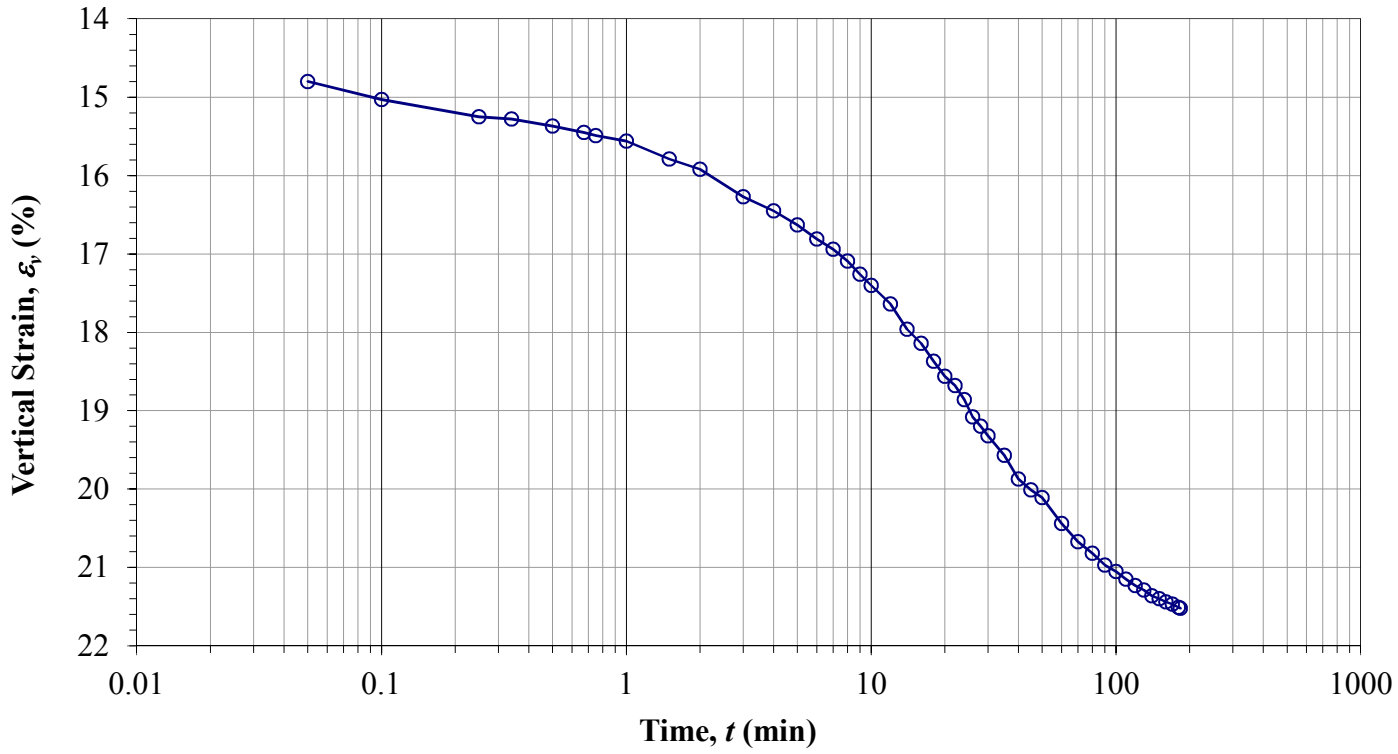
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

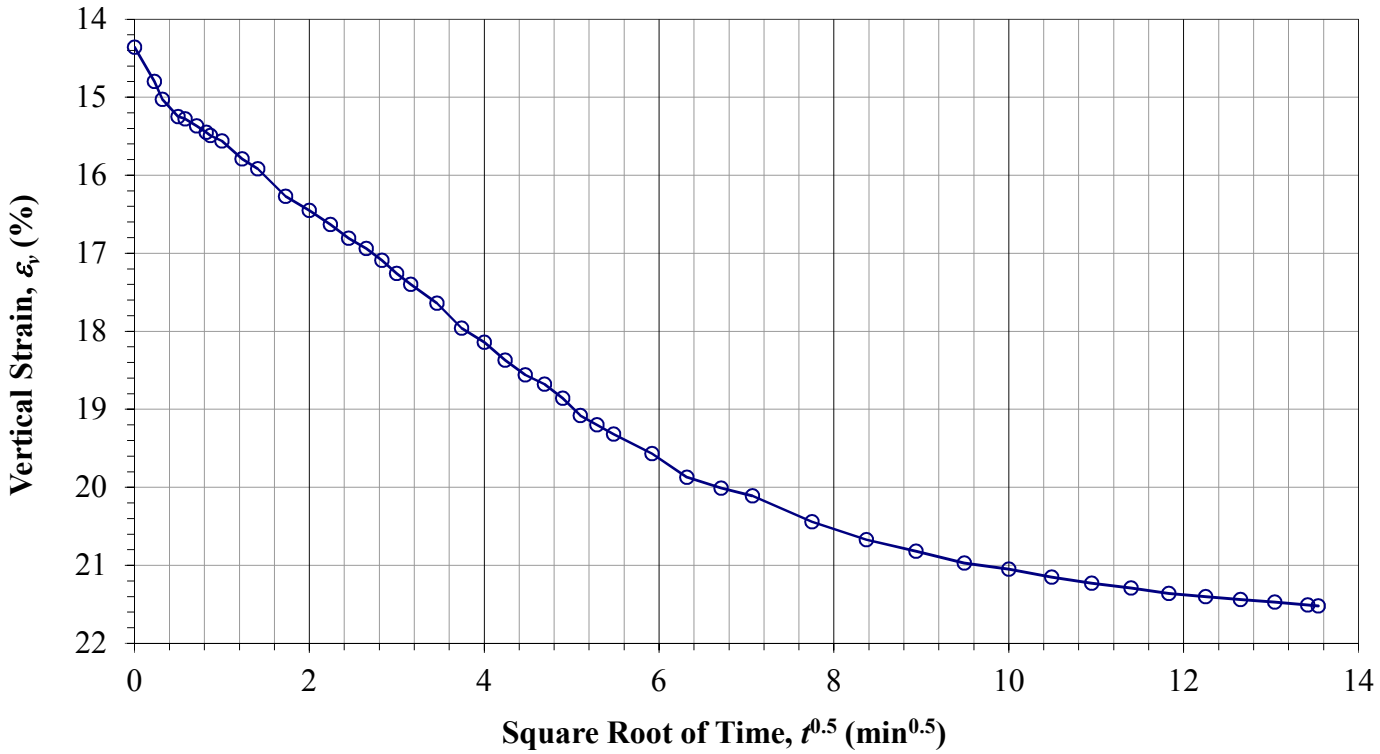
© IGES 2011, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 23
Depth: 100'

Constant Load Step: 9 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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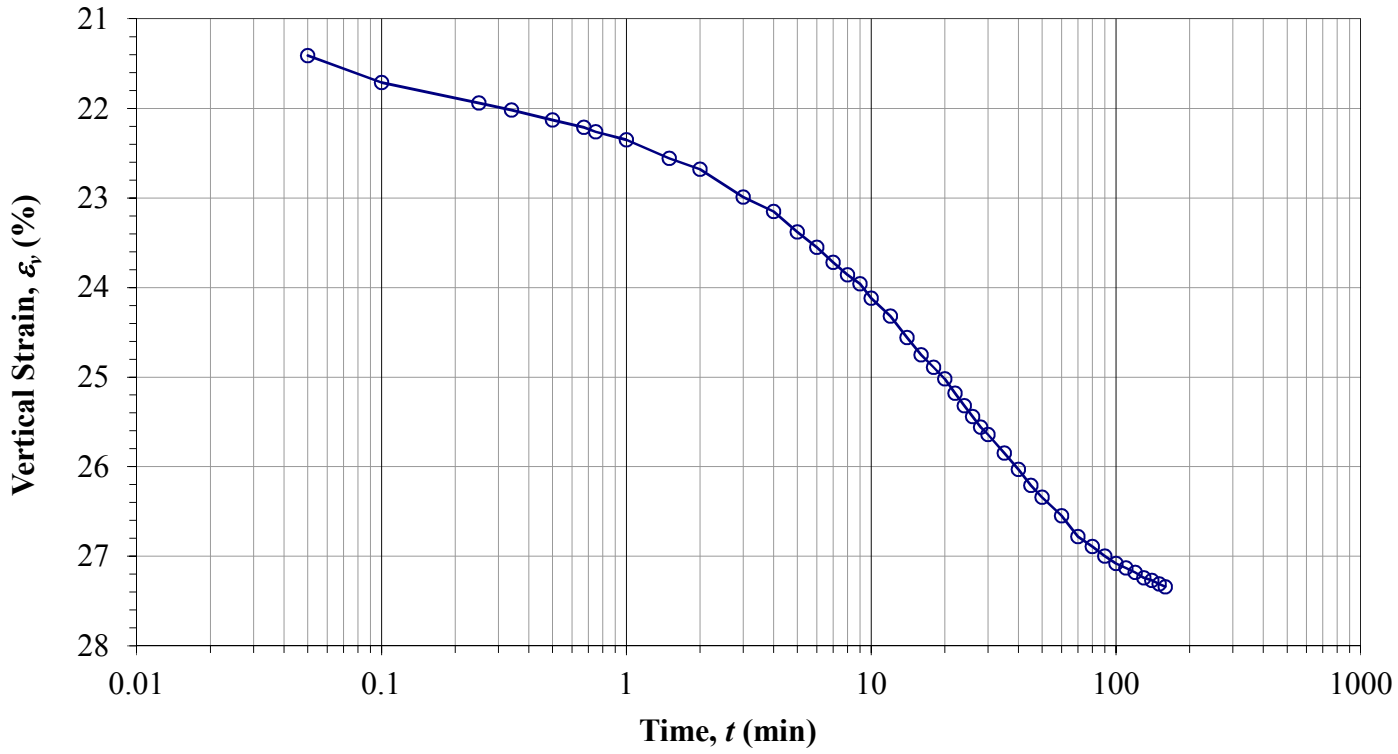
Project: AECOM **Boring No.:** BH19-ES-2

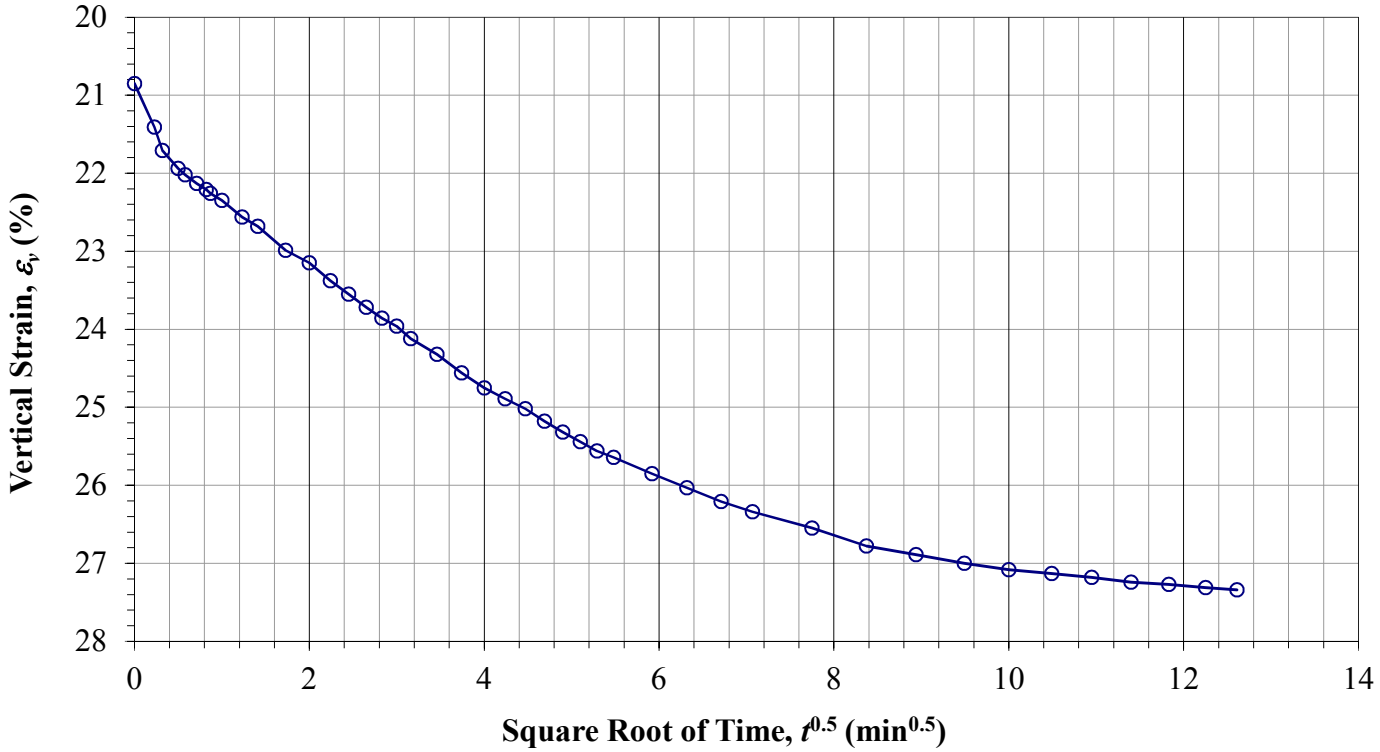
No: 00100-015, 3G2 (XIII) **Sample:** 23

Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 10 of 14

Stress: 51200 psf





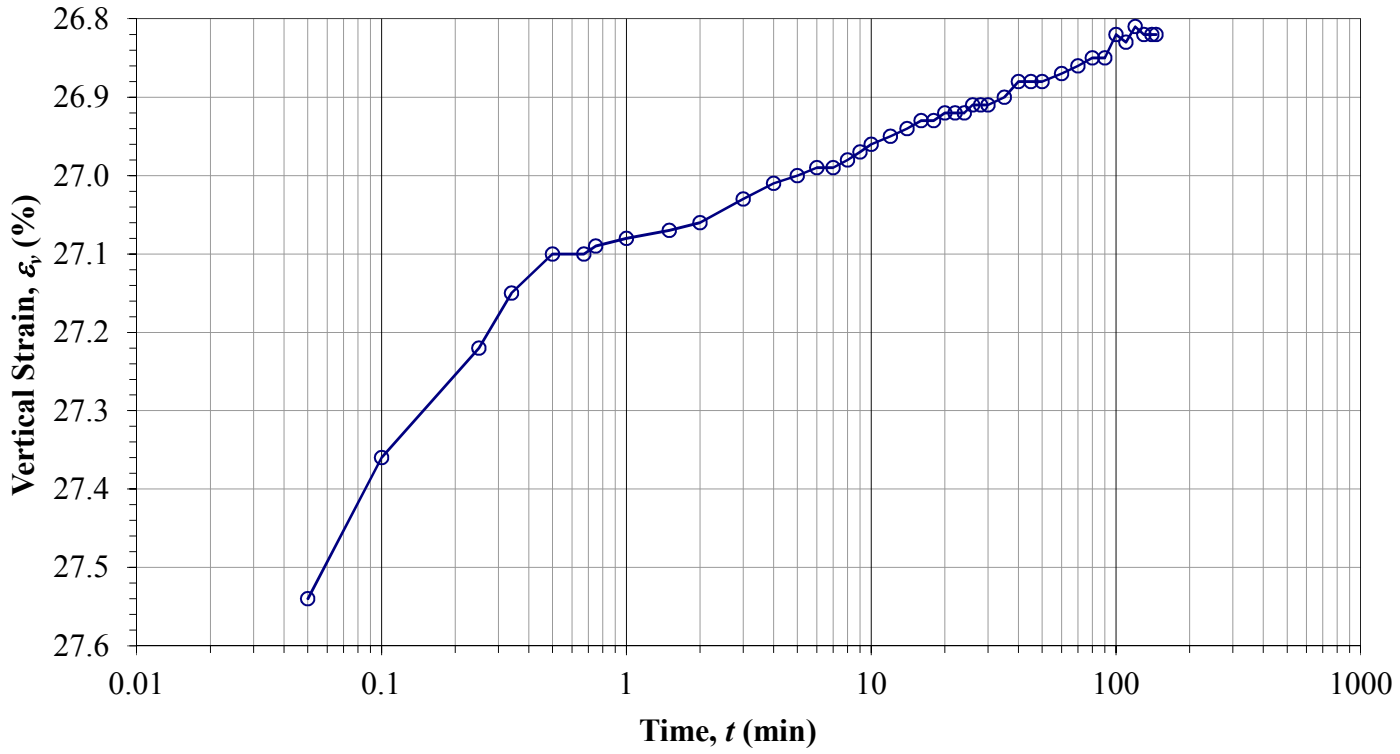
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

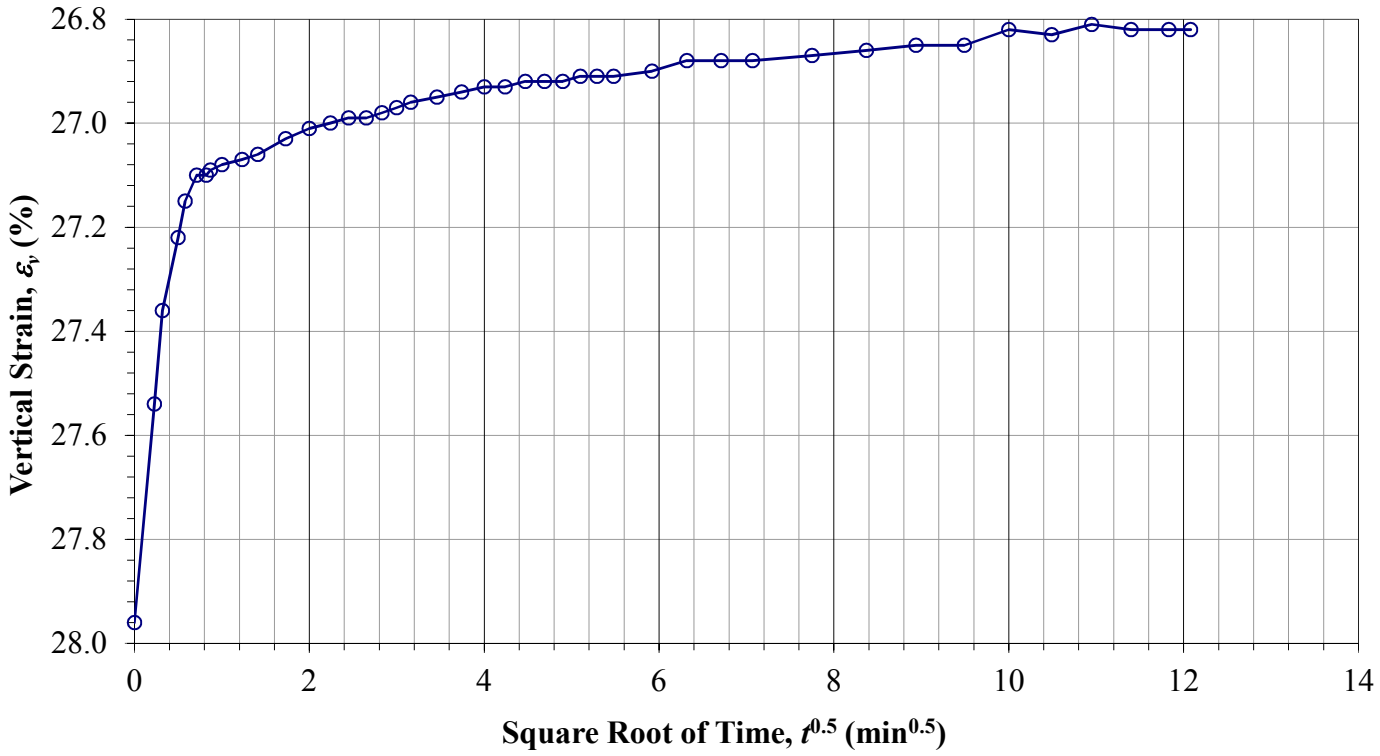
© IGES 2011, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 23
Depth: 100'

Constant Load Step: 11 of 14
Stress: 25600 psf



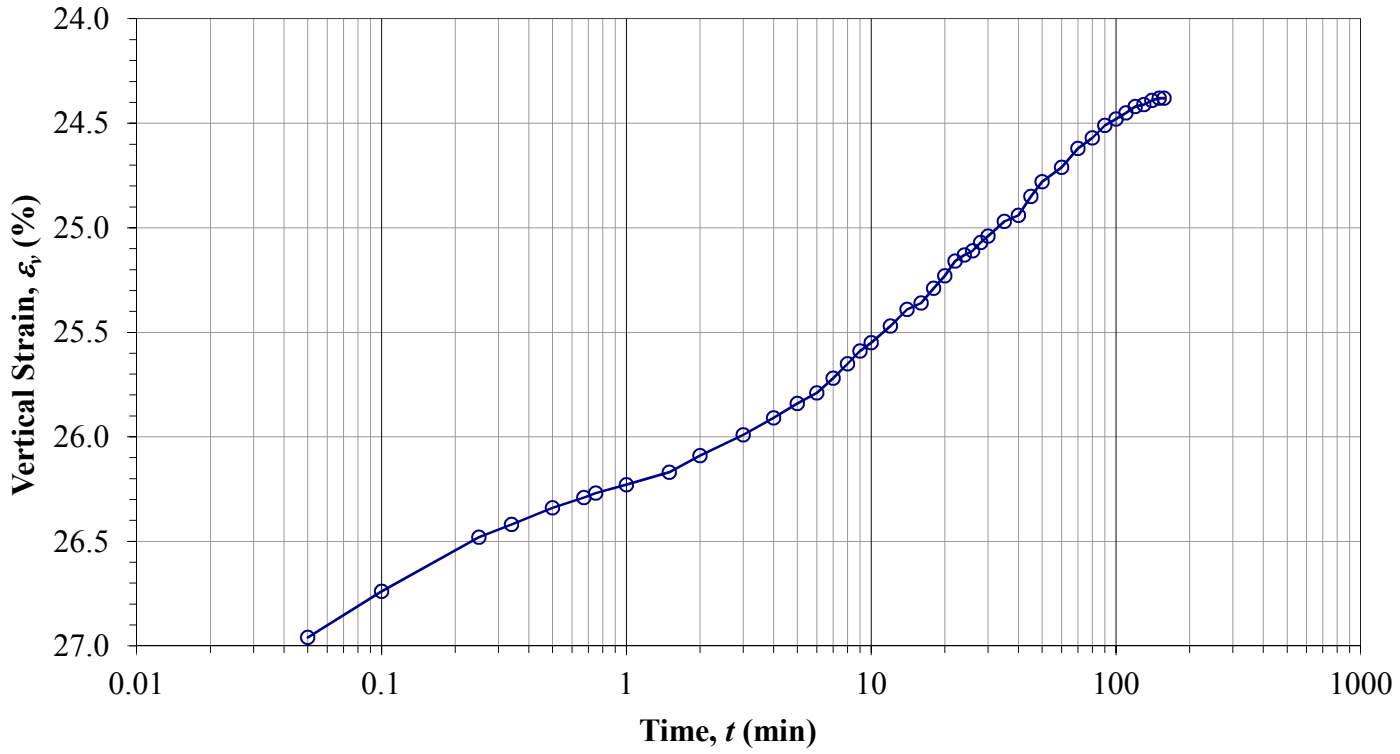


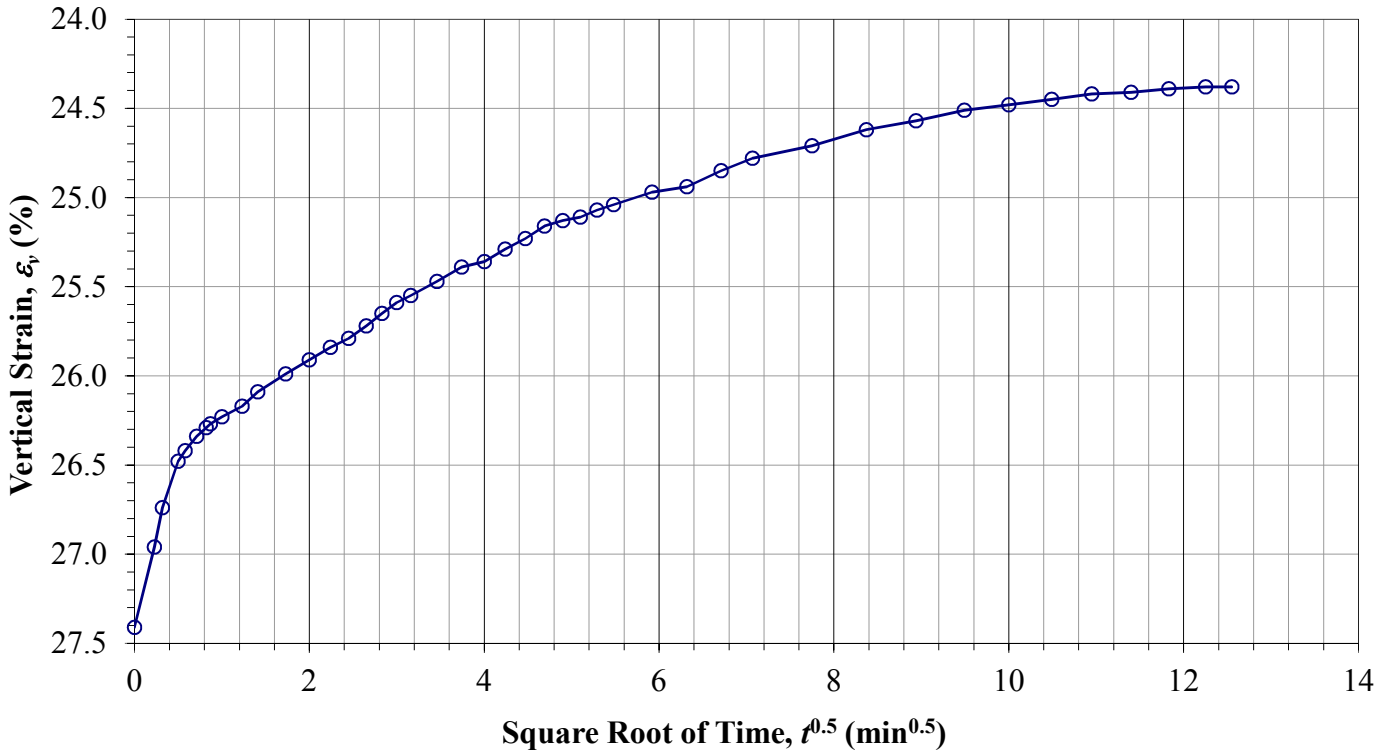
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 23
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 12 of 14
Stress: 6400 psf



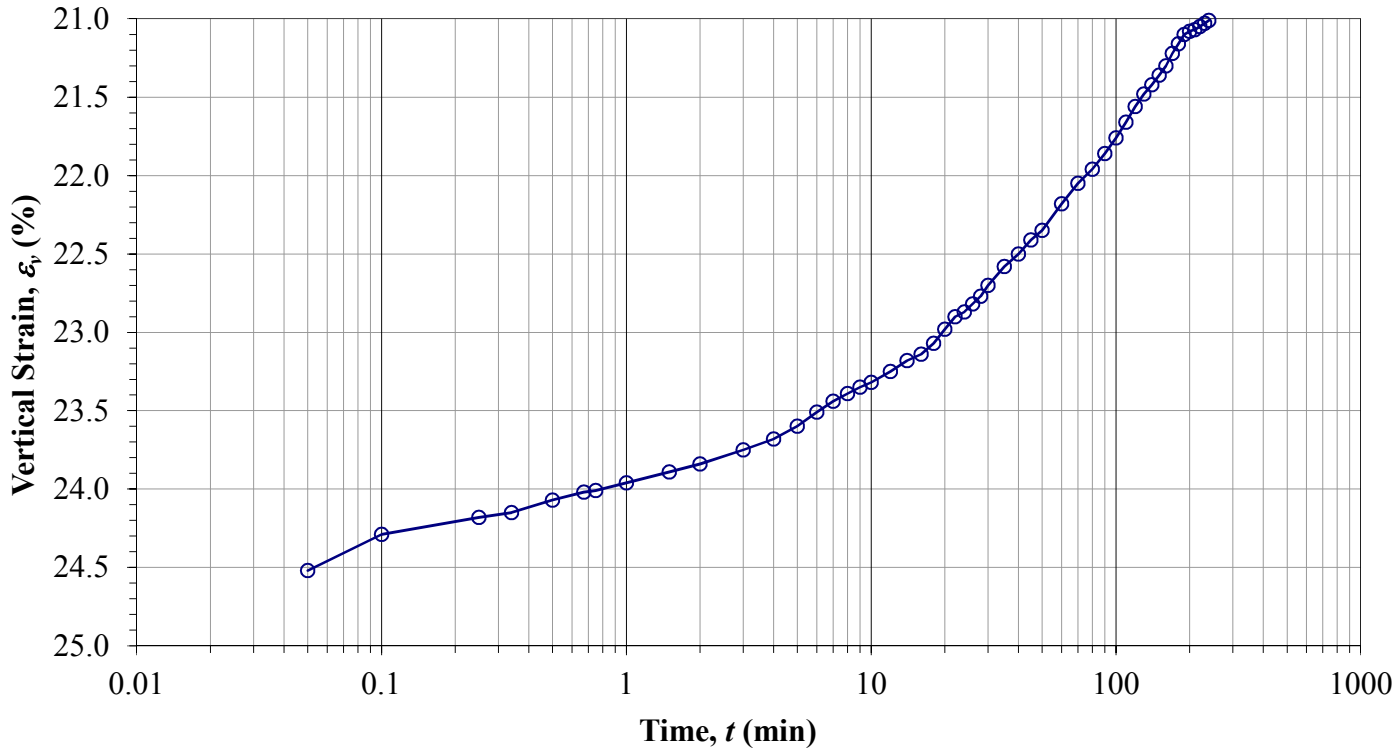


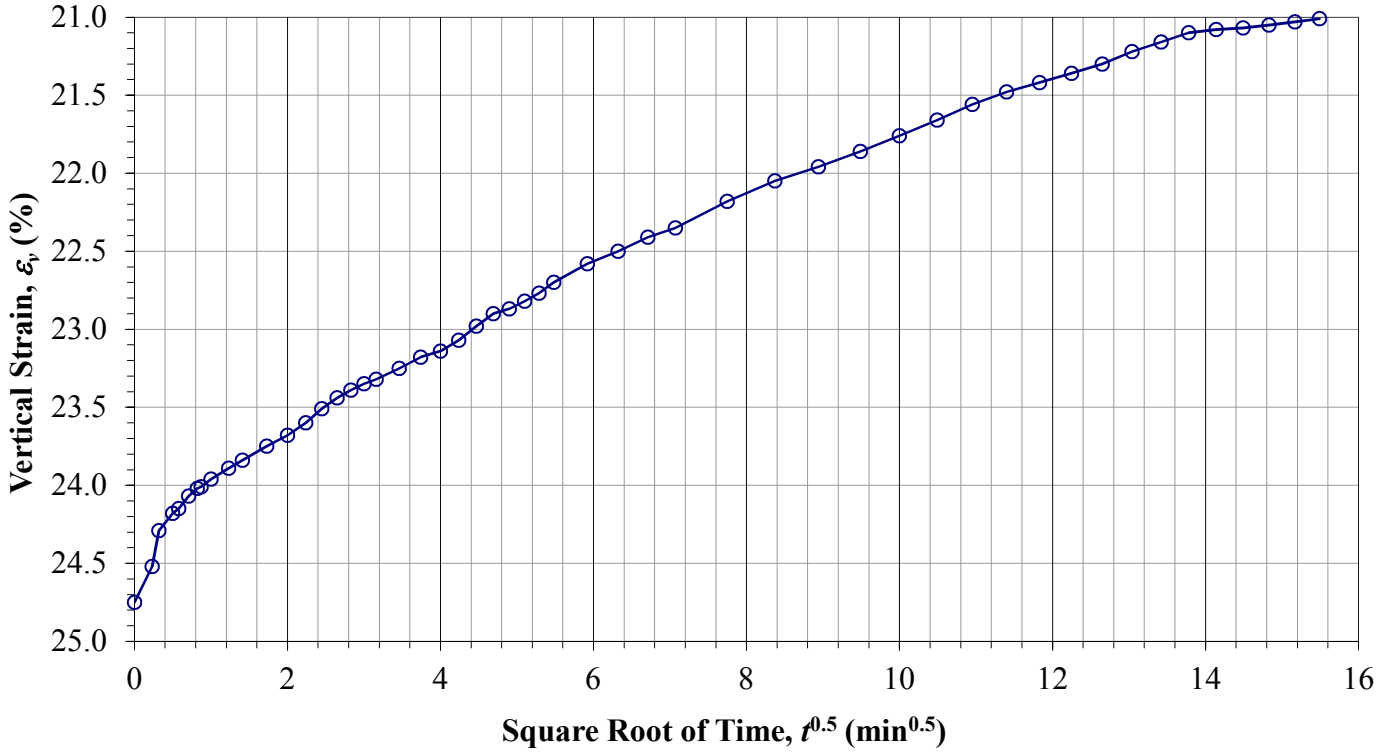
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 23
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 13 of 14
Stress: 1600 psf



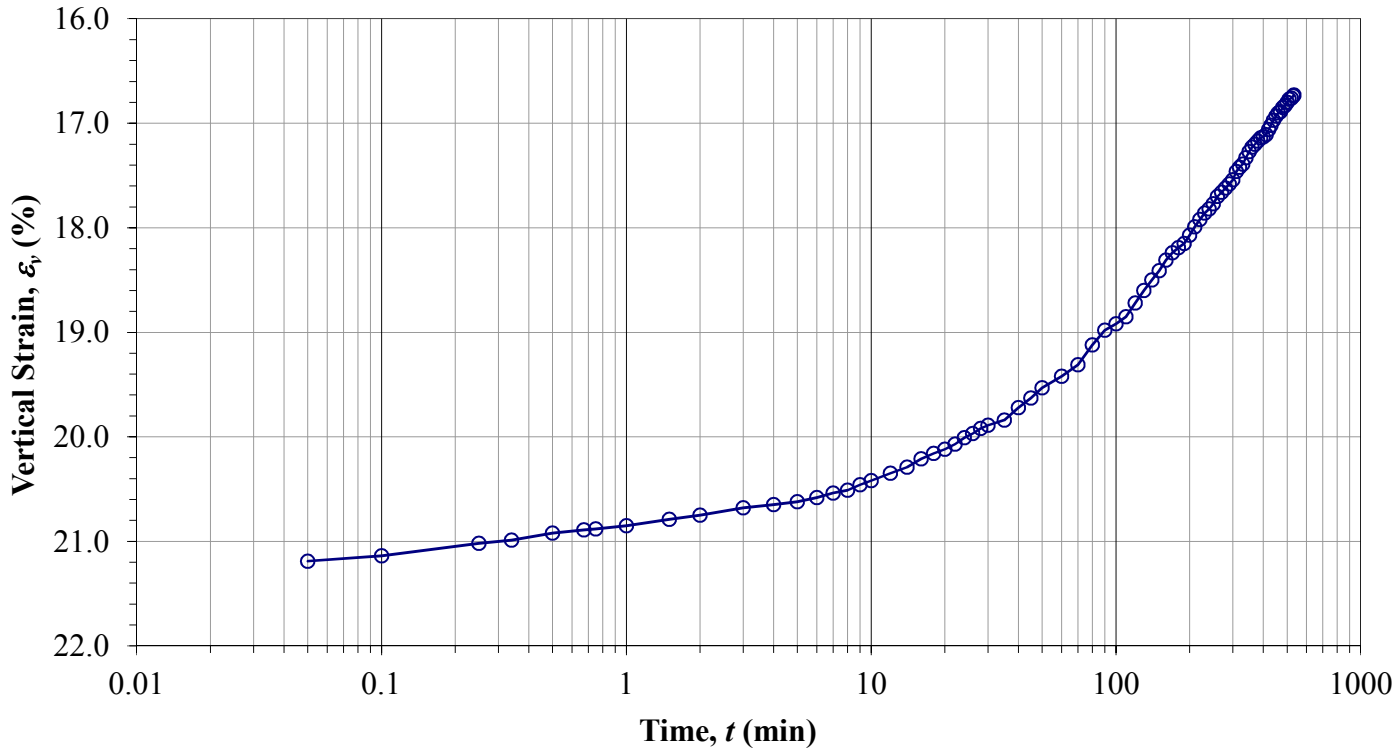


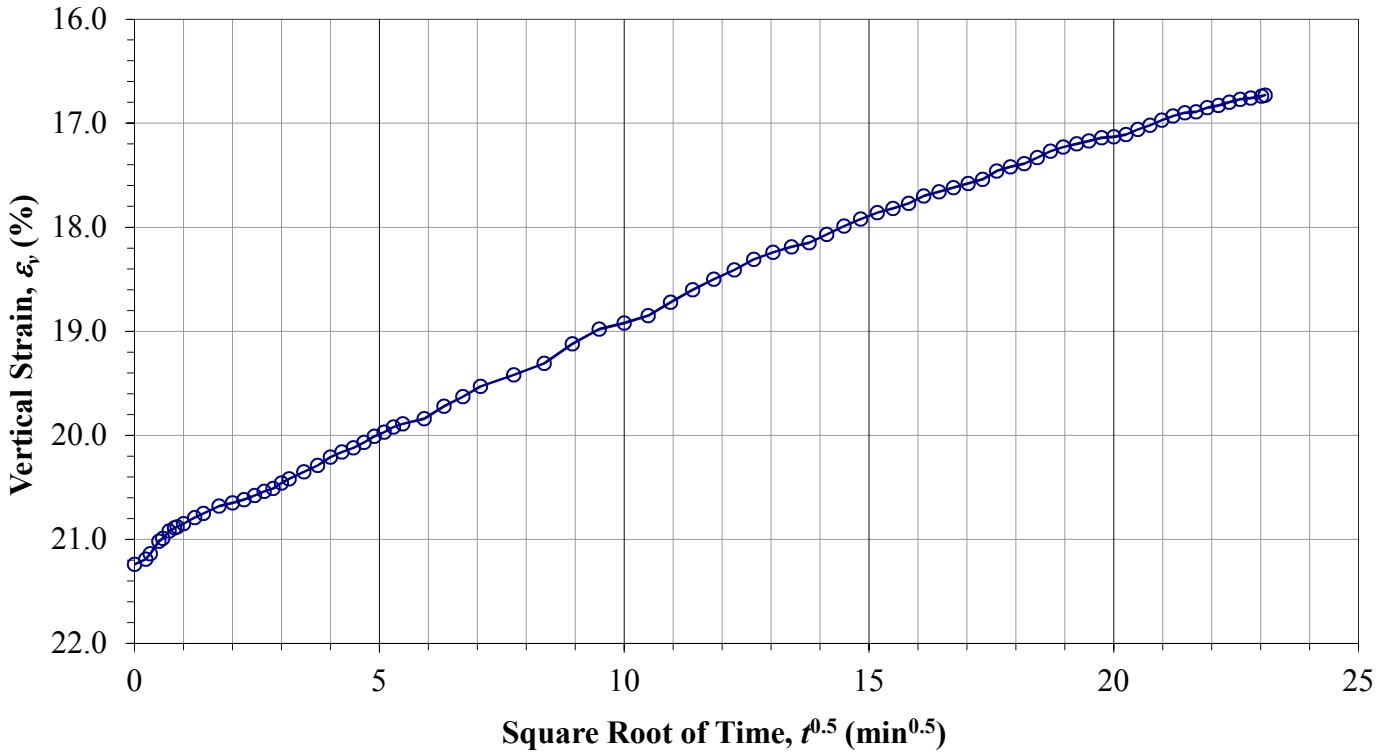
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

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Project: AECOM **Boring No.:** BH19-ES-2
No: 00100-015, 3G2 (XIII) **Sample:** 23
Location: SLCity Public Utilities Waste Water Reclamation Facility **Depth:** 100'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: SLCWRF
No: 00100-015, 3G2 (XXIII)
Location: Salt Lake City, Utah
Date: 8/6/2021
By: JDF

Boring No.: BH18-IT-5
Sample:
Depth: 10.0'
Sample Description: Grey clay with sand
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from ring

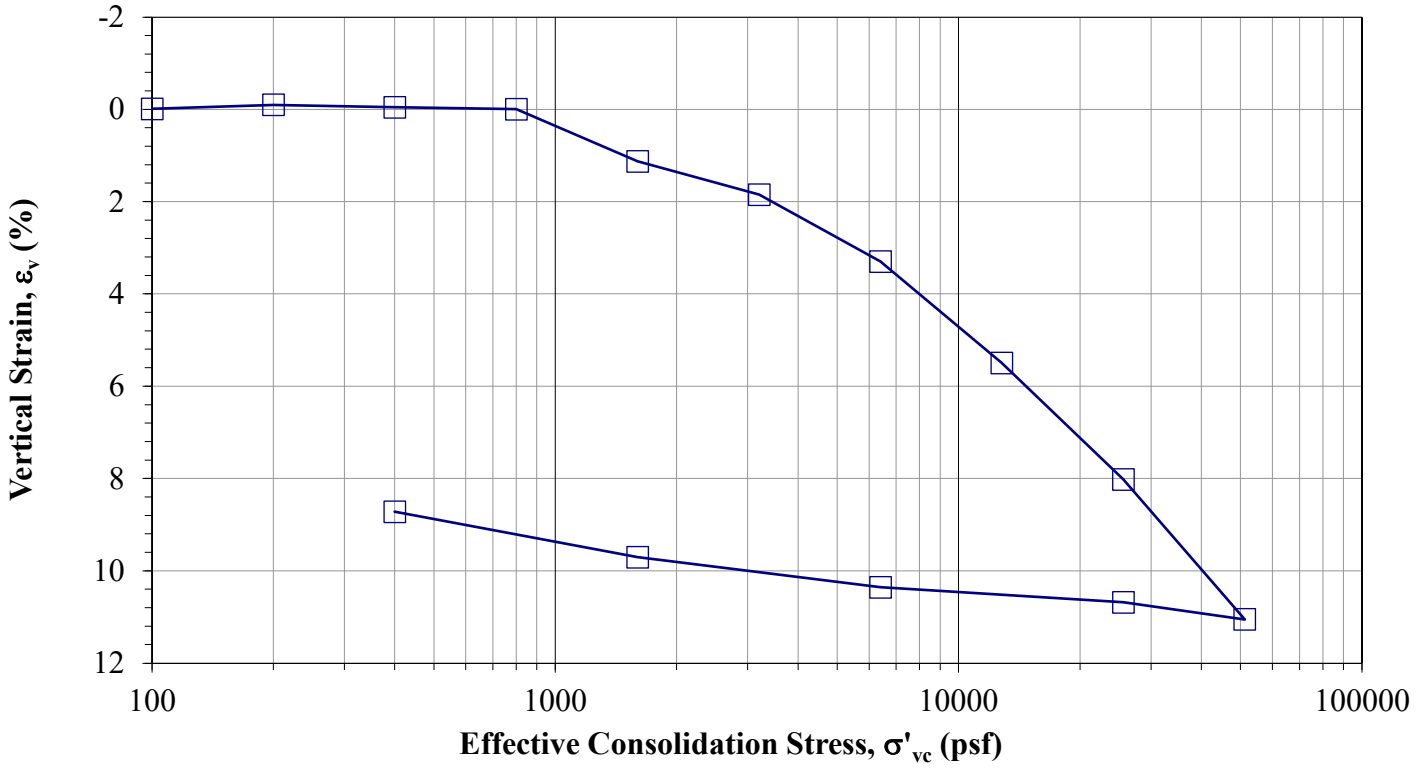
Test method:	A	
Inundation stress (psf), timing:	Seating	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation: Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.923	0.843
Sample diameter, D (in.)	2.410	2.410
Wt. rings + wet soil (g)	172.83	167.60
Wt. rings/tare (g)	46.28	46.28
Moist unit wt., γ_m (pcf)	114.5	120.25
Wet soil + tare (g)	409.61	253.94
Dry soil + tare (g)	347.95	230.79
Tare (g)	124.42	127.02
Water content, w (%)	27.6	22.3
Dry unit wt., γ_d (pcf)	89.7	98.3
Saturation	0.85	0.84

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9230	0.8781
100	-0.0001	-0.01	0.9231	0.8784
200	-0.0009	-0.10	0.9239	0.8800
400	-0.0004	-0.04	0.9234	0.8790
800	0.0000	0.00	0.9230	0.8782
1600	0.0104	1.12	0.9126	0.8570
3200	0.0171	1.85	0.9059	0.8434
6400	0.0304	3.29	0.8926	0.8163
12800	0.0507	5.50	0.8723	0.7749
25600	0.0740	8.02	0.8490	0.7276
51200	0.1020	11.05	0.8210	0.6706
25600	0.0986	10.68	0.8244	0.6775
6400	0.0956	10.36	0.8274	0.6836
1600	0.0895	9.70	0.8335	0.6959
400	0.0805	8.72	0.8425	0.7144



Entered: _____
Reviewed: _____

One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/15/2021
By: JDF/EH

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

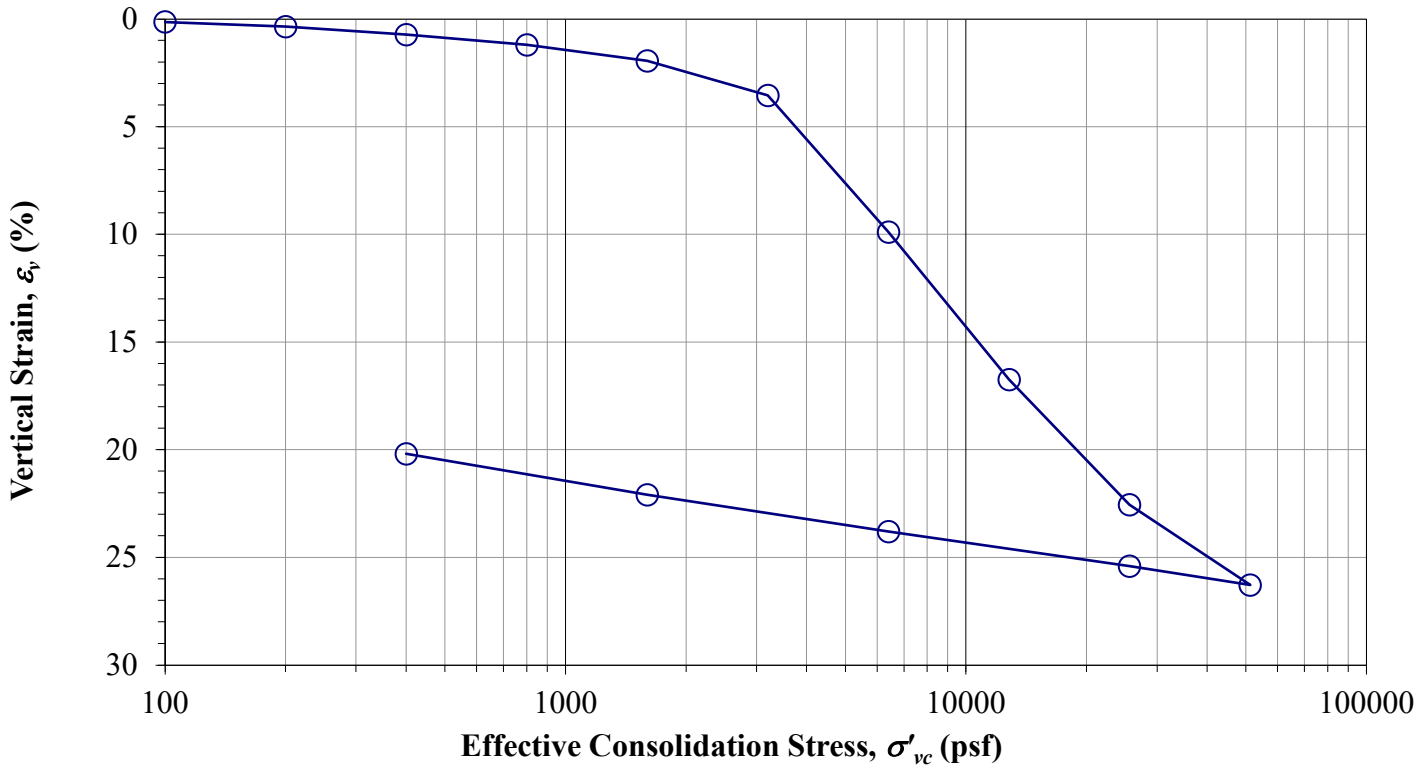
Test method:	B	
Inundation stress (psf), timing:	100	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.920	0.734
Sample diameter, D (in.)	2.422	2.422
Wt. rings + wet soil (g)	160.08	147.55
Wt. rings/tare (g)	42.18	42.18
Total unit wt., γ (pcf)	106.0	118.66
Wet soil + tare (g)	312.37	227.03
Dry soil + tare (g)	250.58	202.04
Tare (g)	124.42	126.65
Water content, ω (%)	49.0	33.1
Dry unit wt., γ_d (pcf)	71.1	89.1
Saturation, S	0.97	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9200	1.3697
100	0.0012	0.13	0.9188	1.3666
200	0.0033	0.36	0.9167	1.3613
400	0.0067	0.73	0.9133	1.3525
800	0.0111	1.20	0.9089	1.3412
1600	0.0179	1.95	0.9021	1.3235
3200	0.0327	3.55	0.8873	1.2855
6400	0.0910	9.89	0.8290	1.1353
12800	0.1540	16.74	0.7660	0.9731
25600	0.2075	22.55	0.7125	0.8352
51200	0.2418	26.28	0.6782	0.7469
25600	0.2338	25.41	0.6862	0.7676
6400	0.2190	23.80	0.7010	0.8056
1600	0.2032	22.09	0.7168	0.8462
400	0.1857	20.19	0.7343	0.8913



Comments: Test specimen contains thin sand seams.

Entered: _____
Reviewed: _____

One-Dimensional Consolidation Properties of Soils

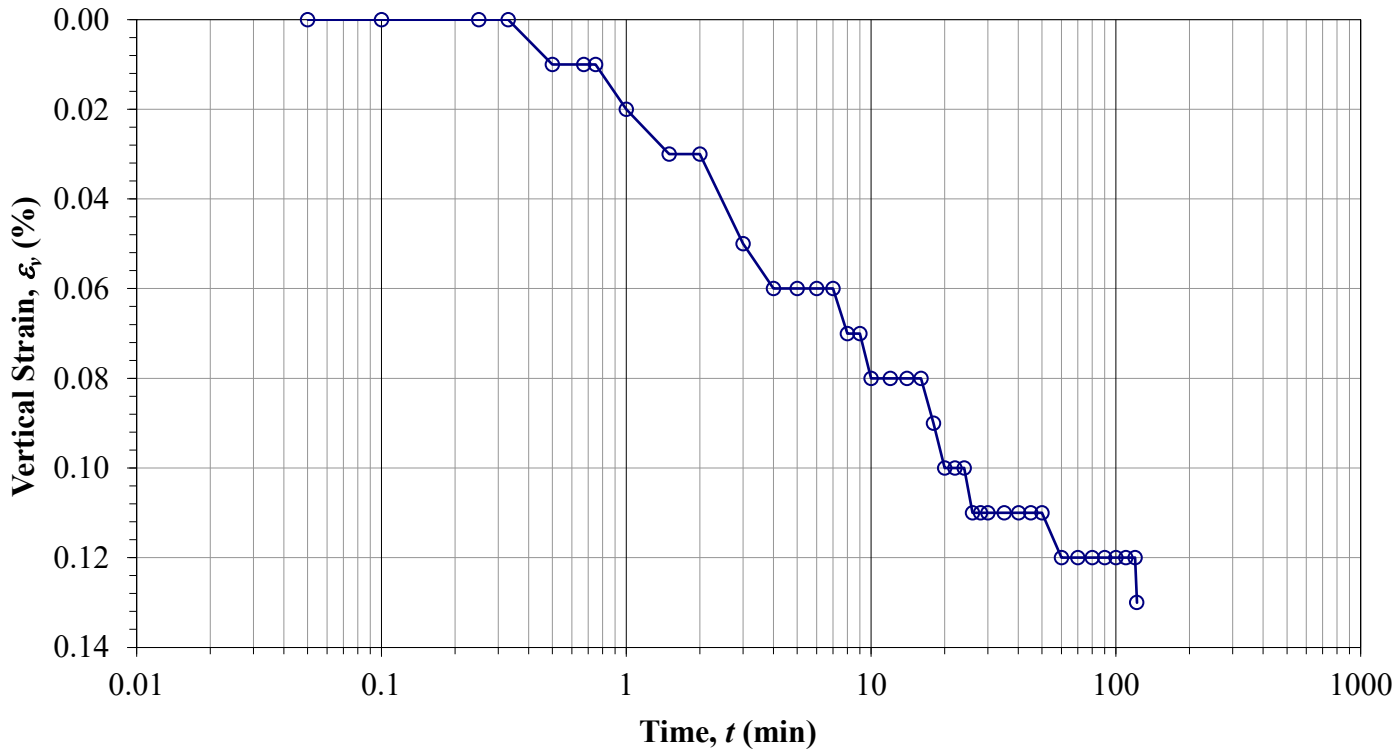
(ASTM D2435)

© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 1 of 14
Stress: 100 psf





One-Dimensional Consolidation Properties of Soils

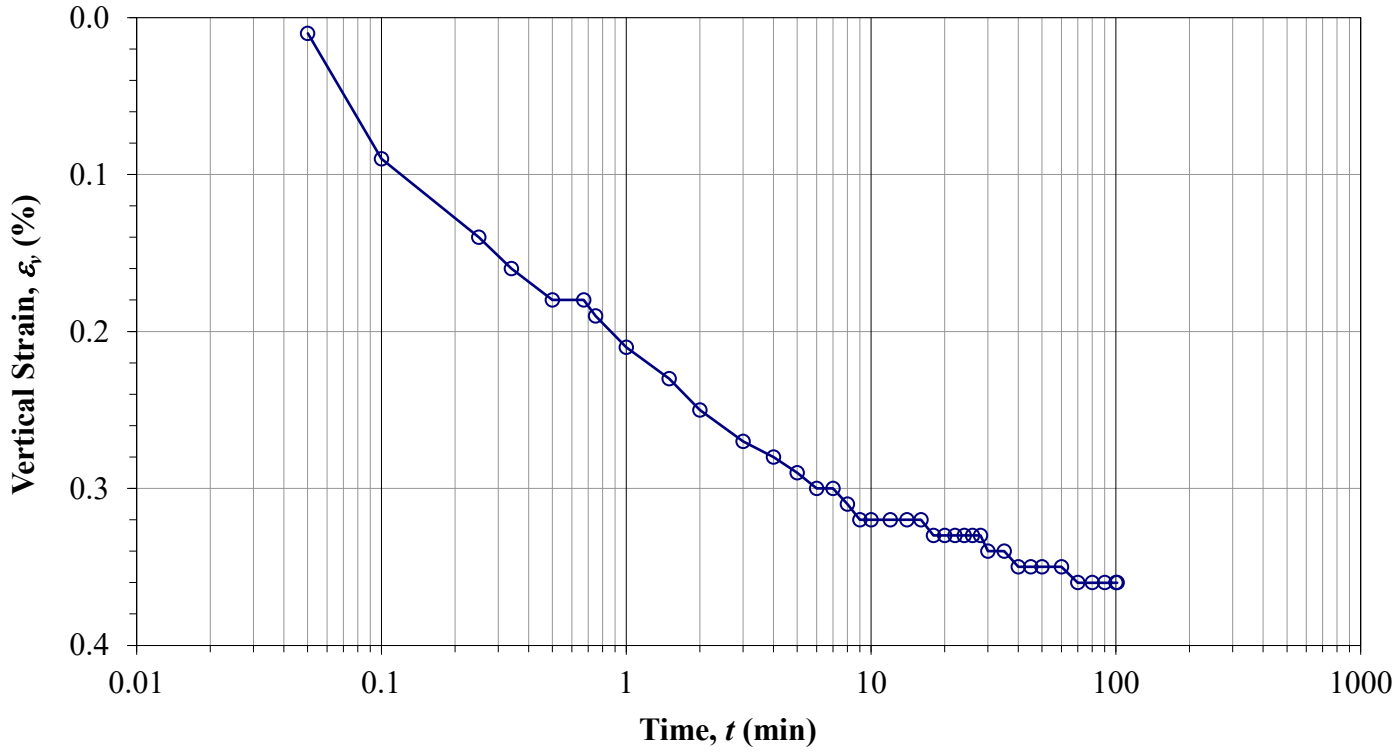
(ASTM D2435)

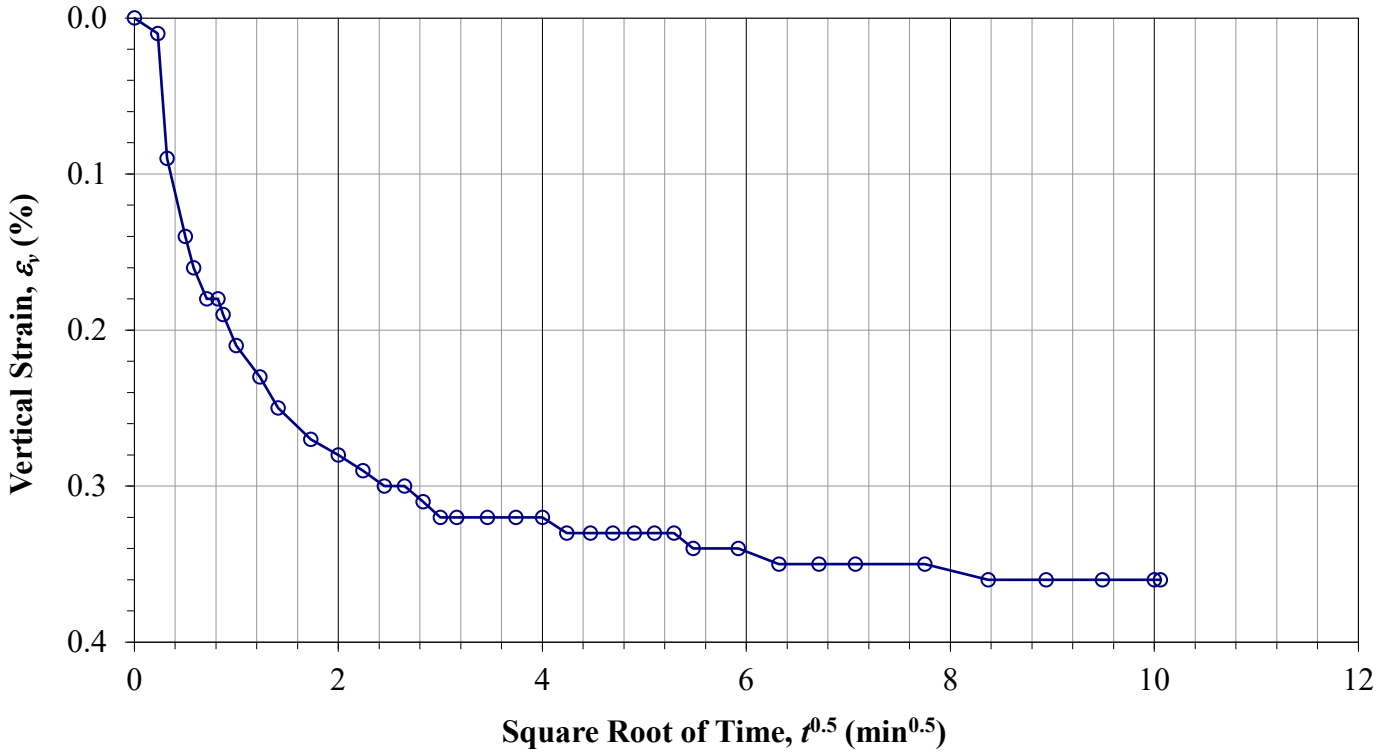
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

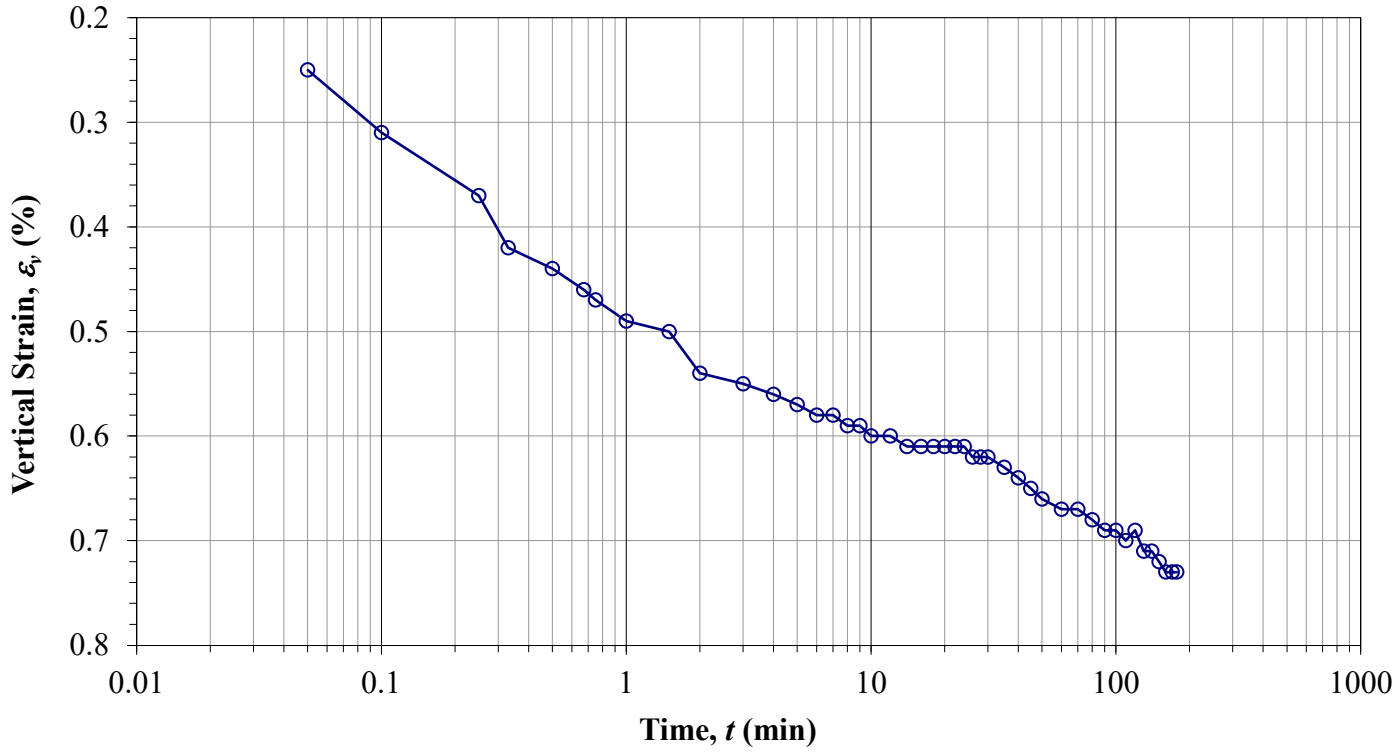
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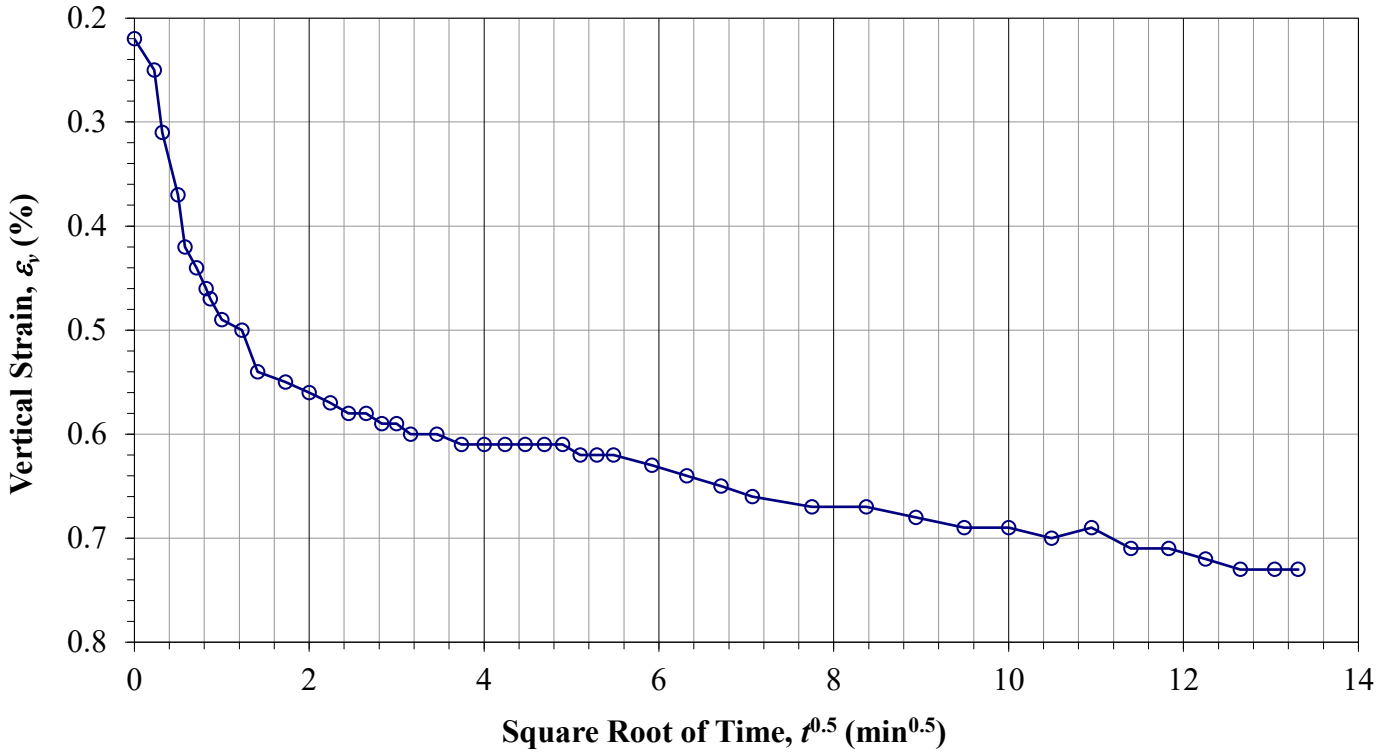
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 3 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

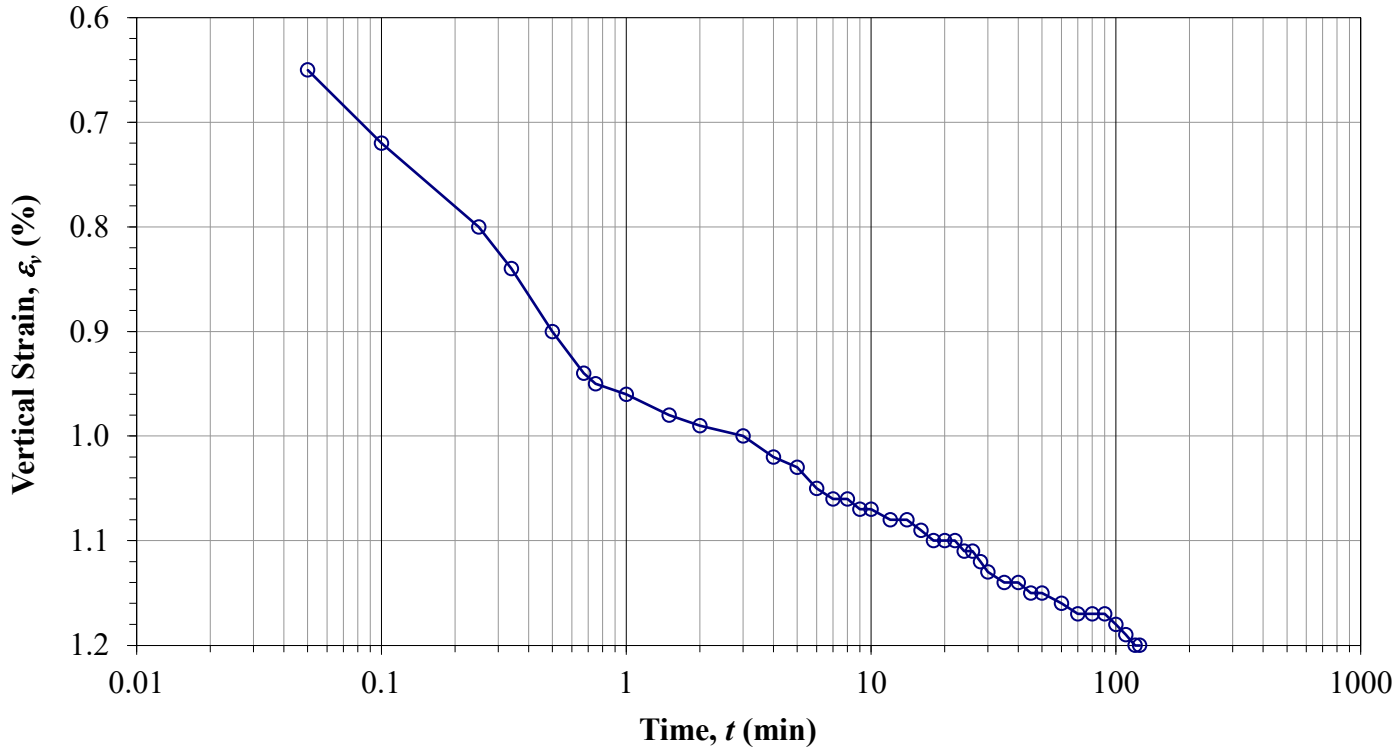
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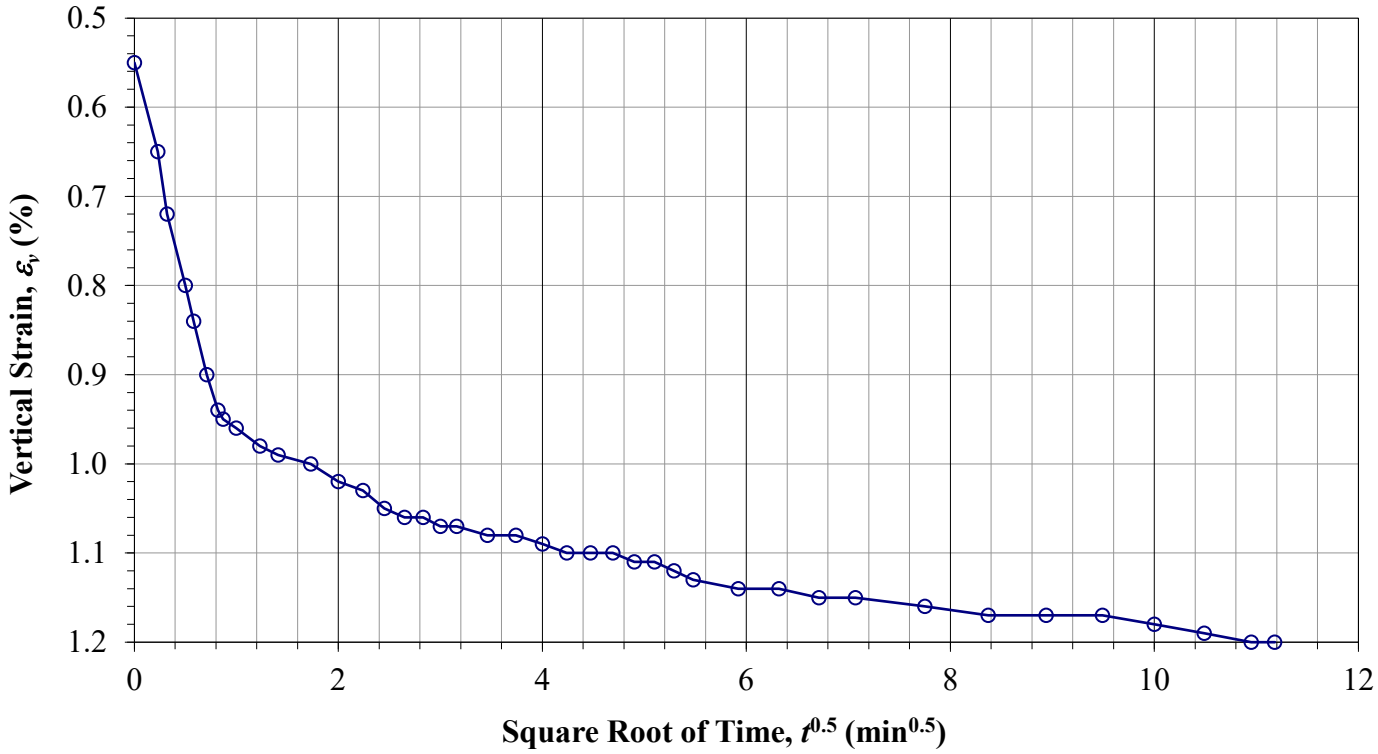
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

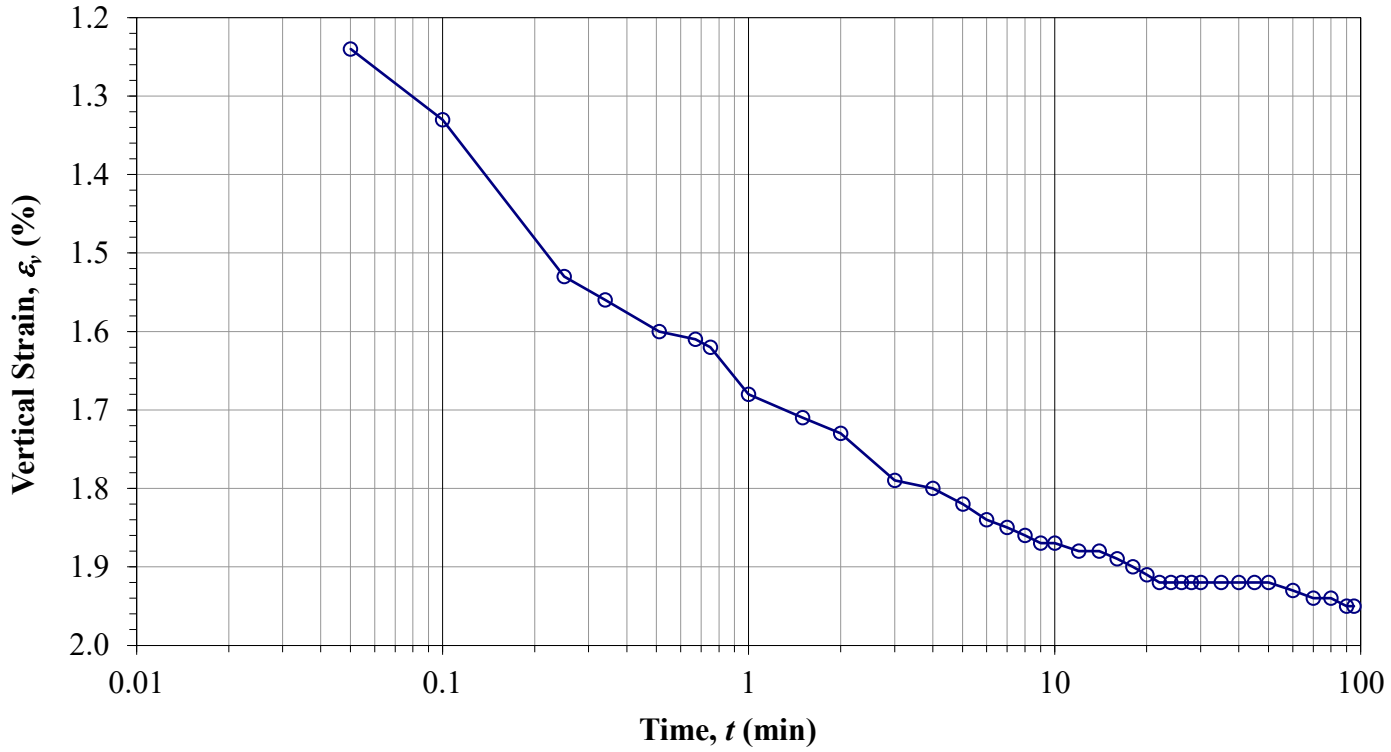
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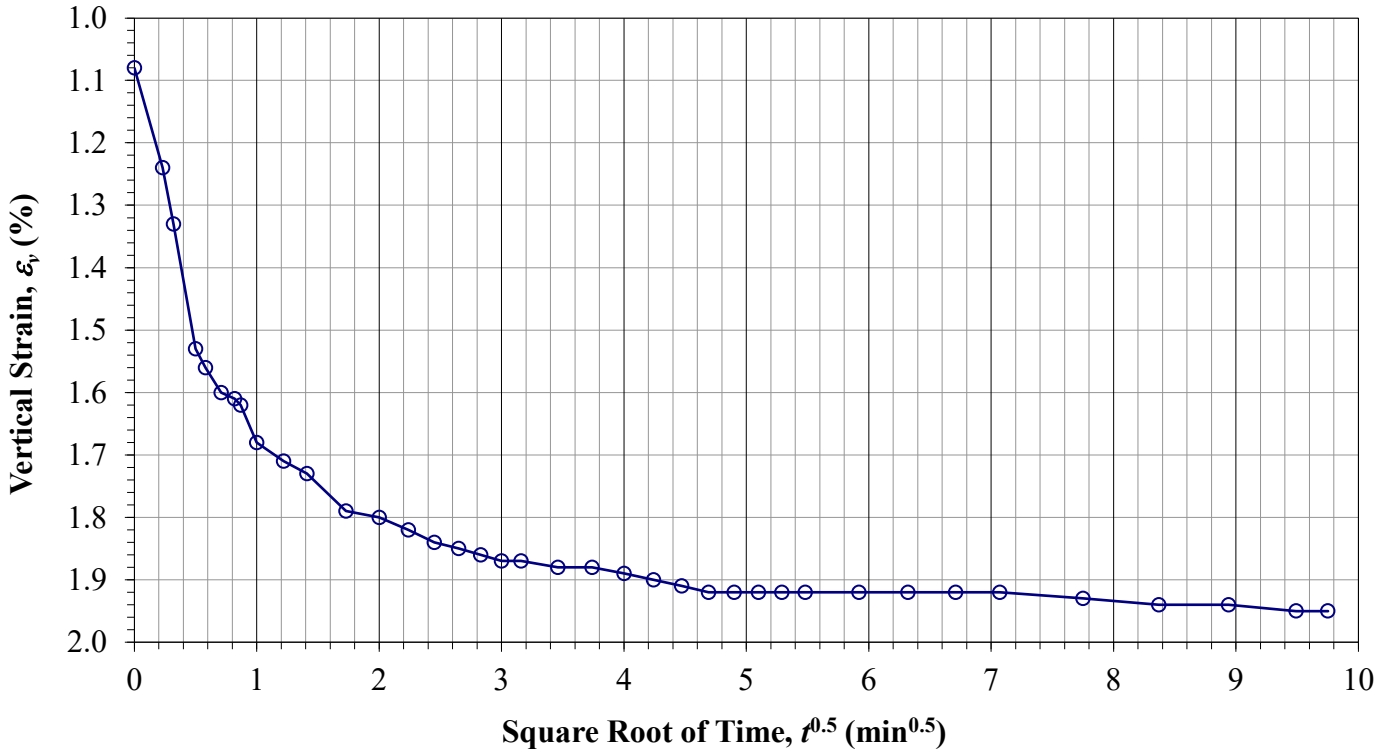
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 5 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

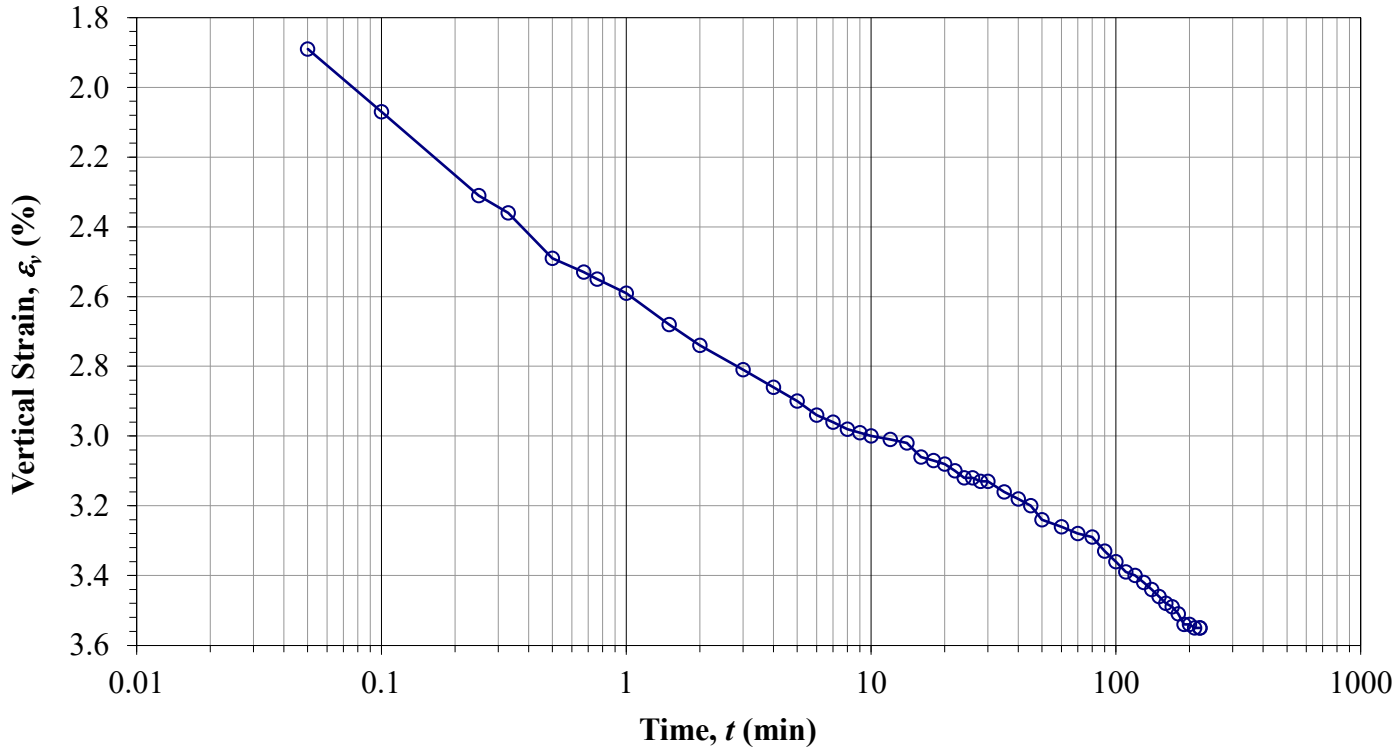
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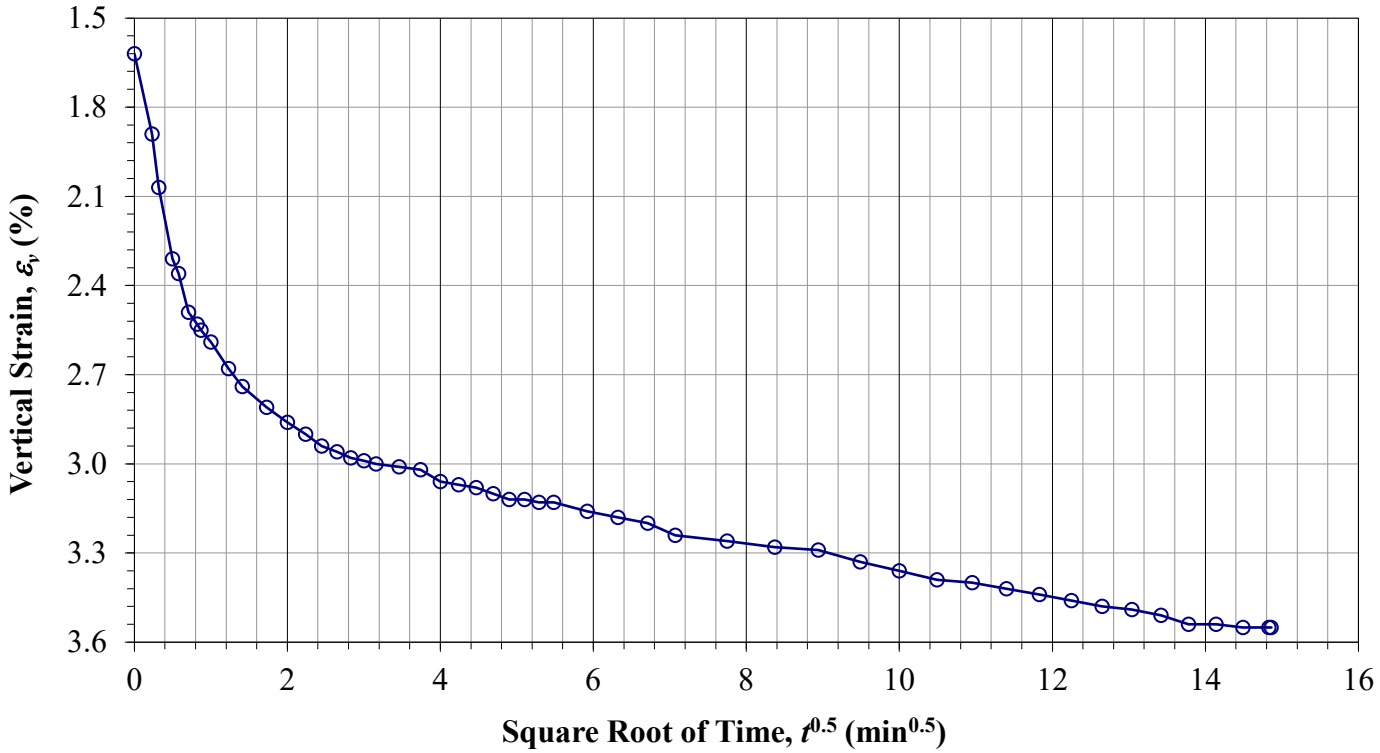
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 6 of 14
Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

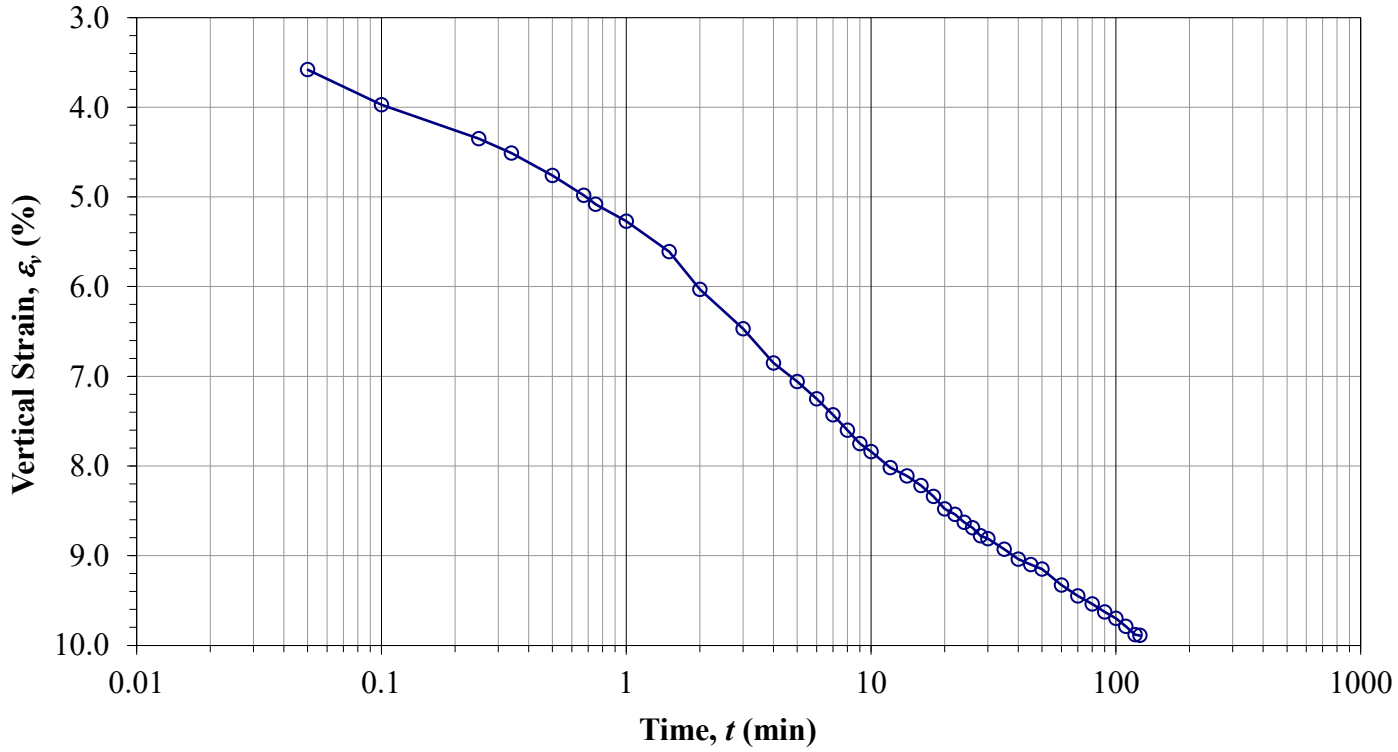
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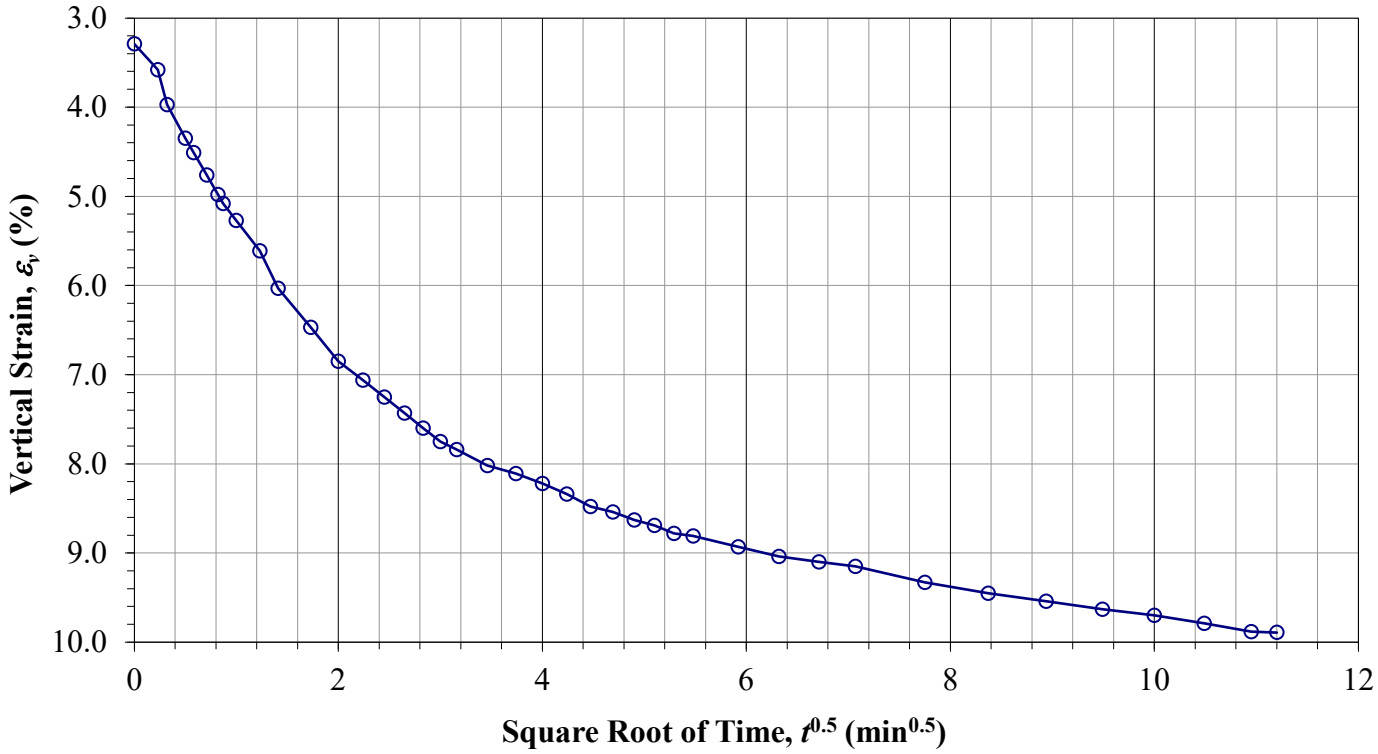
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 7 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

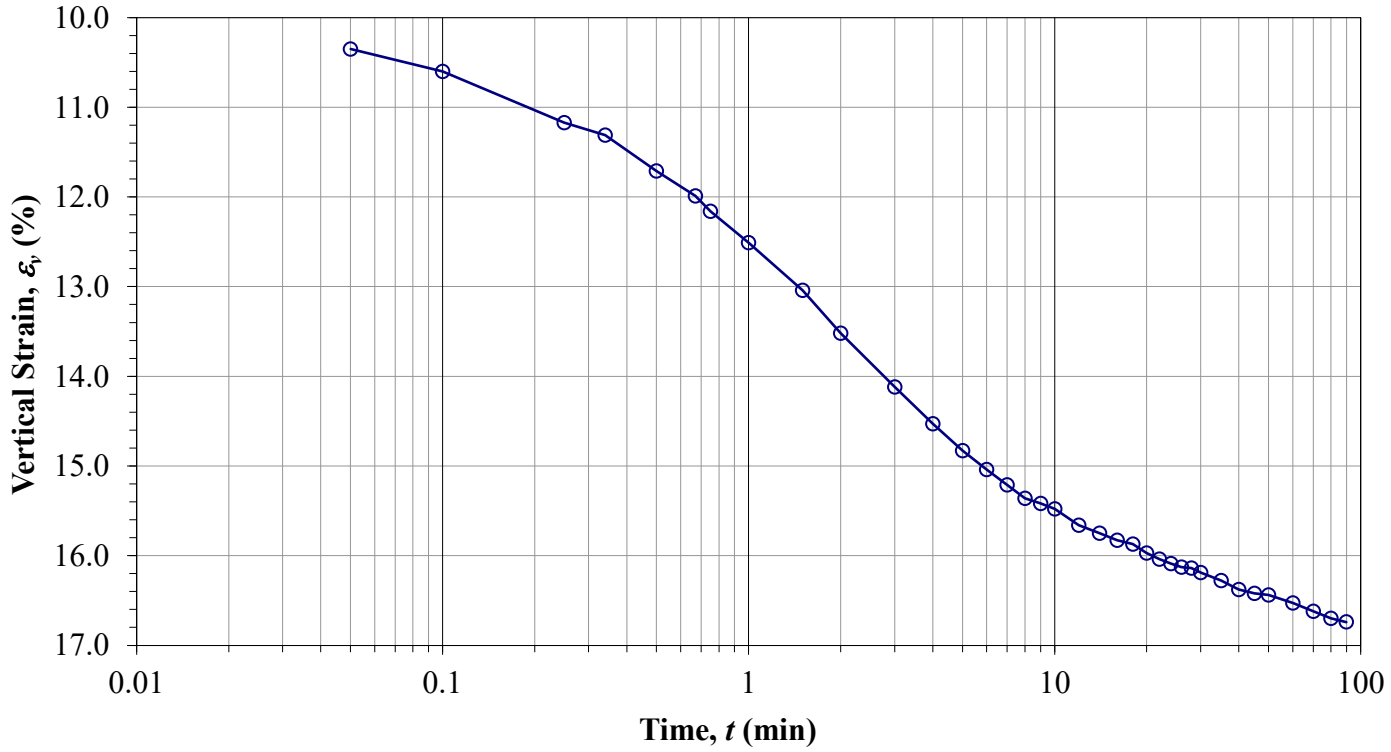
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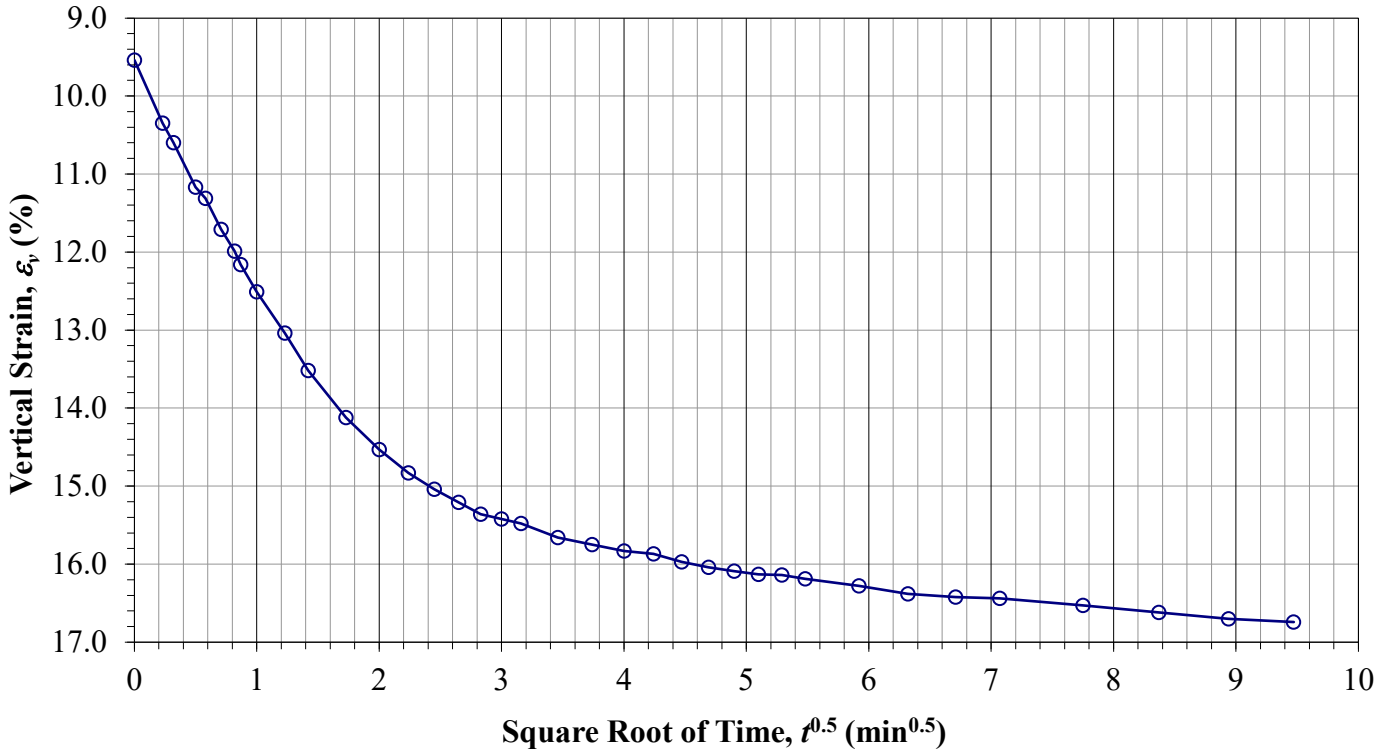
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 8 of 14
Stress: 12800 psf





One-Dimensional Consolidation Properties of Soils

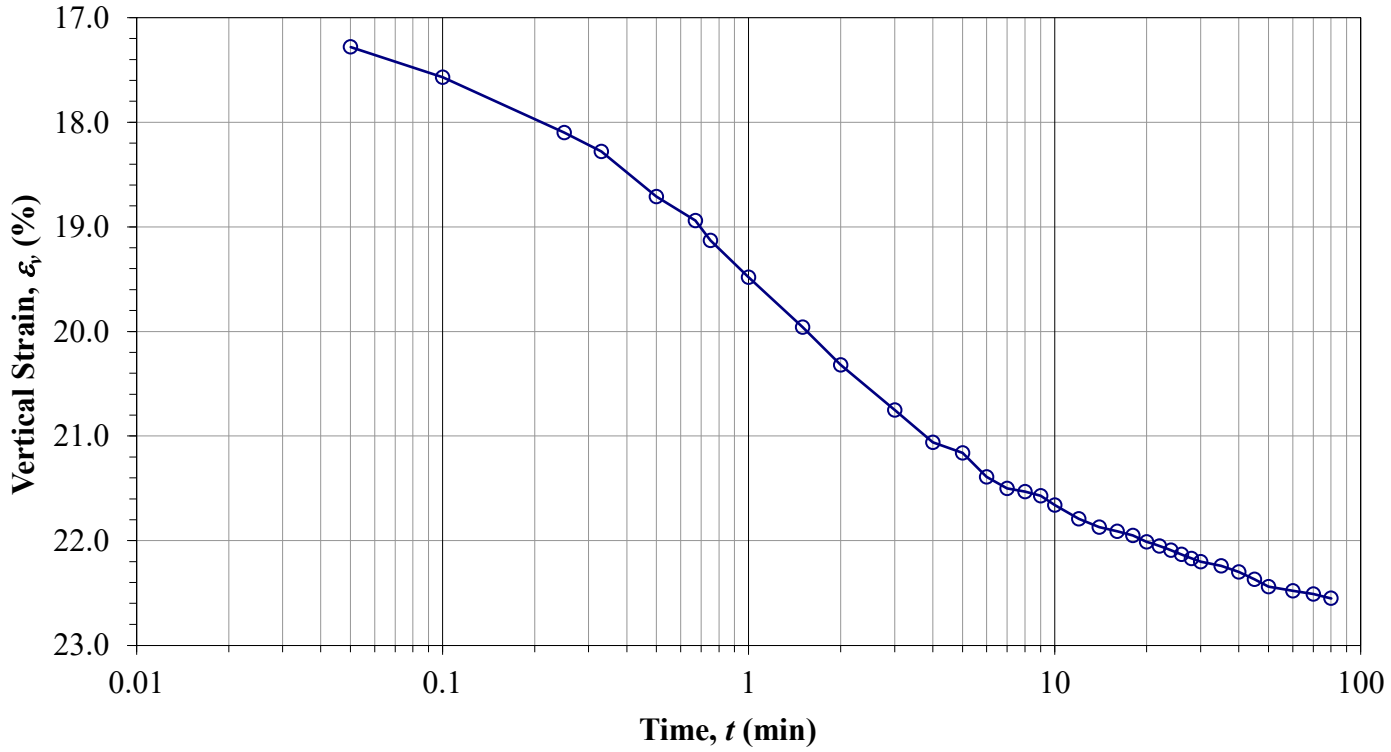
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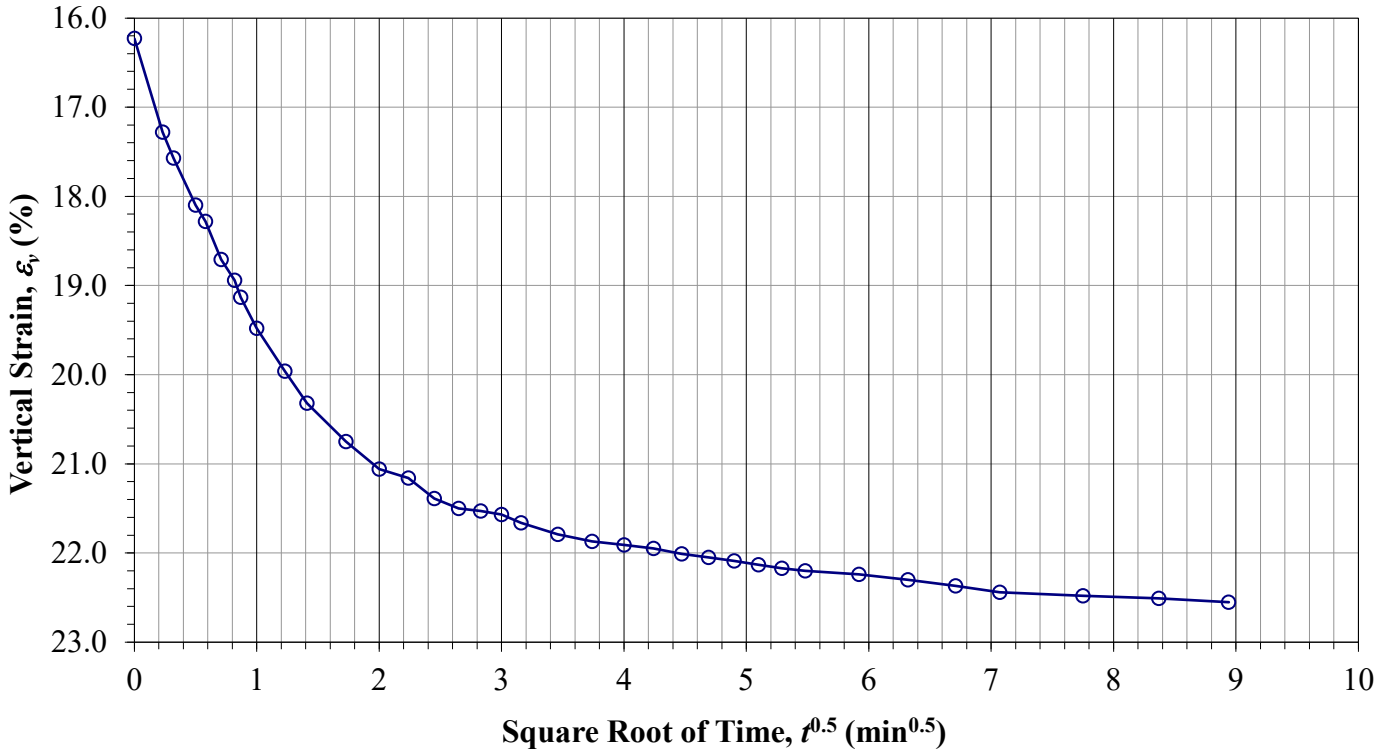
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 9 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

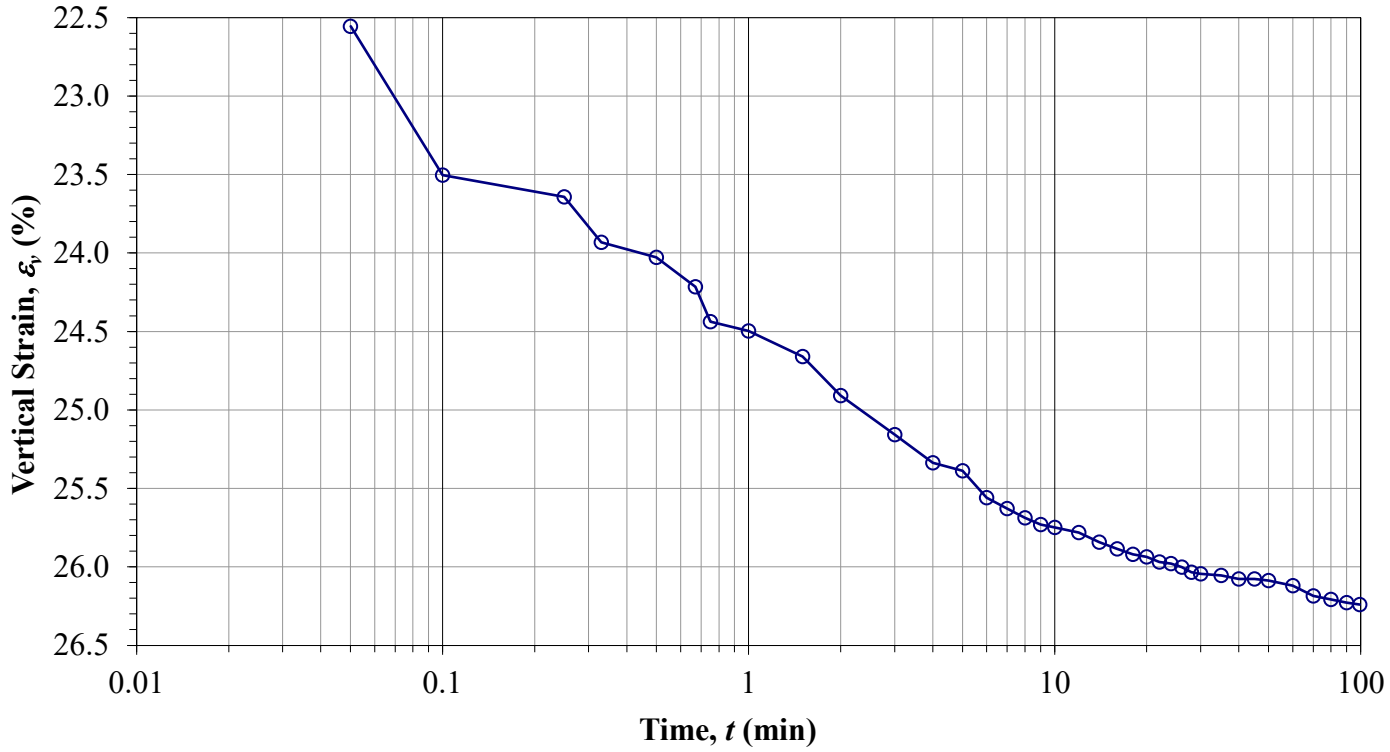
(ASTM D2435)

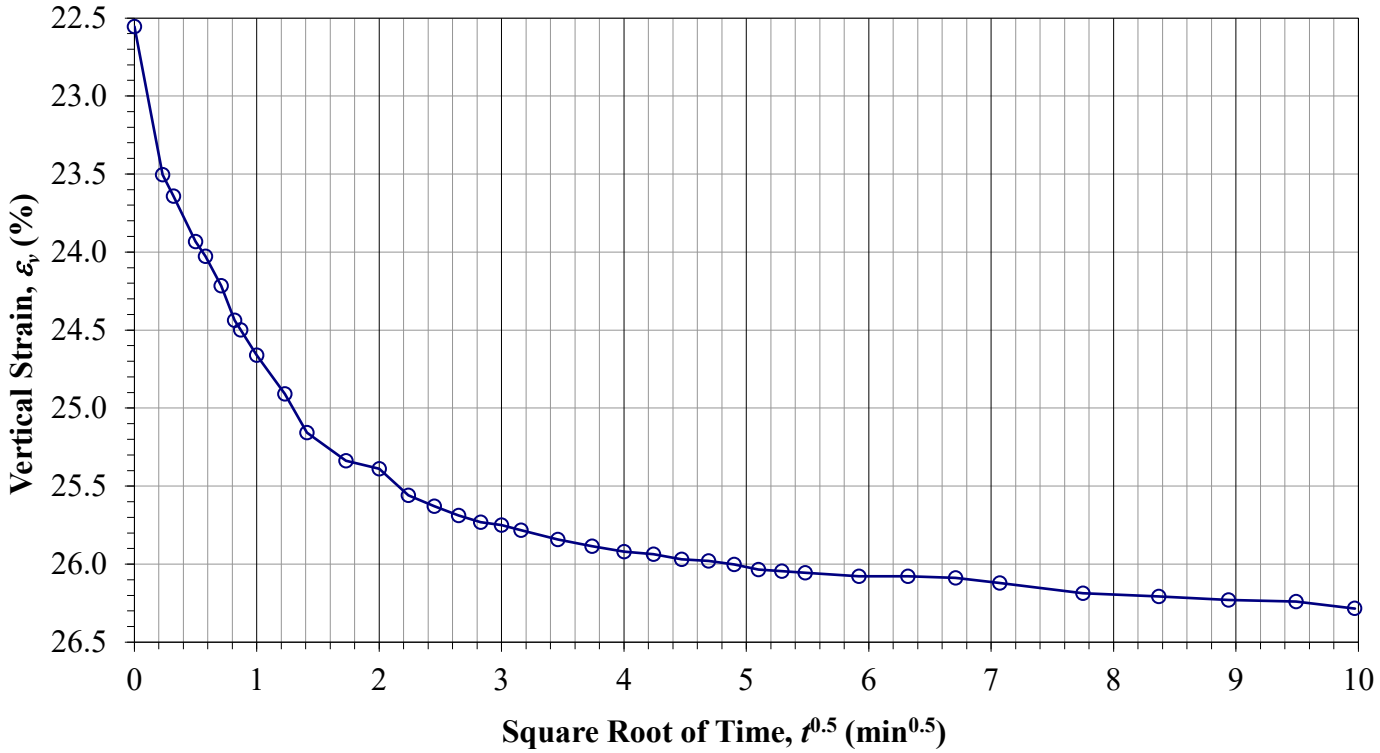
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 10 of 14
Stress: 51200 psf





Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[CONSOL_GC+TRv1_B21-OIPS-01_6_28ft.xlsm]10

One-Dimensional Consolidation Properties of Soils

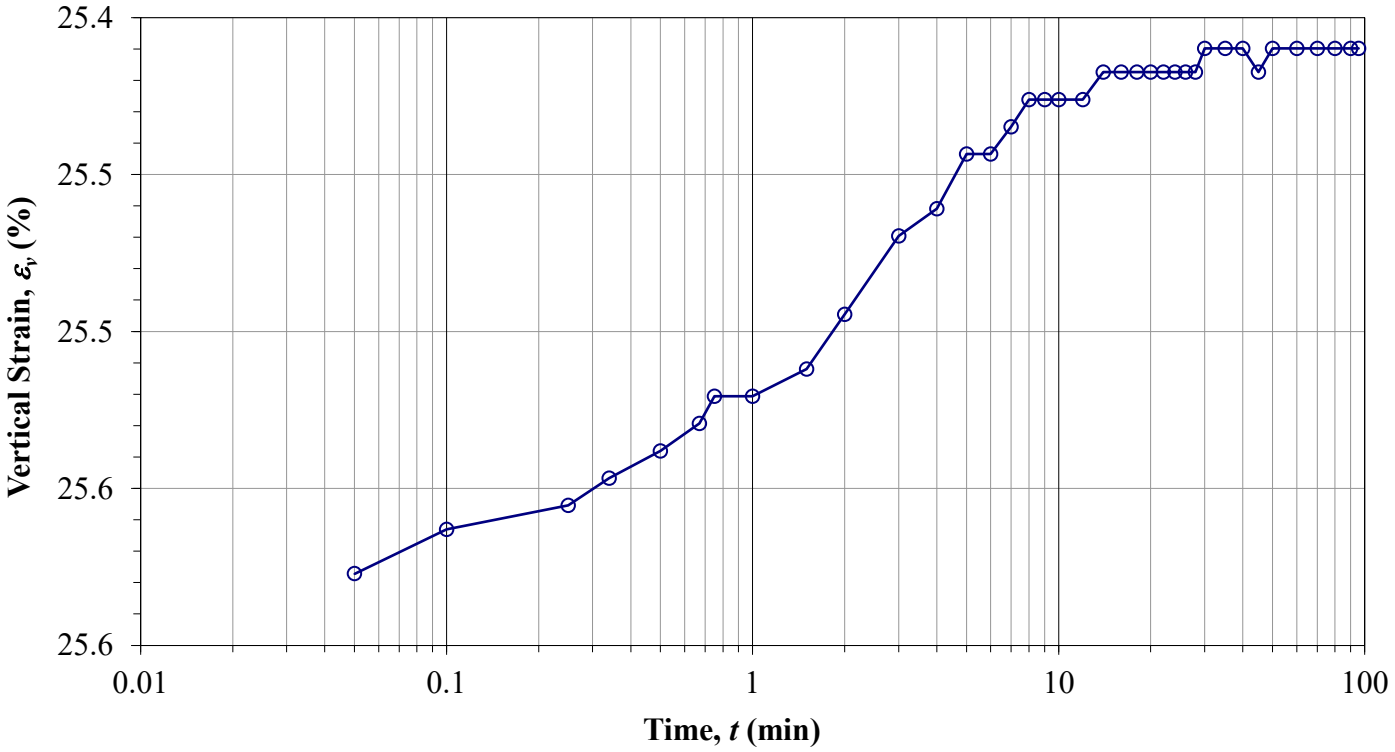
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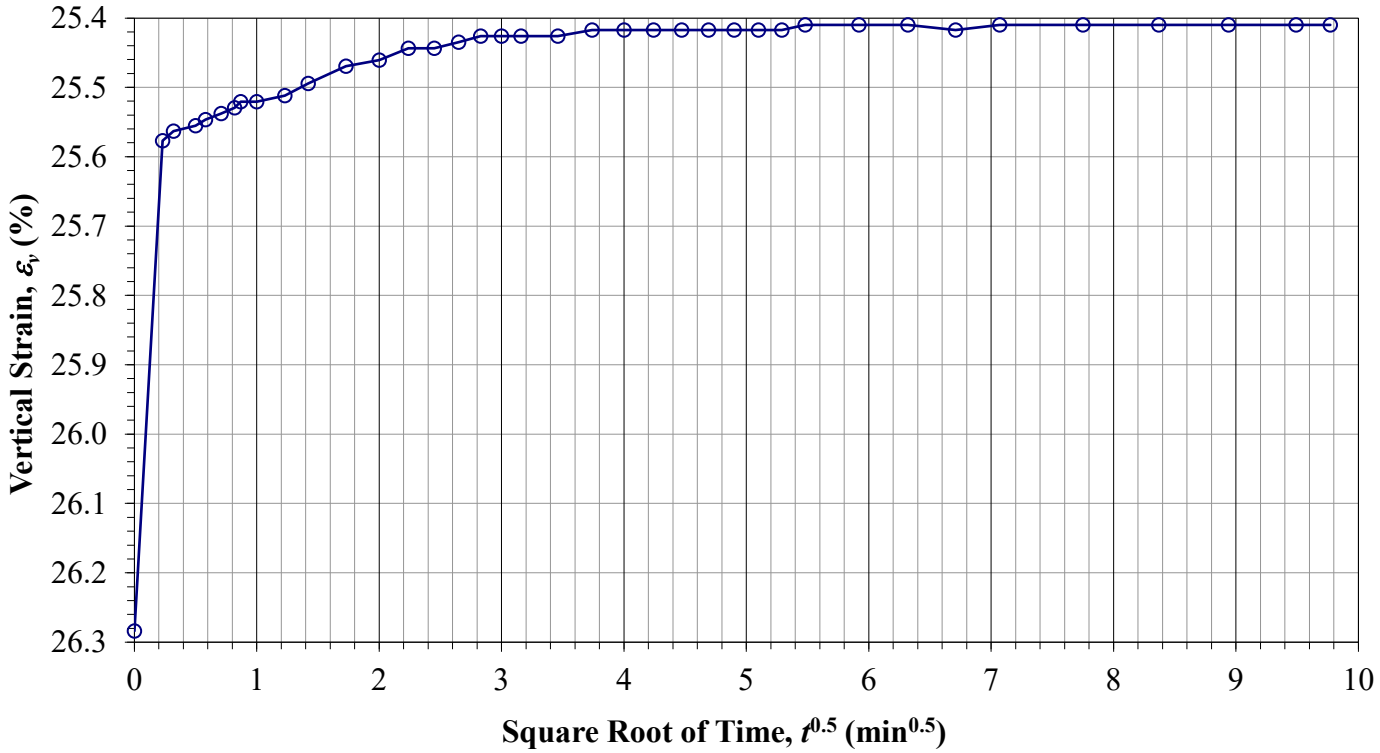
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 11 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

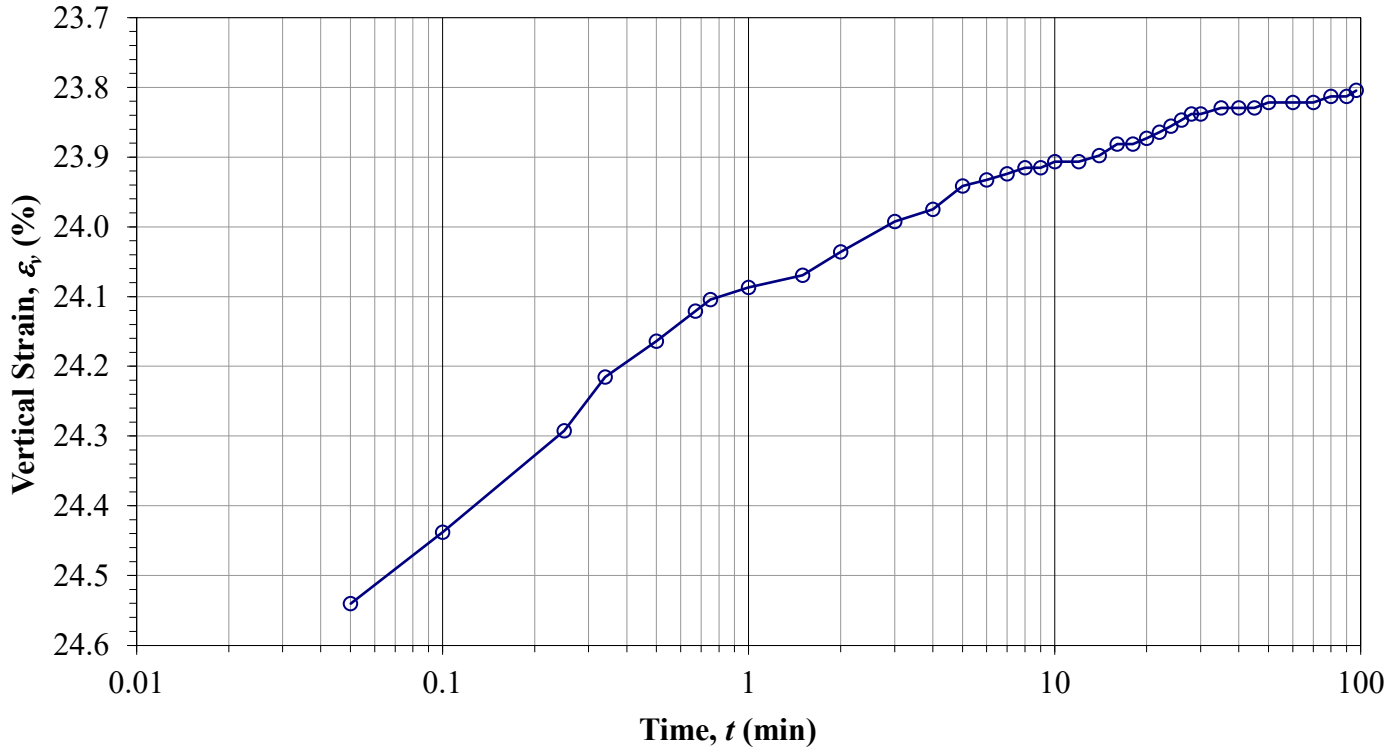
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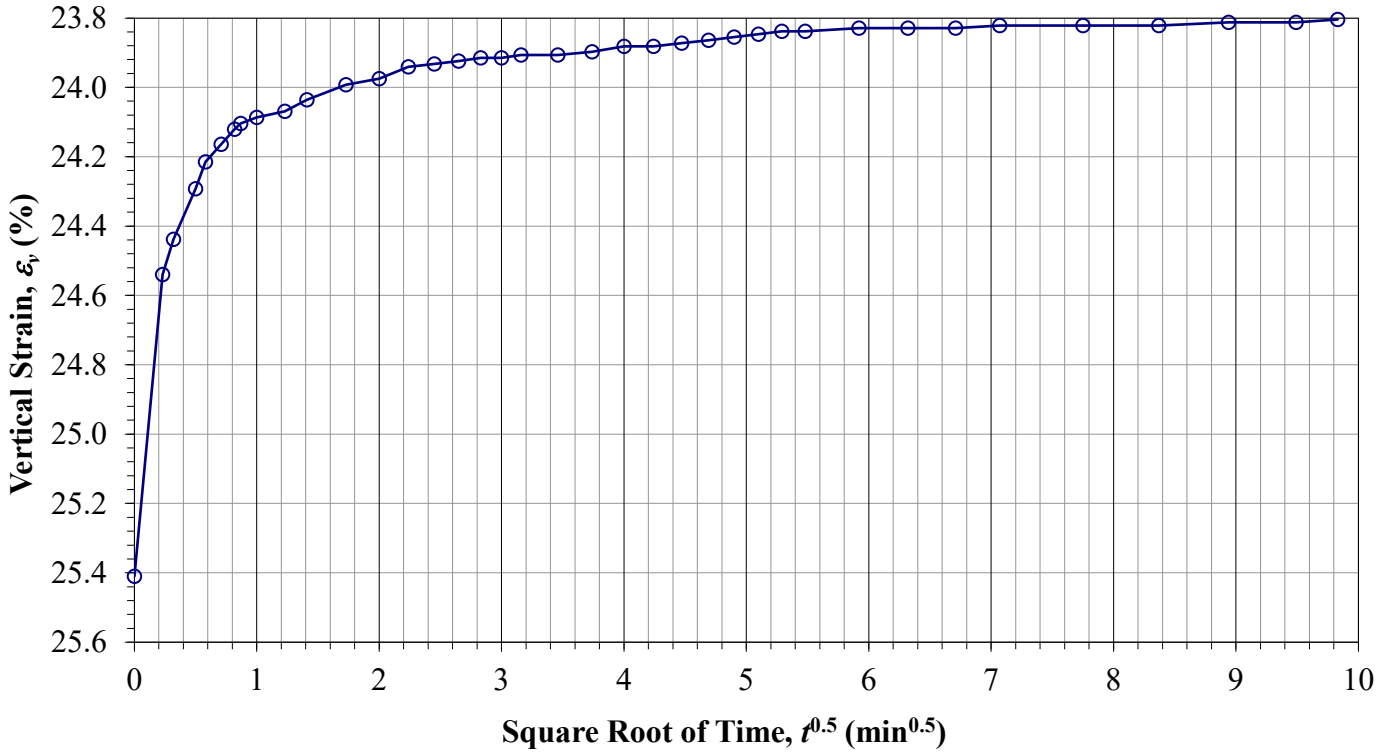
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 12 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

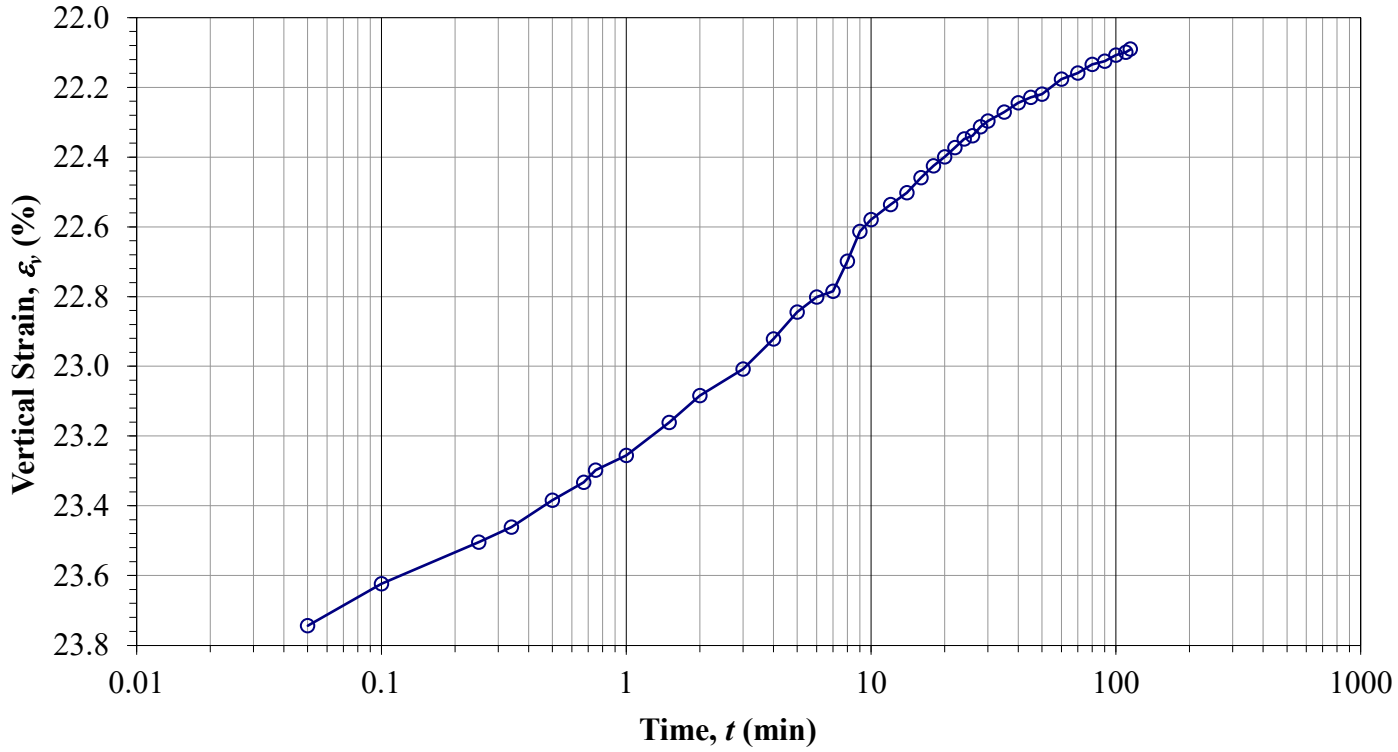
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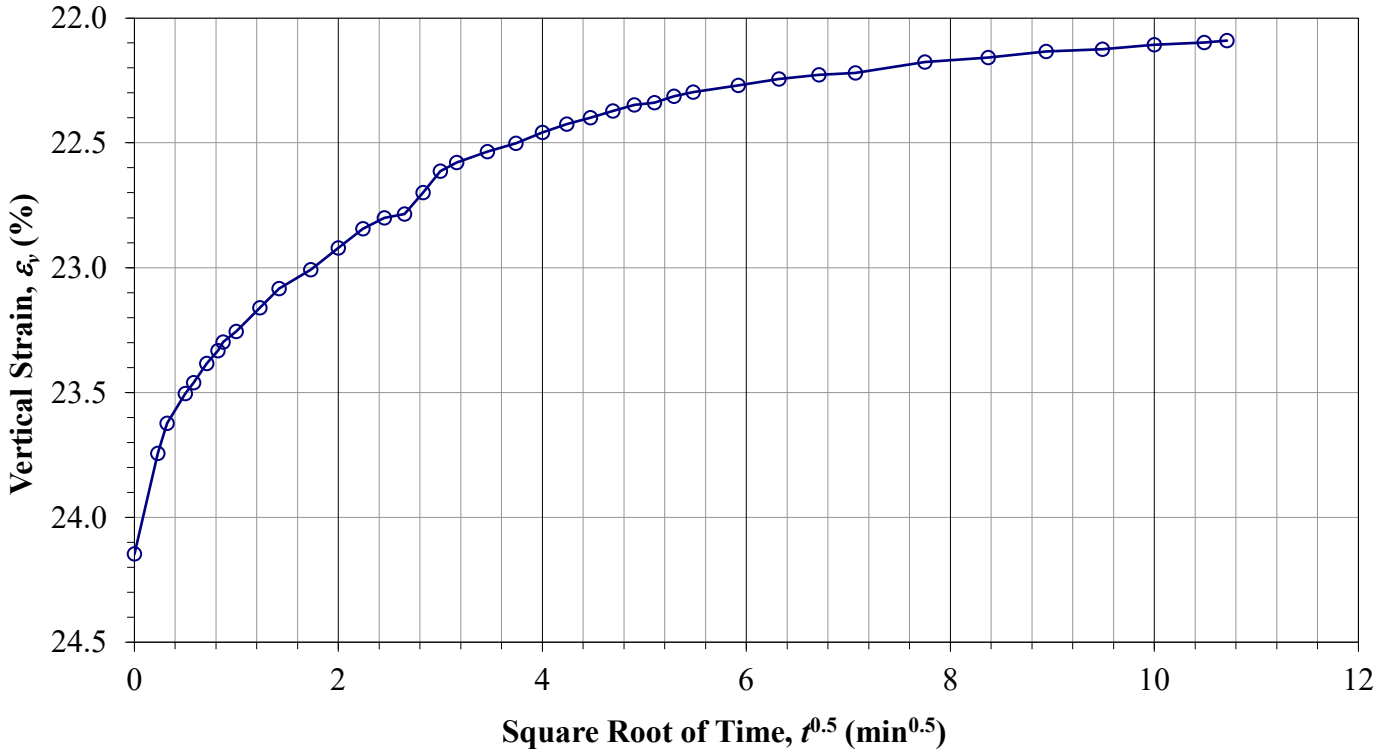
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 13 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

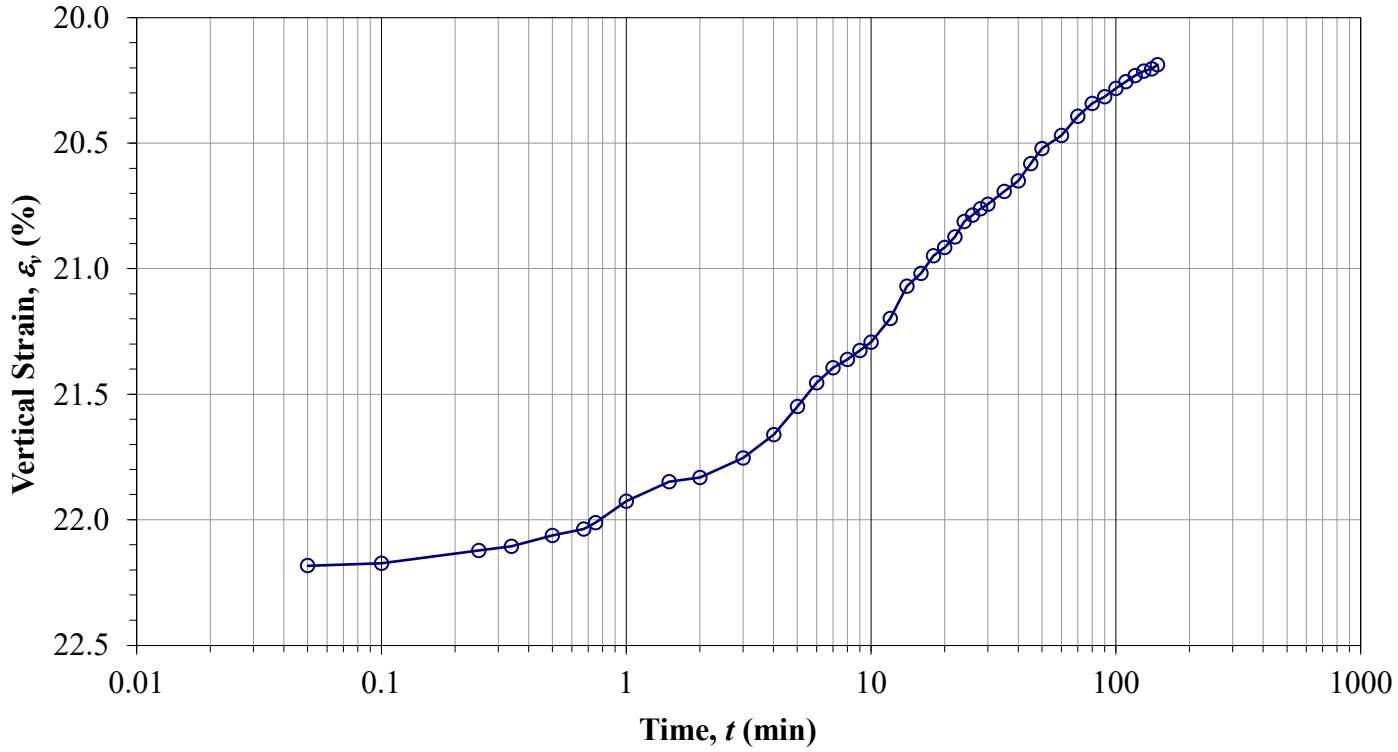
(ASTM D2435)

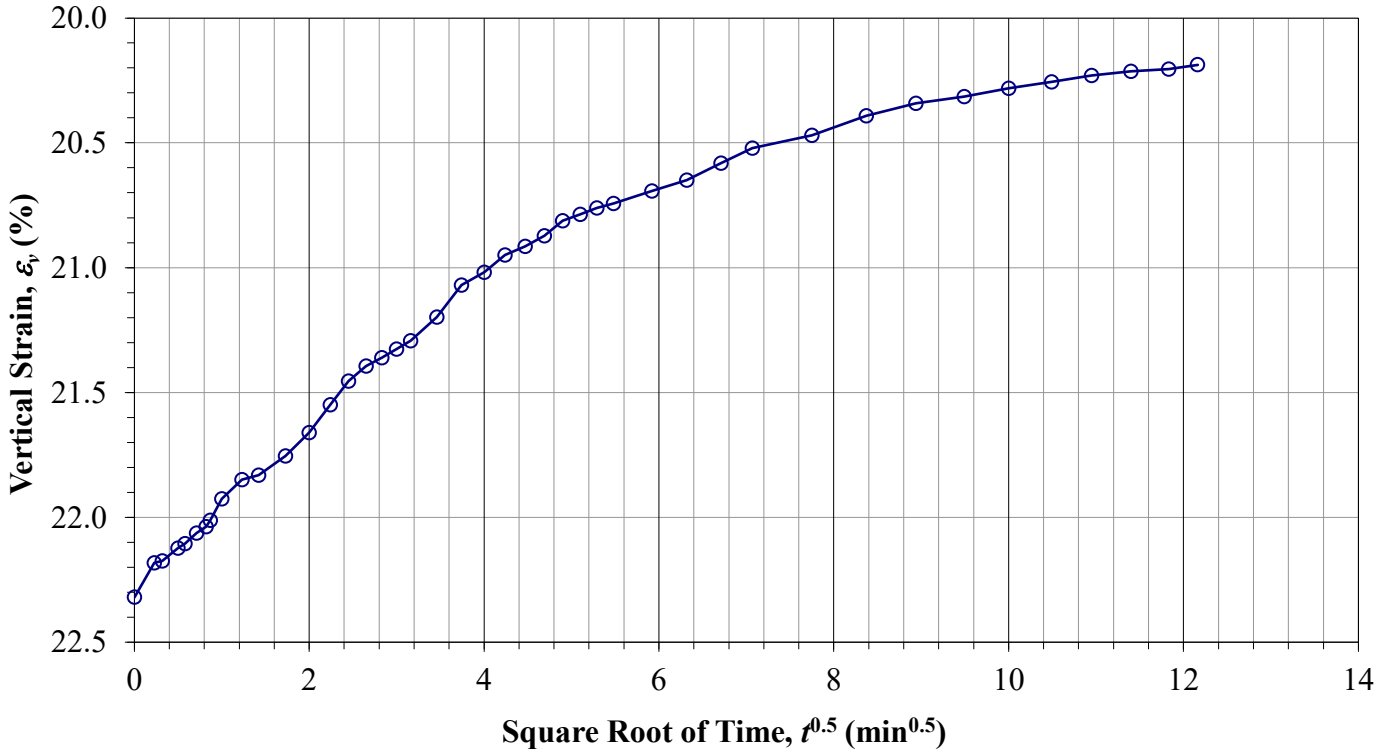
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-01
Sample: 6
Depth: 28'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: EH

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

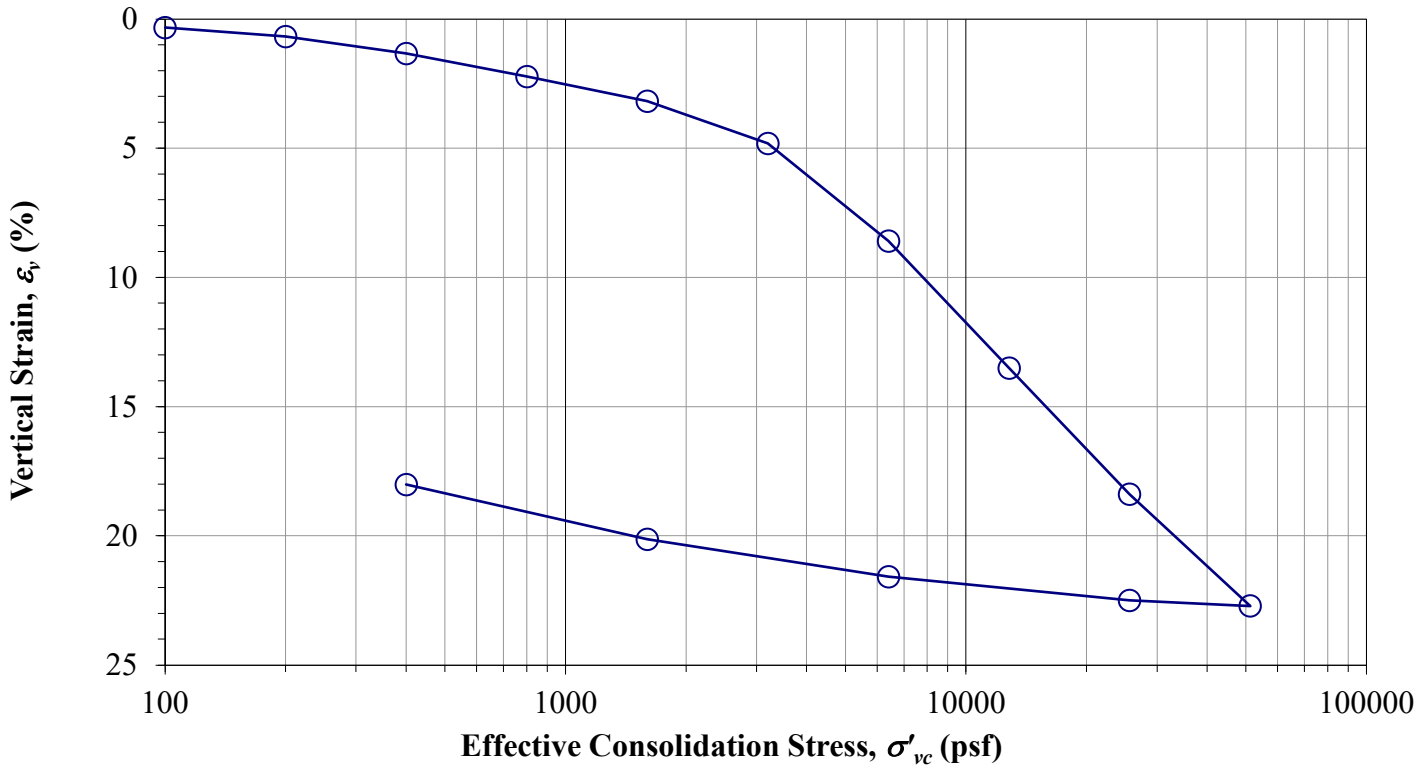
Test method:	B	
Inundation stress (psf), timing:	100	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.918	0.753
Sample diameter, D (in.)	2.413	2.413
Wt. rings + wet soil (g)	170.88	163.23
Wt. rings/tare (g)	44.86	44.86
Total unit wt., γ (pcf)	114.4	131.02
Wet soil + tare (g)	386.84	241.99
Dry soil + tare (g)	317.38	216.48
Tare (g)	128.42	126.82
Water content, ω (%)	36.8	28.5
Dry unit wt., γ_d (pcf)	83.6	102.0
Saturation, S	0.98	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9180	1.0157
100	0.0030	0.33	0.9150	1.0091
200	0.0062	0.68	0.9118	1.0020
400	0.0122	1.33	0.9058	0.9889
800	0.0205	2.23	0.8975	0.9707
1600	0.0292	3.18	0.8888	0.9516
3200	0.0442	4.82	0.8738	0.9186
6400	0.0789	8.59	0.8392	0.8426
12800	0.1240	13.51	0.7940	0.7434
25600	0.1688	18.39	0.7492	0.6451
51200	0.2085	22.71	0.7095	0.5579
25600	0.2065	22.49	0.7115	0.5623
6400	0.1981	21.58	0.7199	0.5807
1600	0.1848	20.13	0.7332	0.6099
400	0.1654	18.02	0.7526	0.6525



Comments: Test specimen contains thin sand seams.

Entered: _____
Reviewed: _____

One-Dimensional Consolidation Properties of Soils

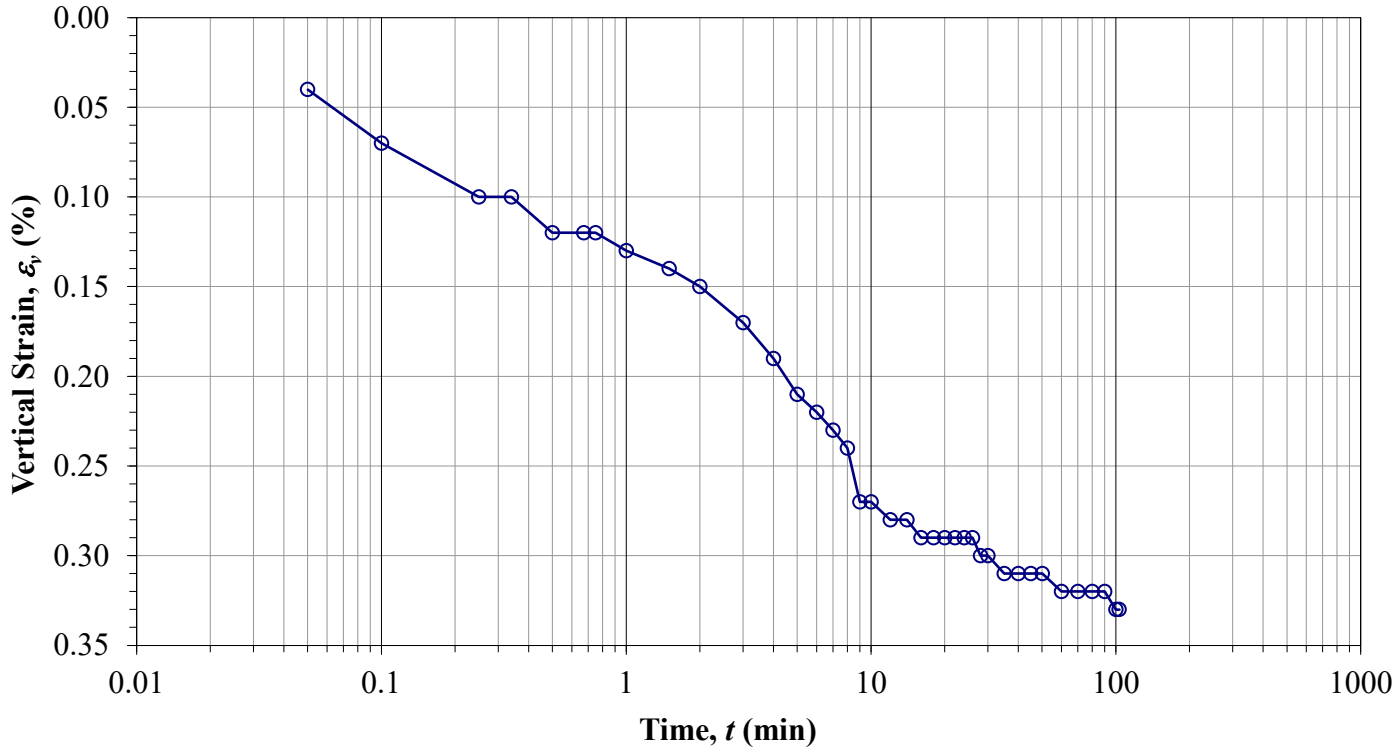
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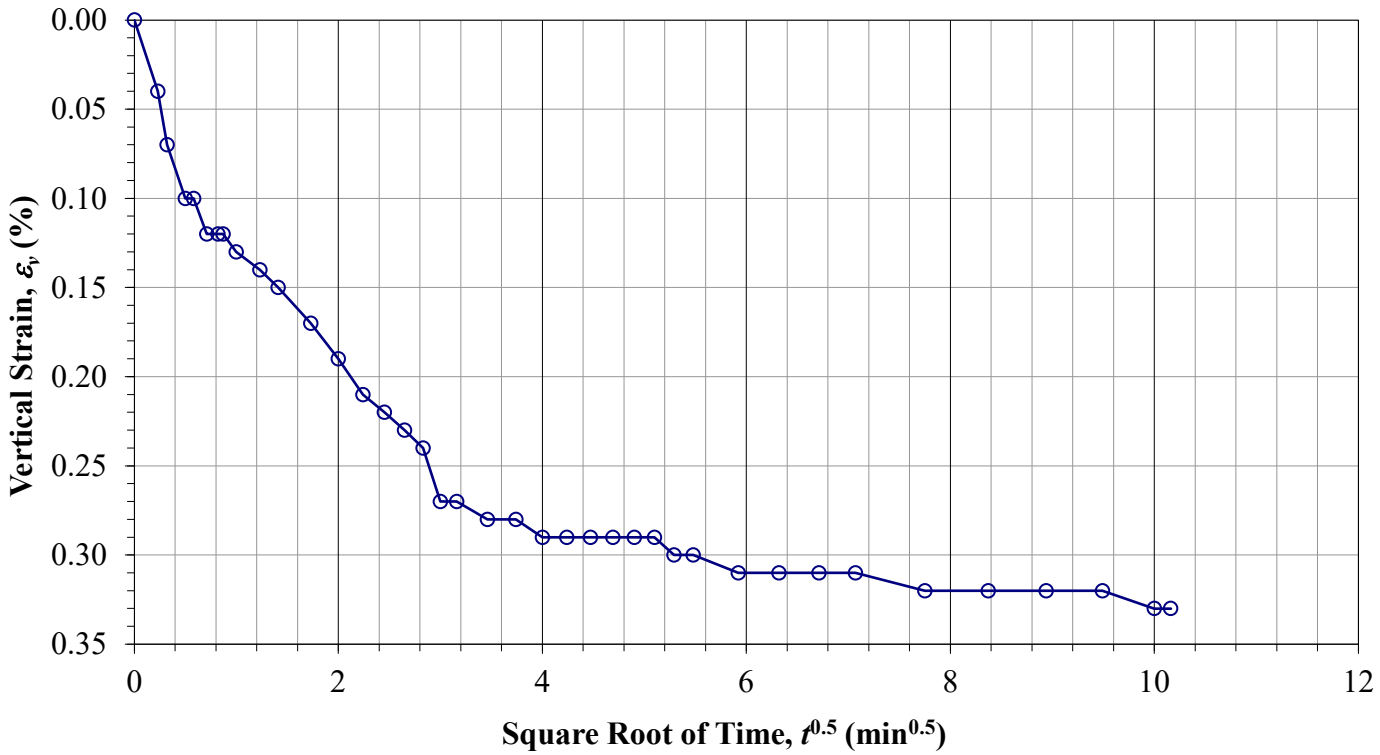
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 1 of 14
Stress: 100 psf





One-Dimensional Consolidation Properties of Soils

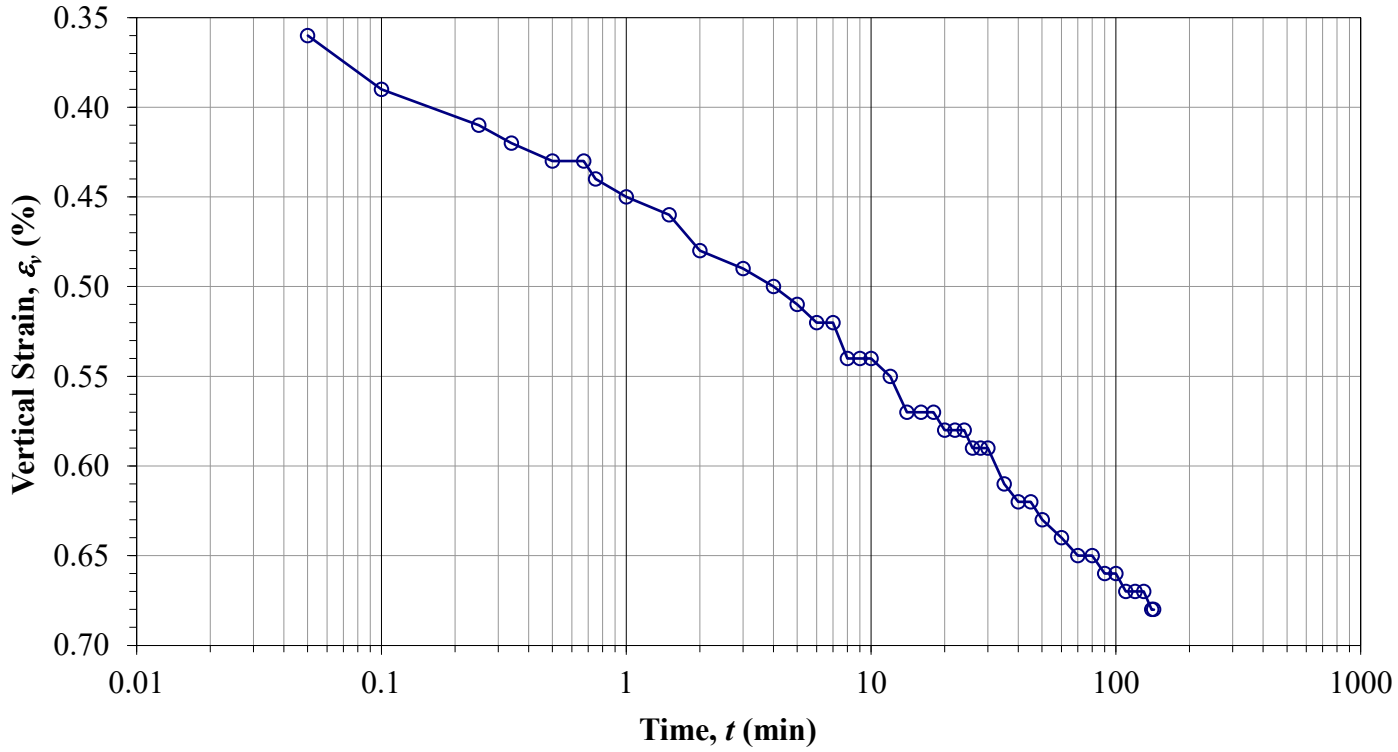
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

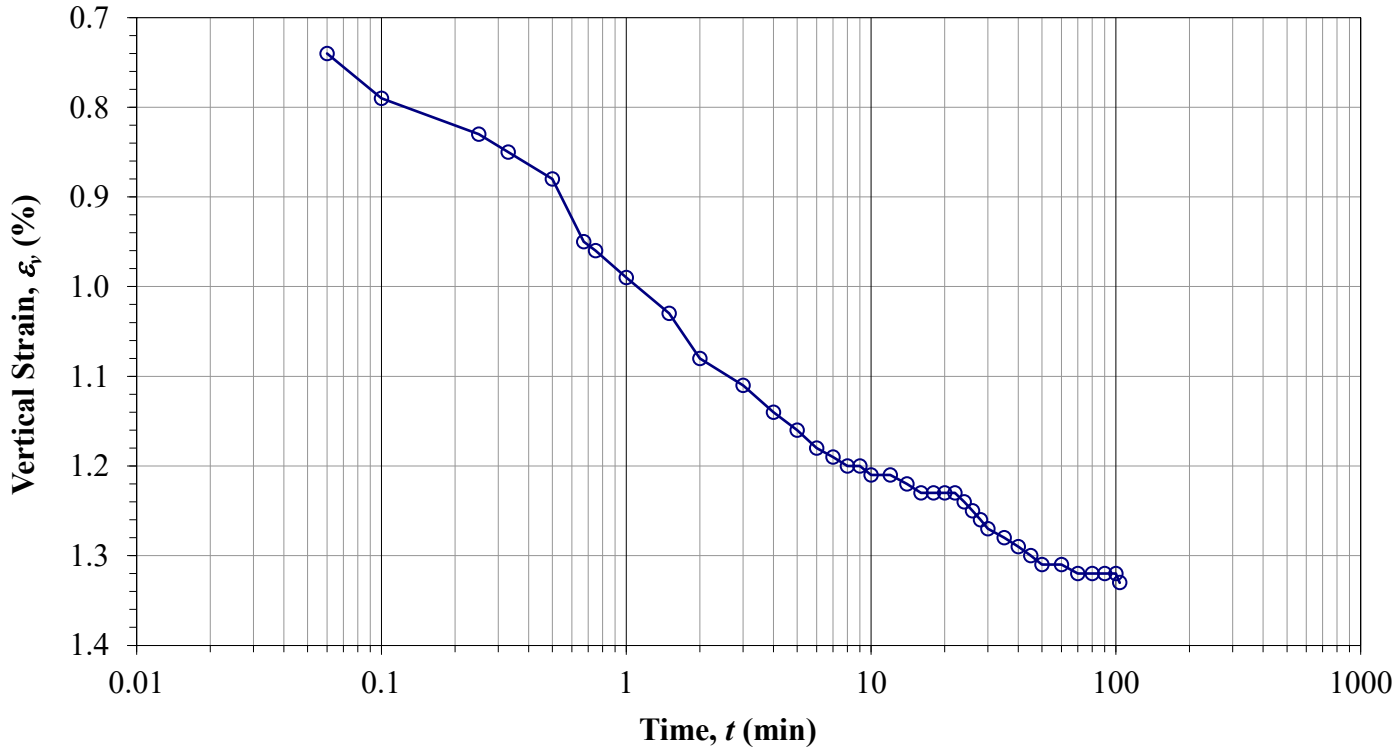
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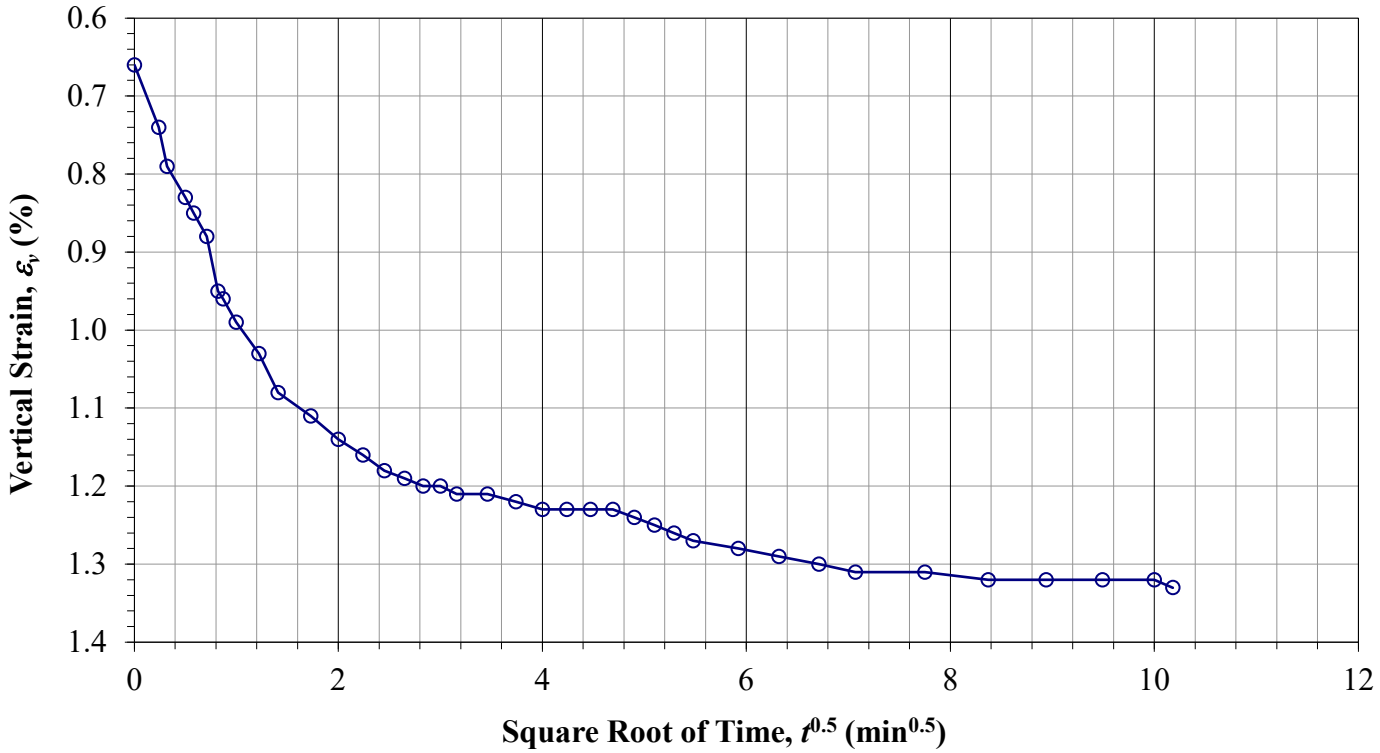
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 3 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

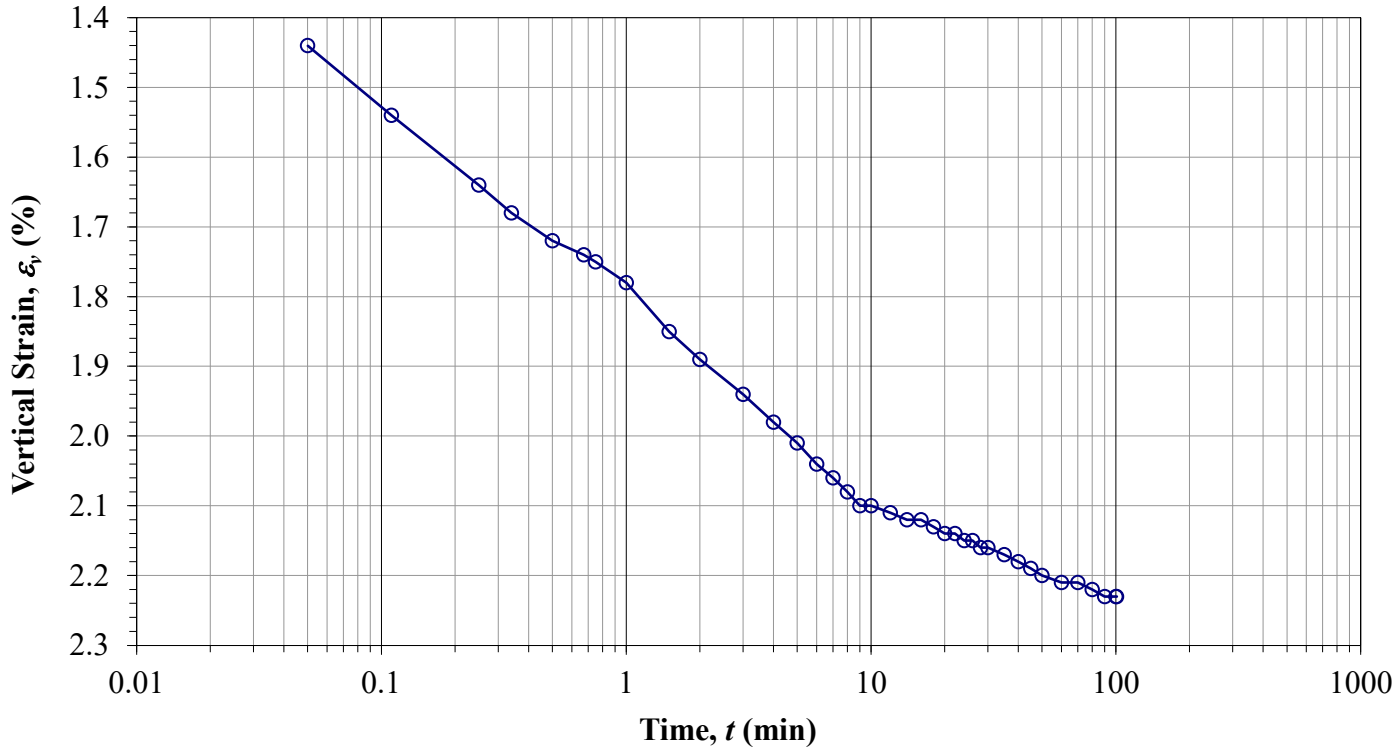
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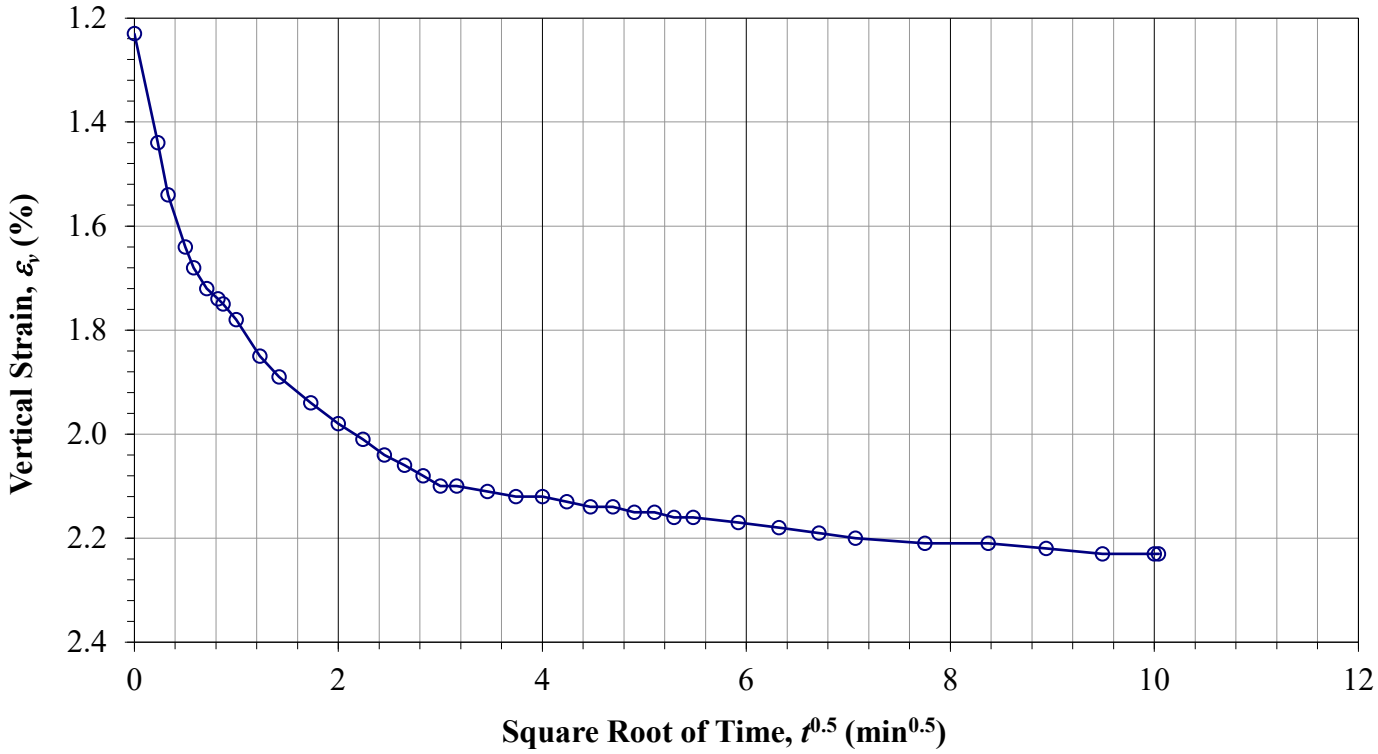
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

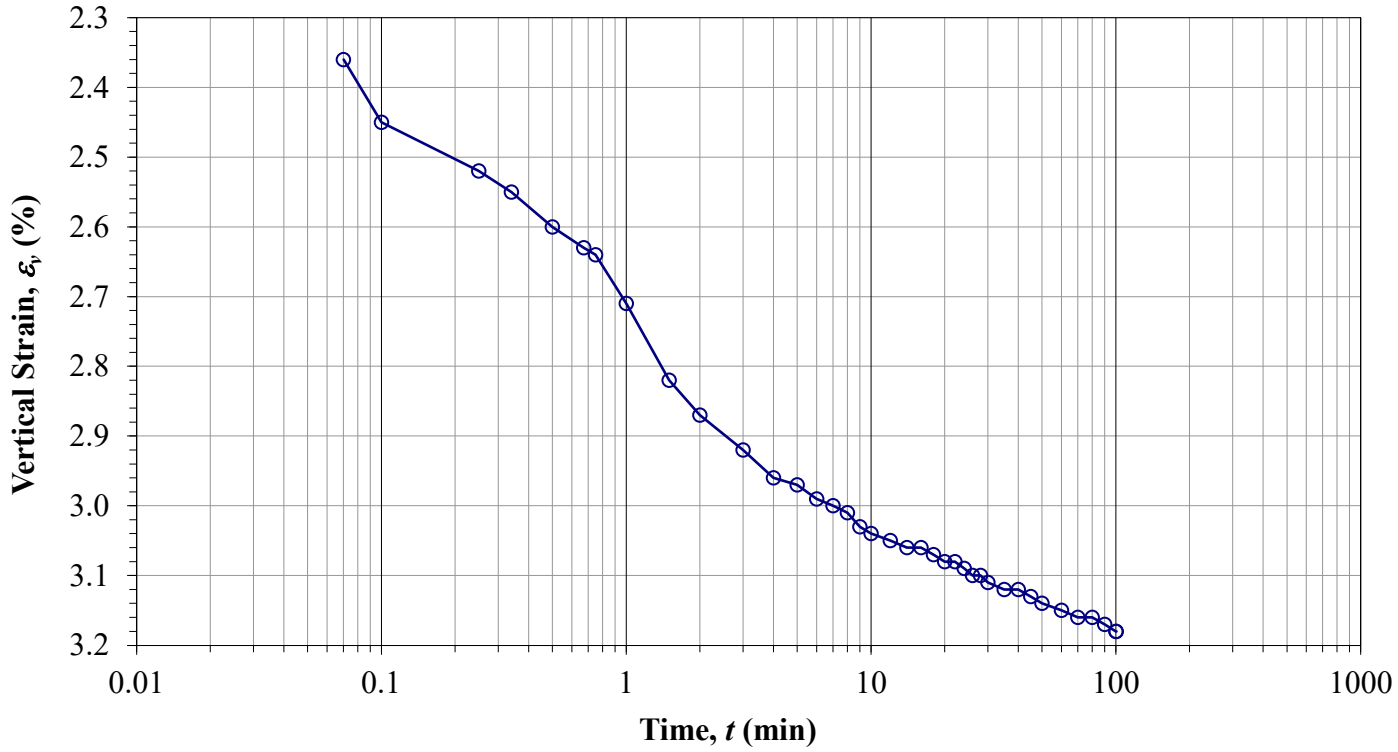
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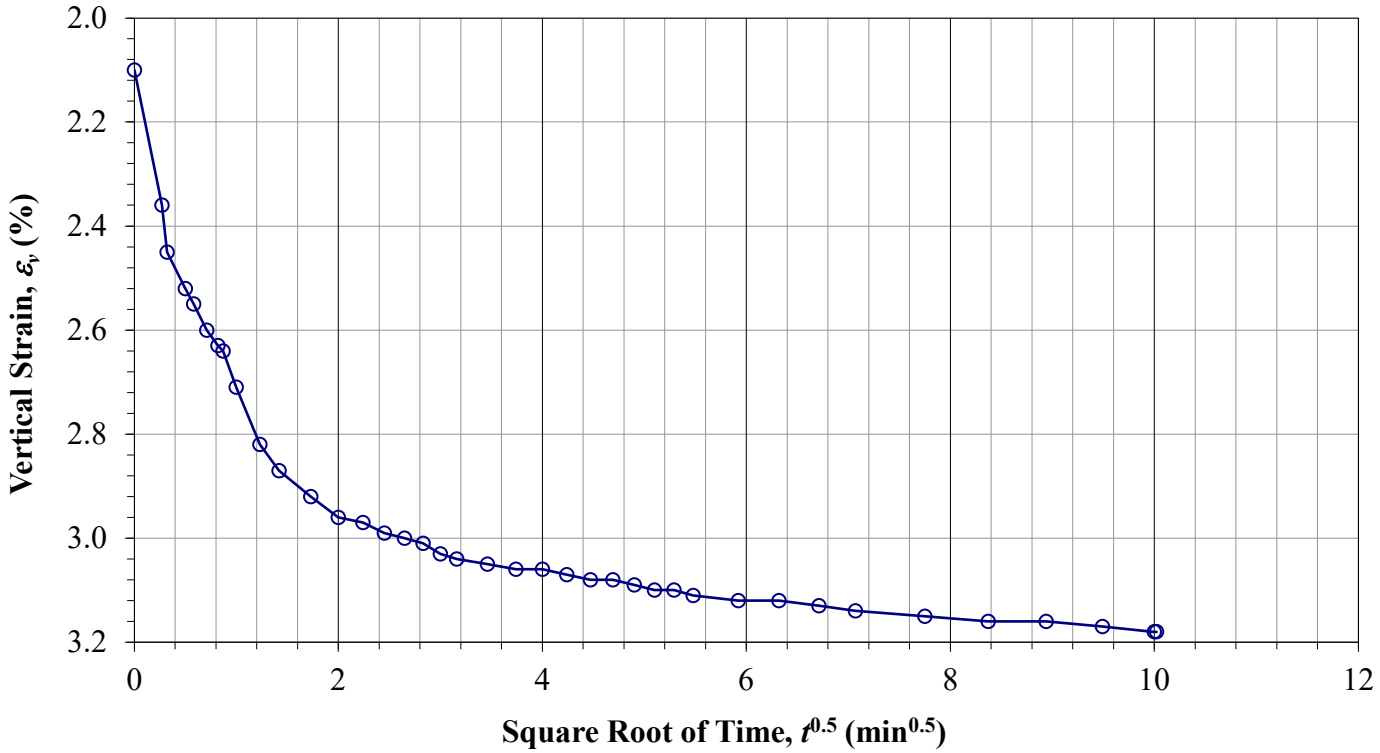
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 5 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

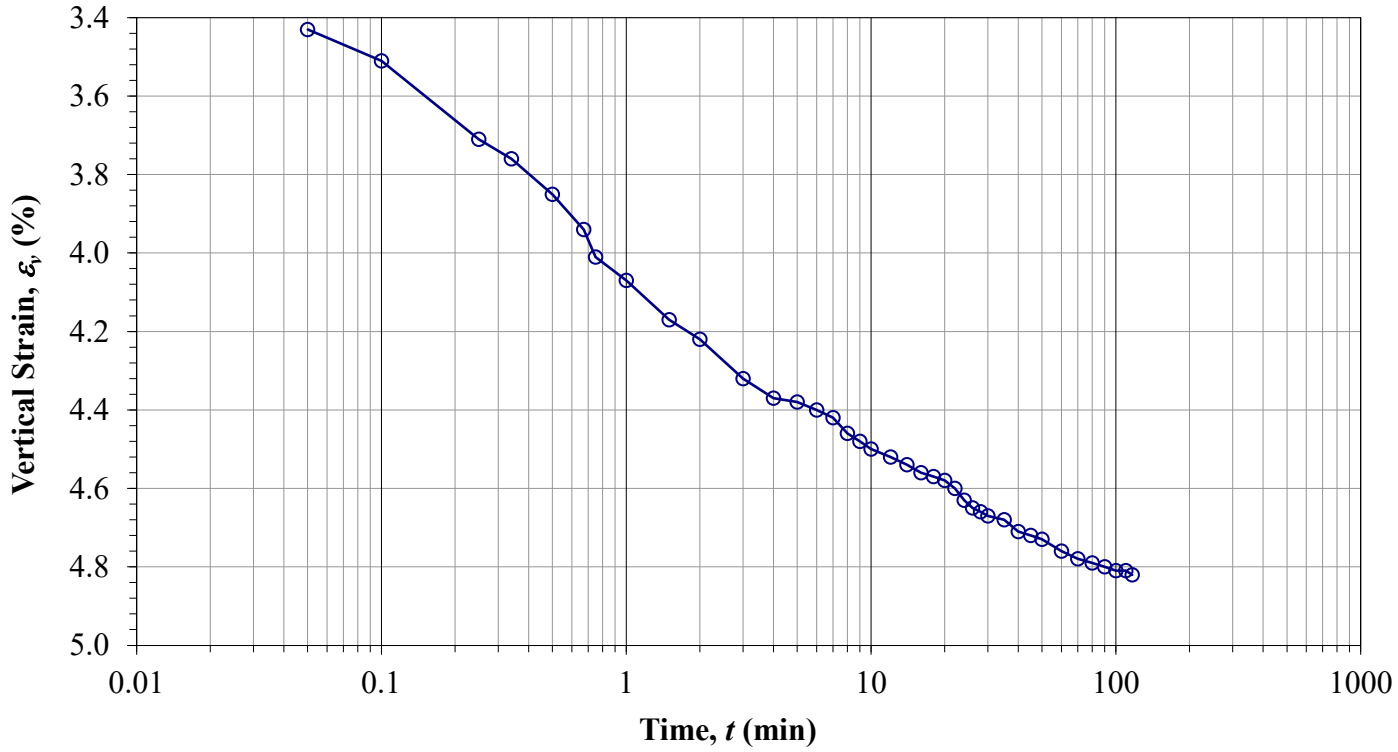
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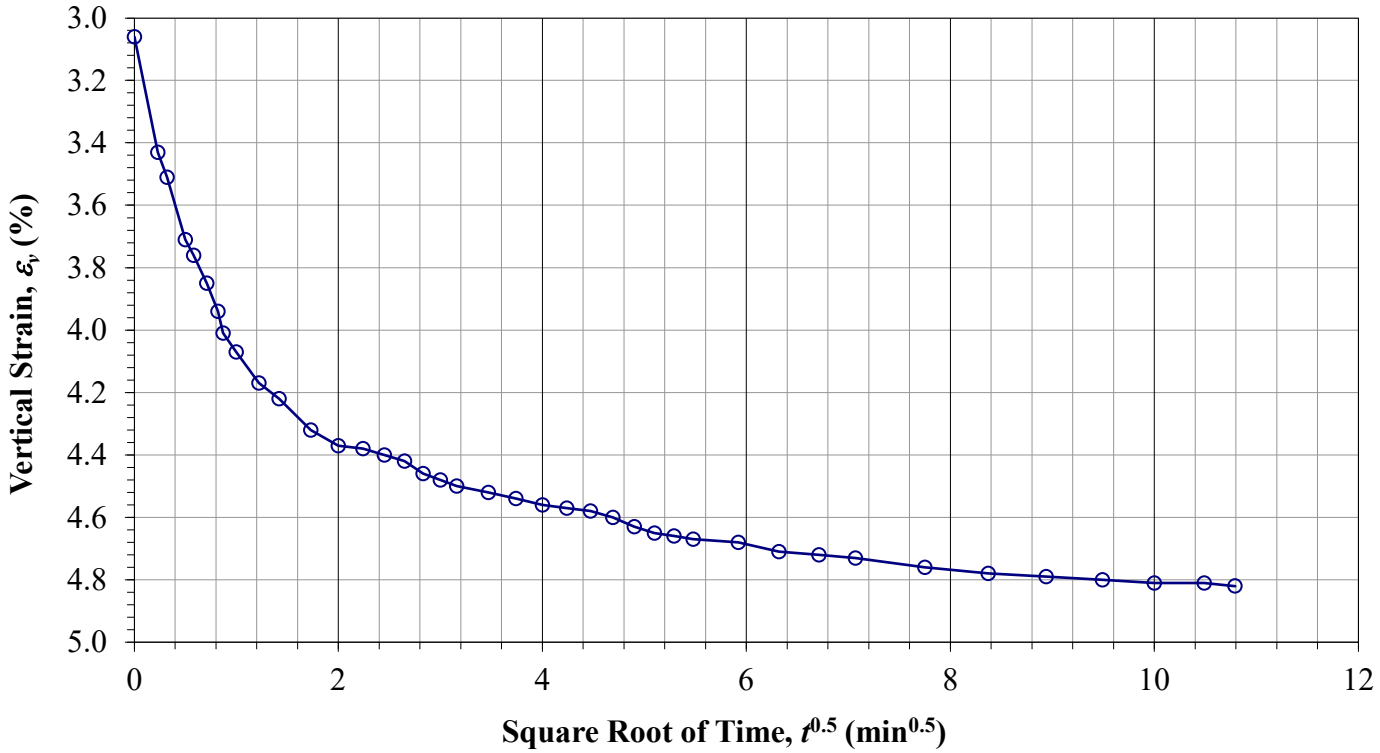
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 6 of 14
Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

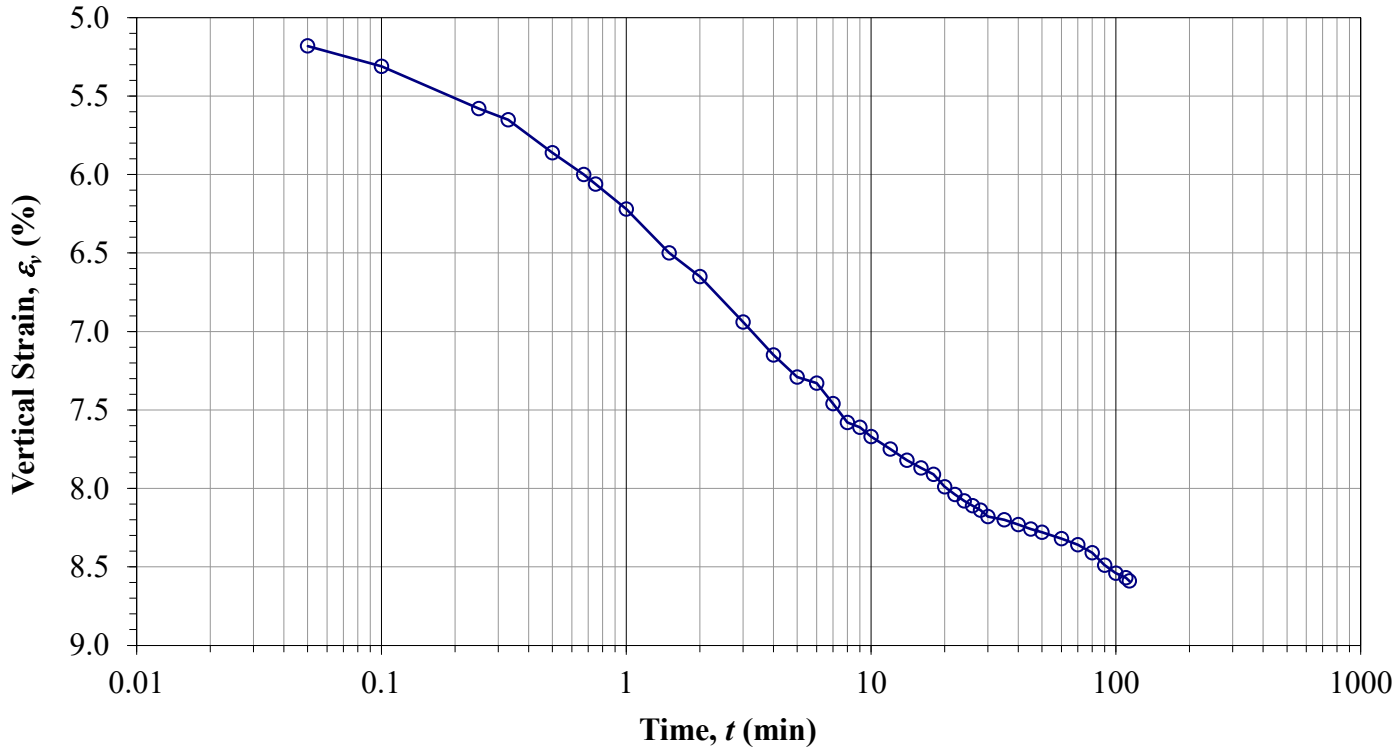
(ASTM D2435)

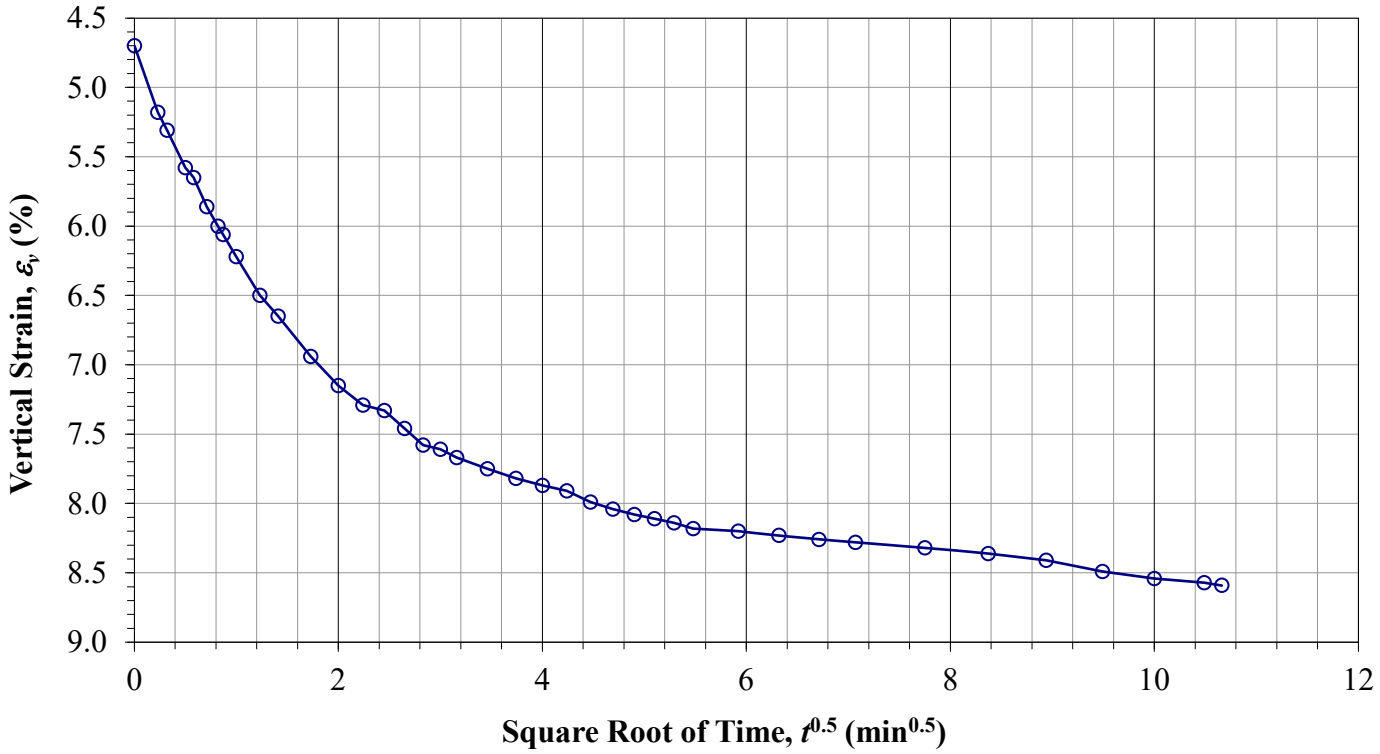
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 7 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

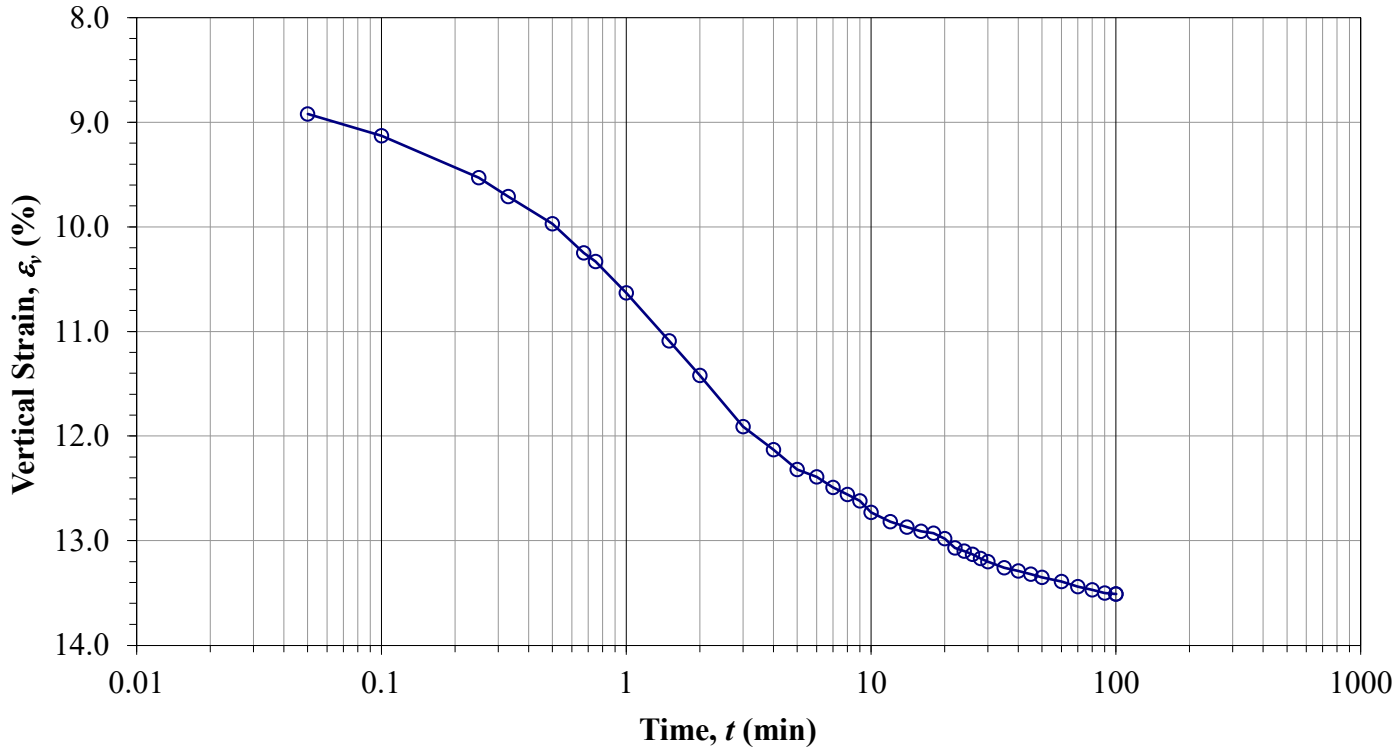
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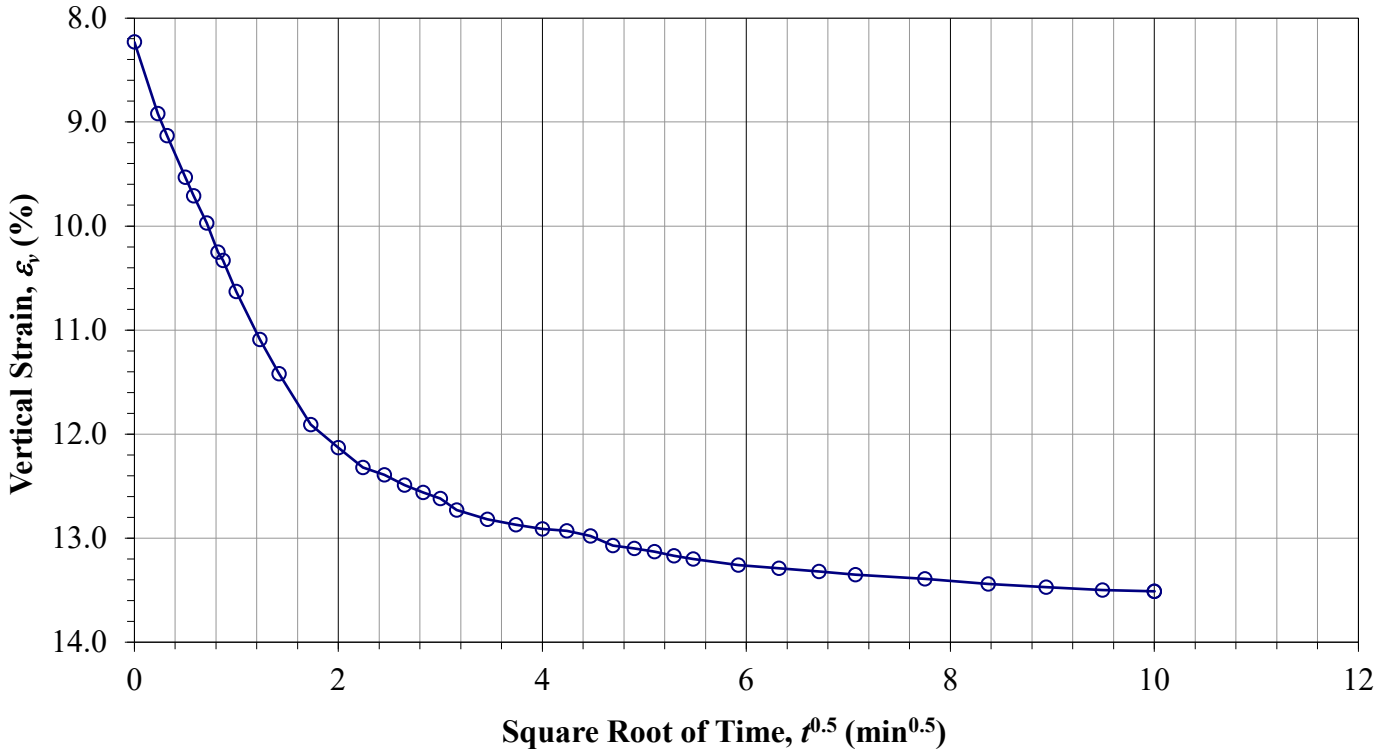
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 8 of 14
Stress: 12800 psf





One-Dimensional Consolidation Properties of Soils

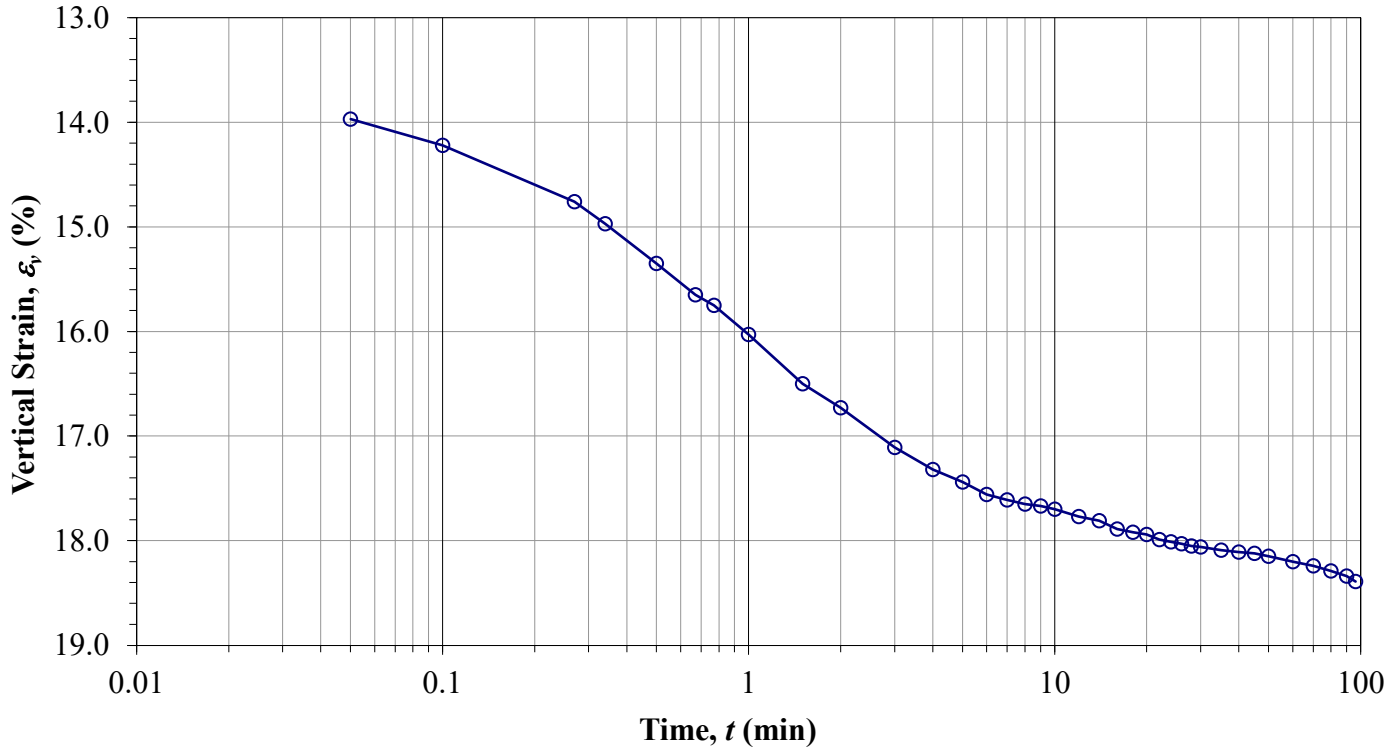
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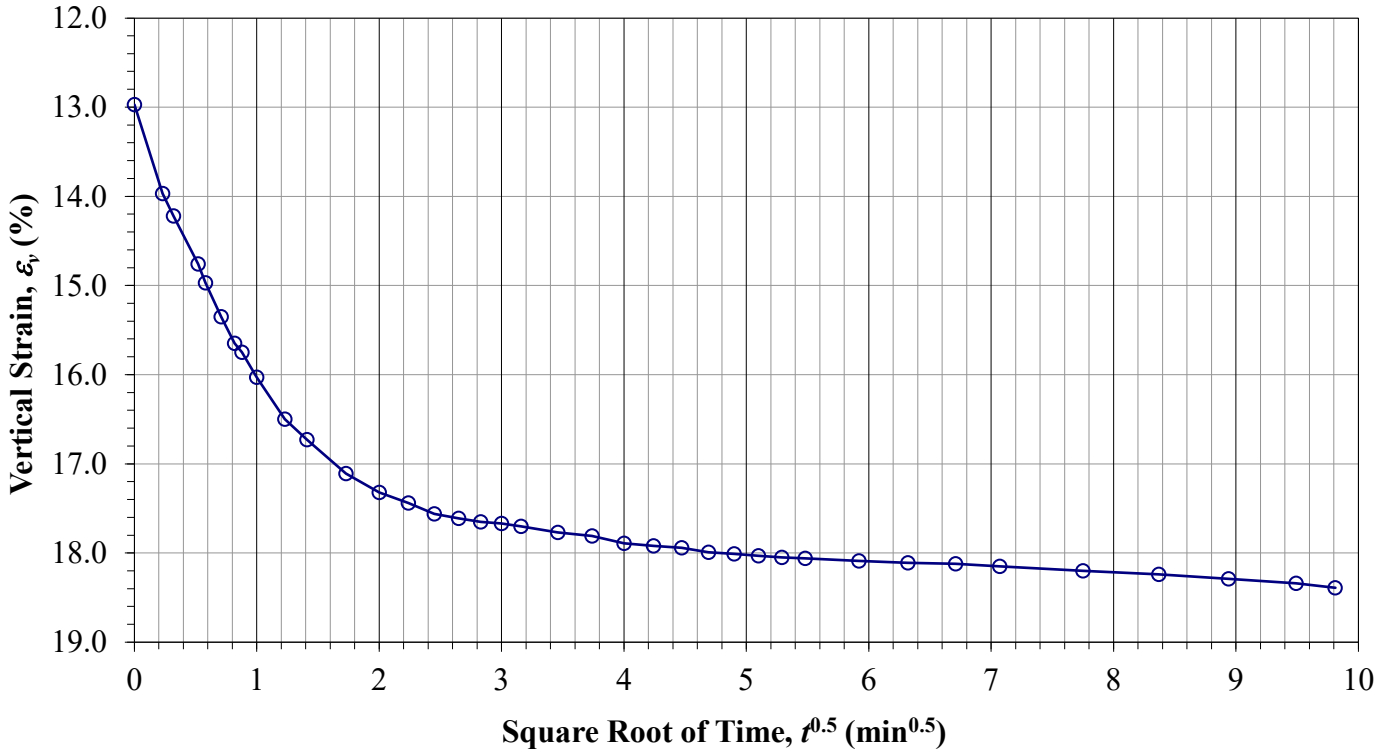
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 9 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

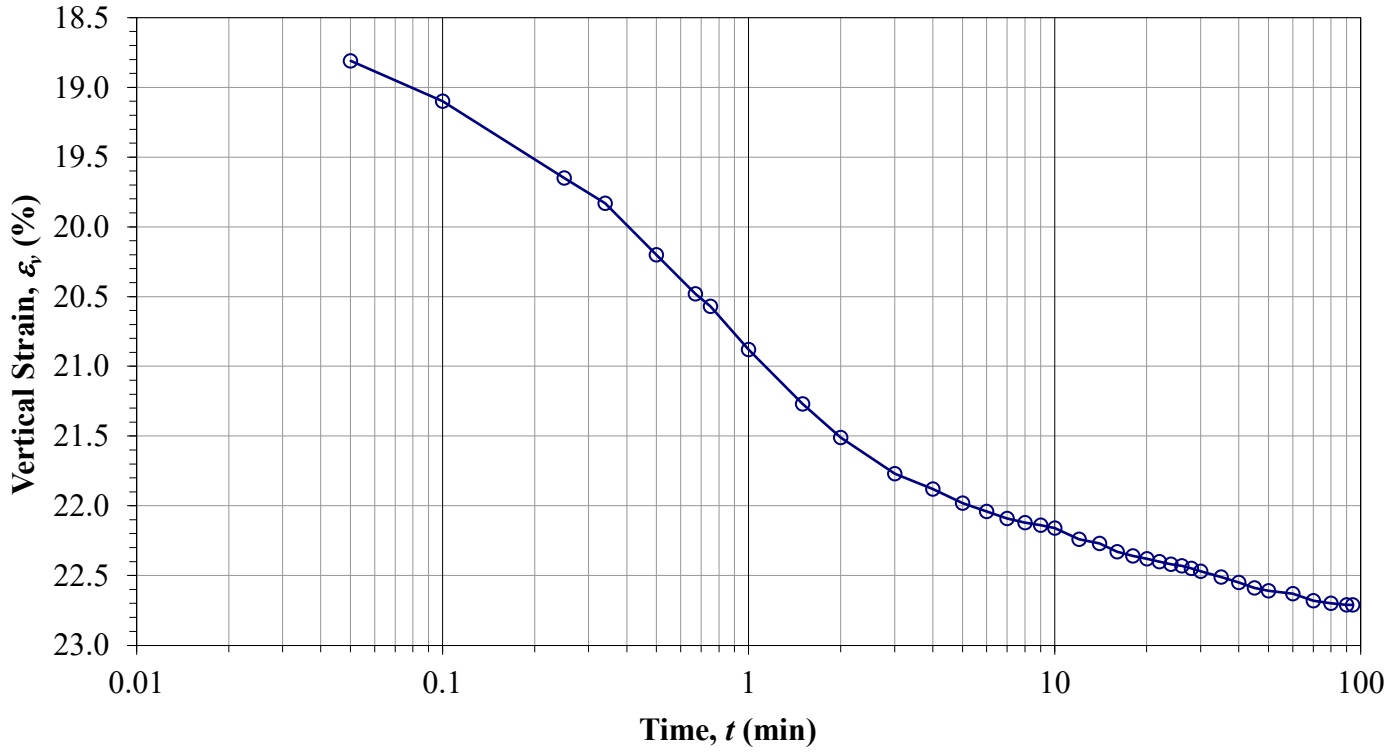
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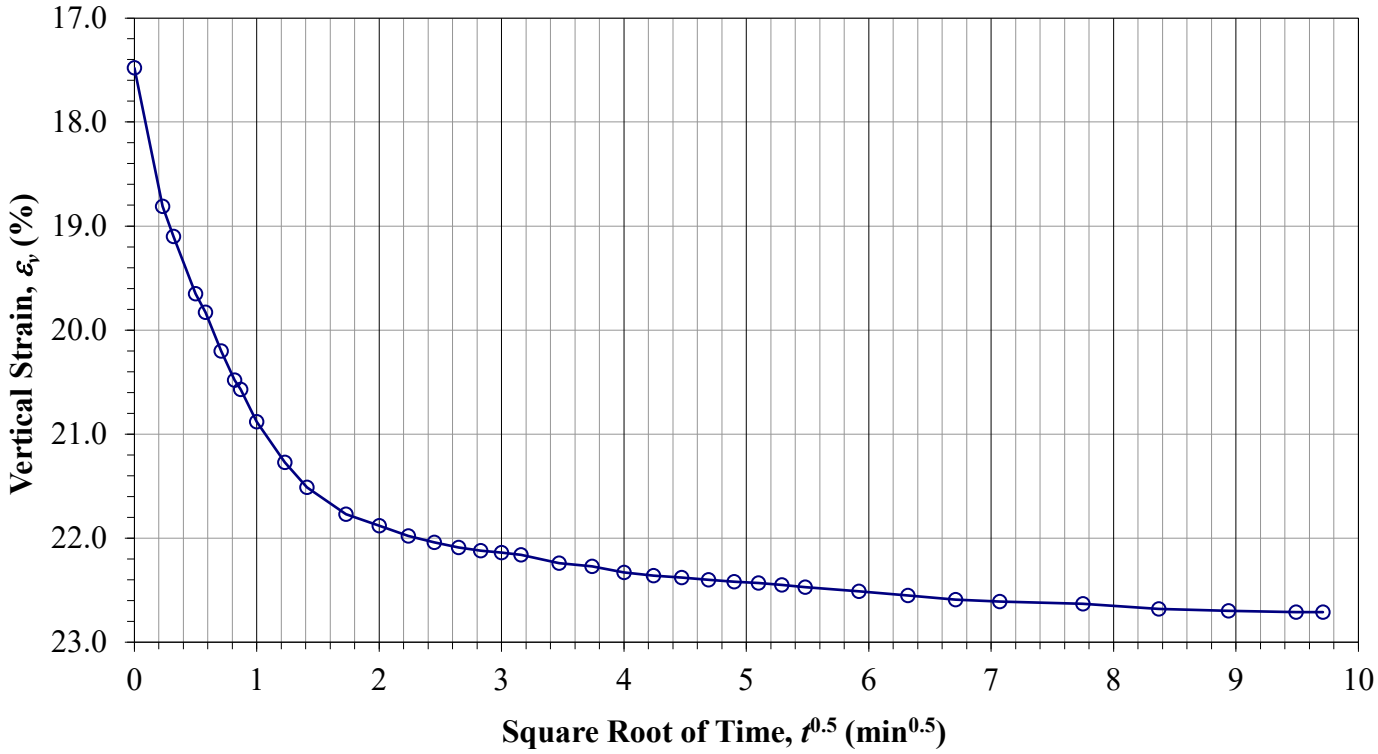
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 10 of 14
Stress: 51200 psf





One-Dimensional Consolidation Properties of Soils

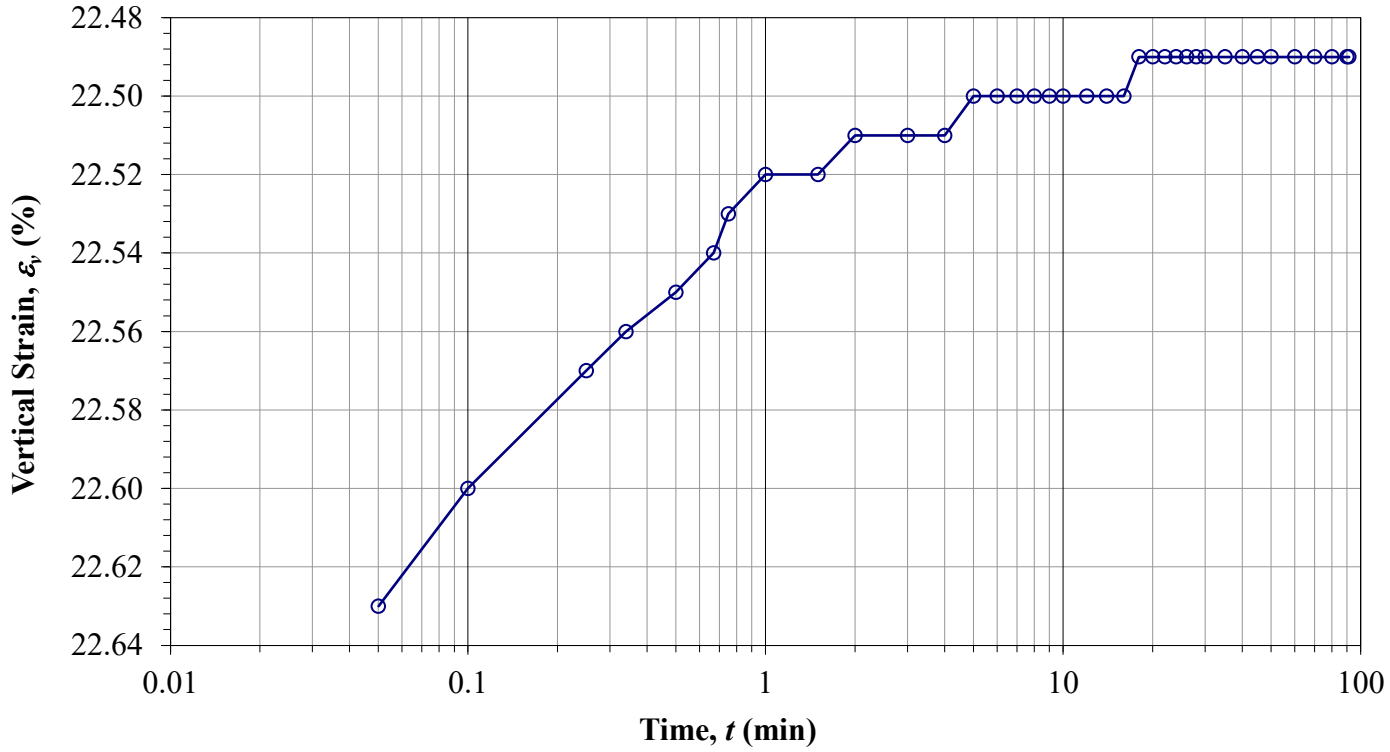
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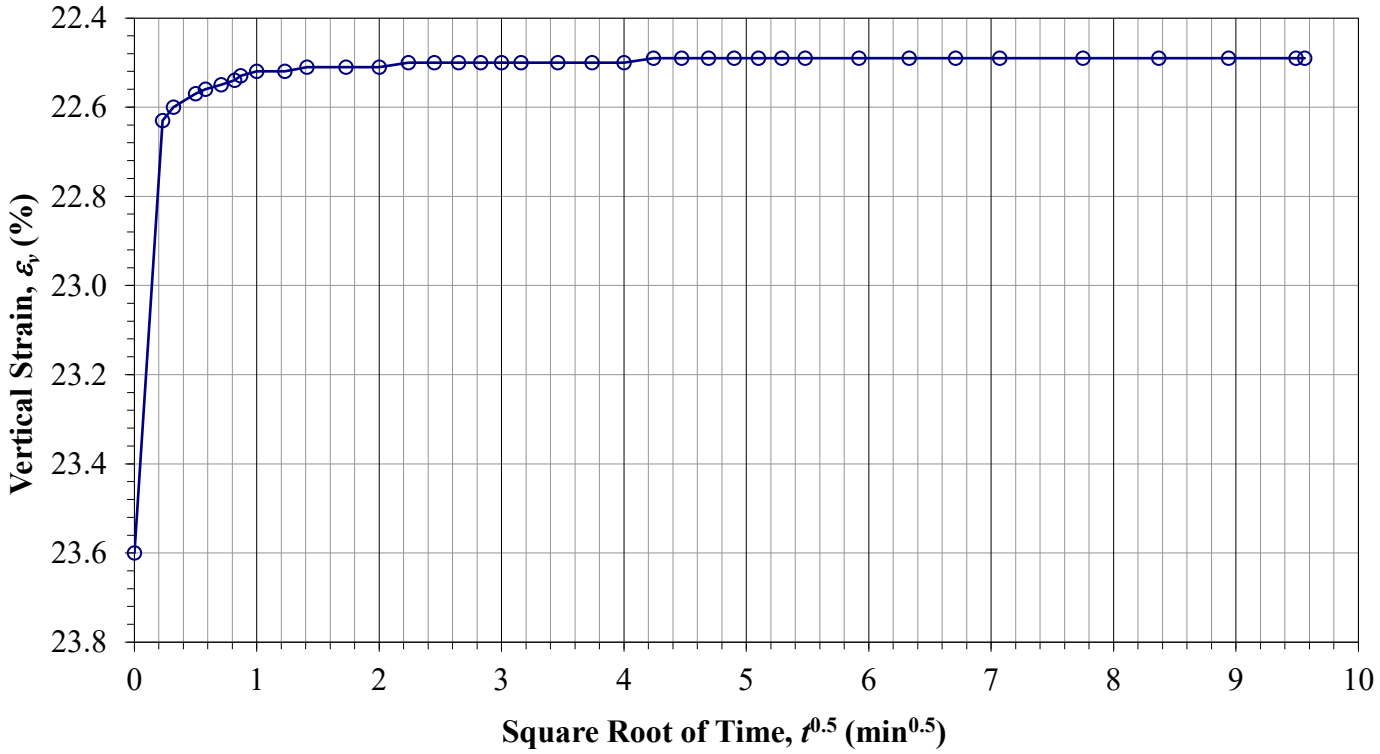
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 11 of 14
Stress: 25600 psf





Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[CONSOL_GC+TRv1_B21-OIPS-02_9_44ft.xlsm]11

One-Dimensional Consolidation Properties of Soils

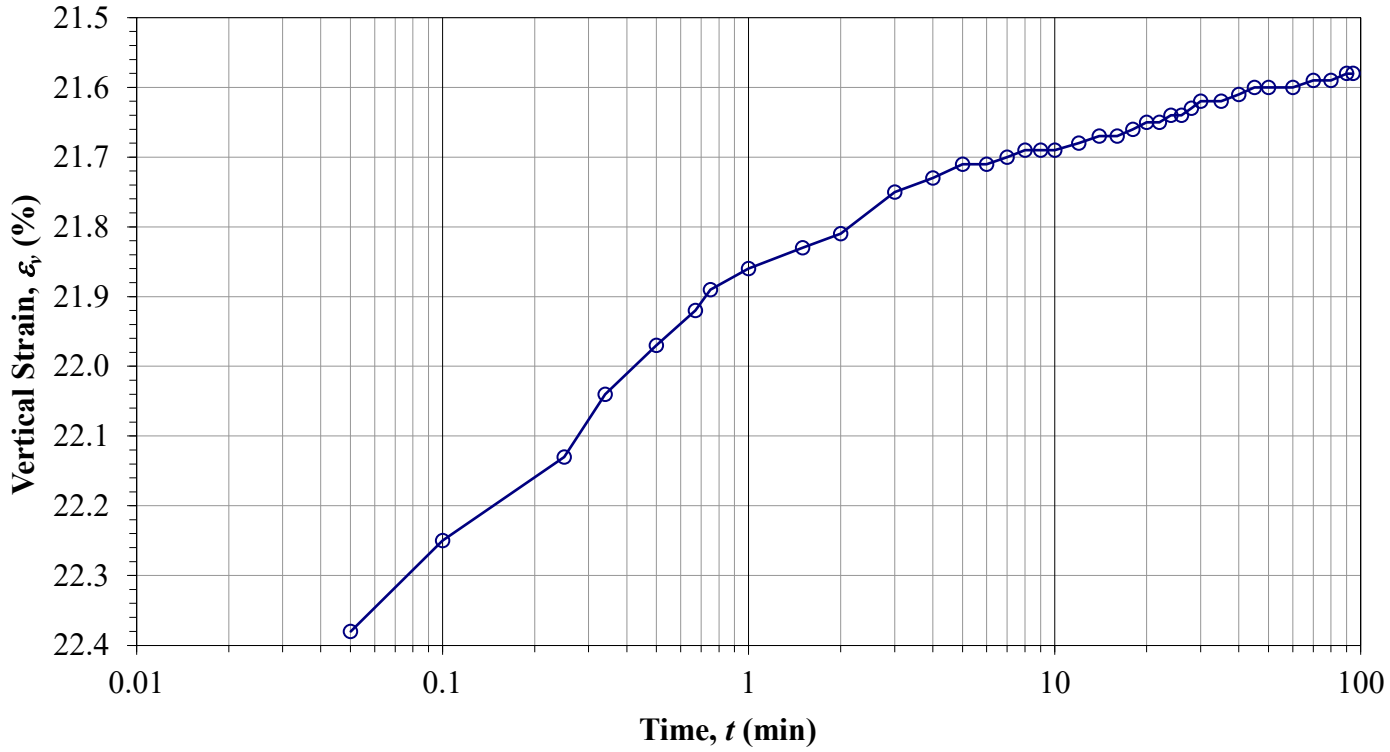
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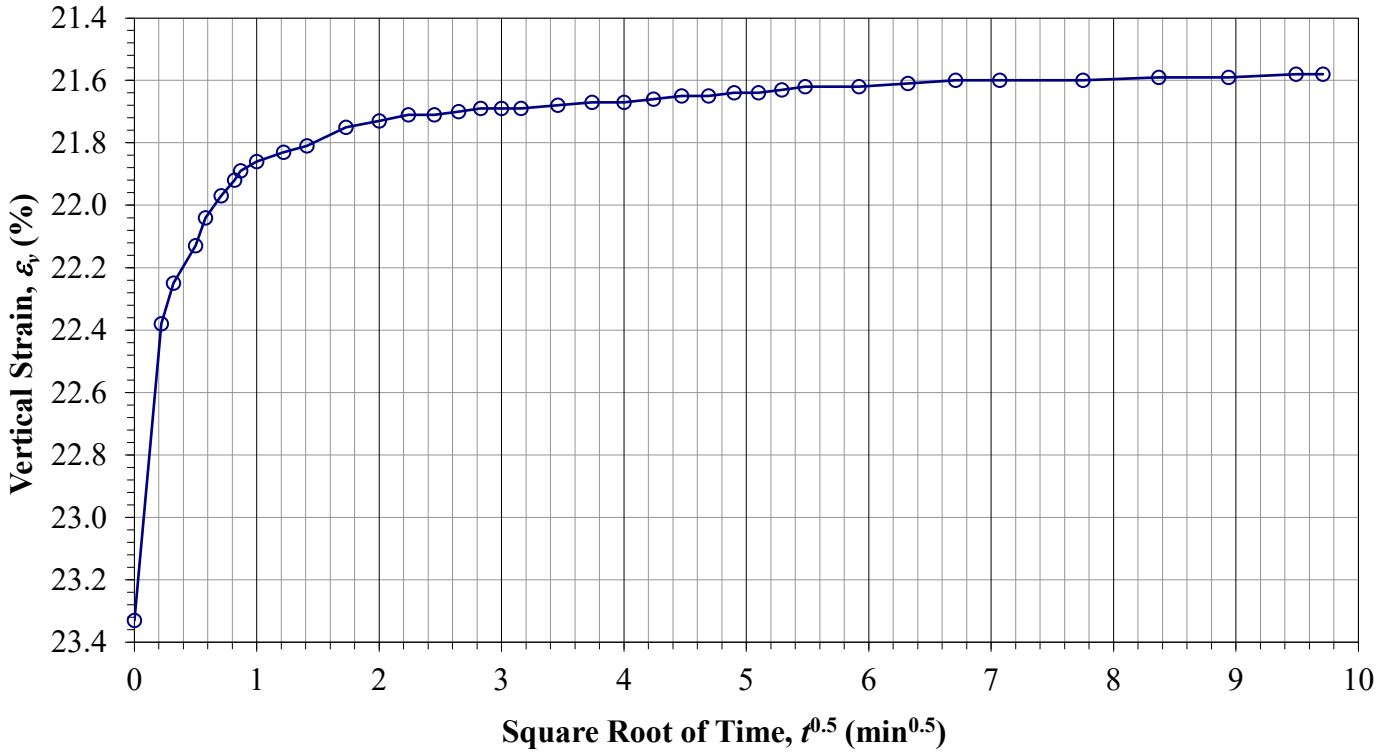
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 12 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

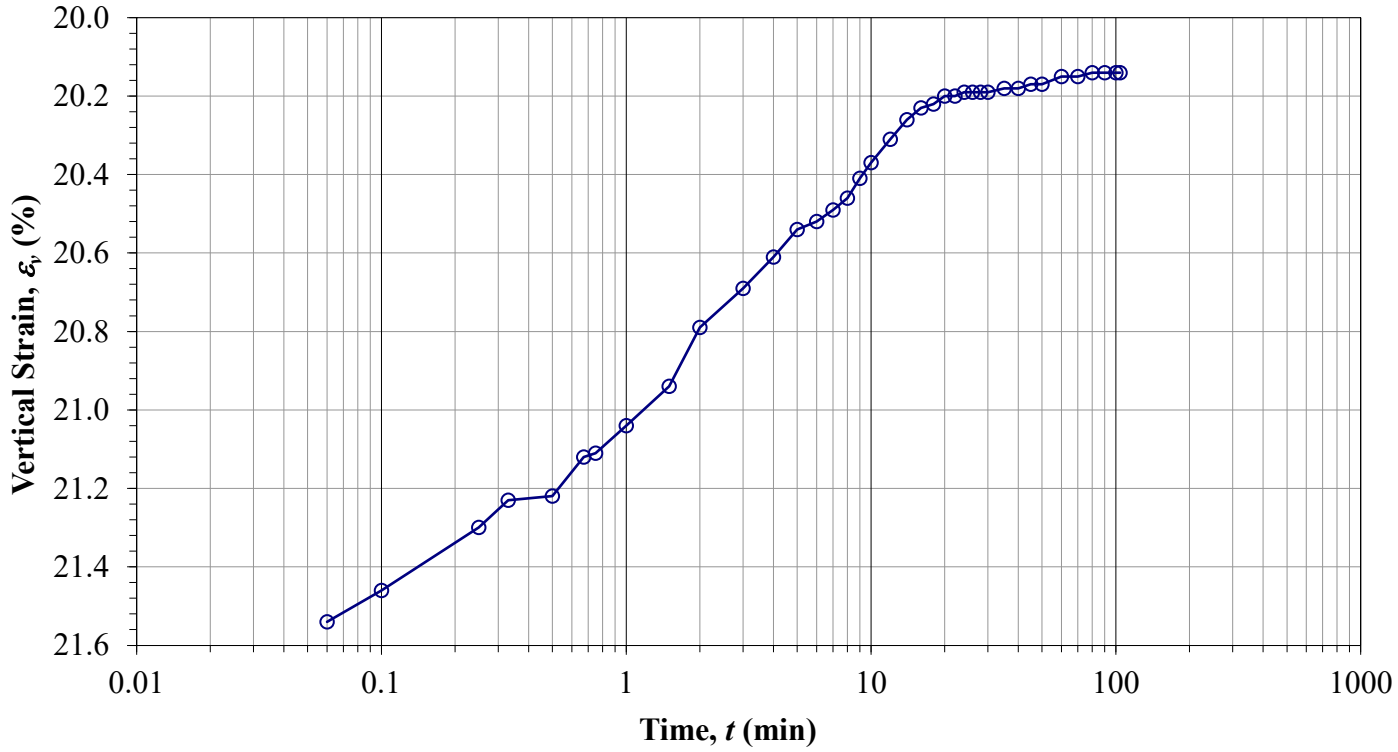
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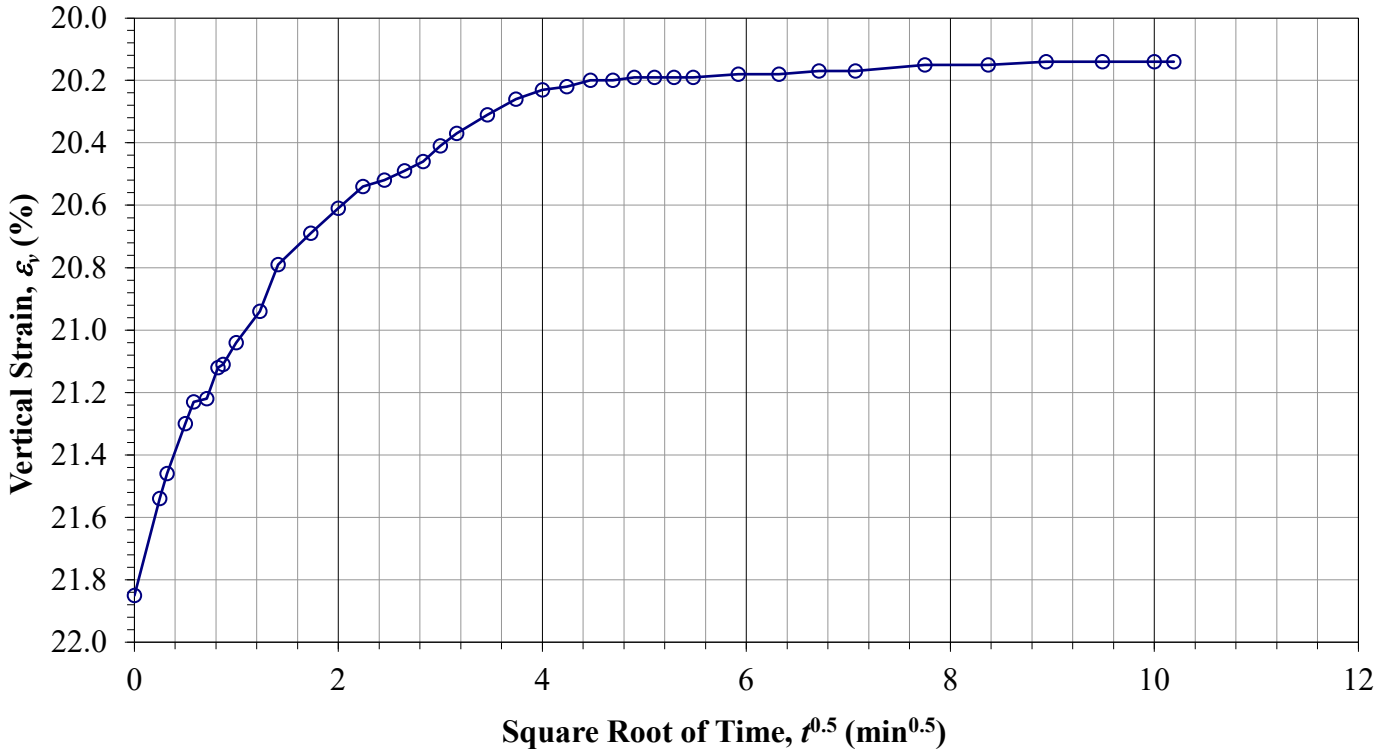
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 13 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

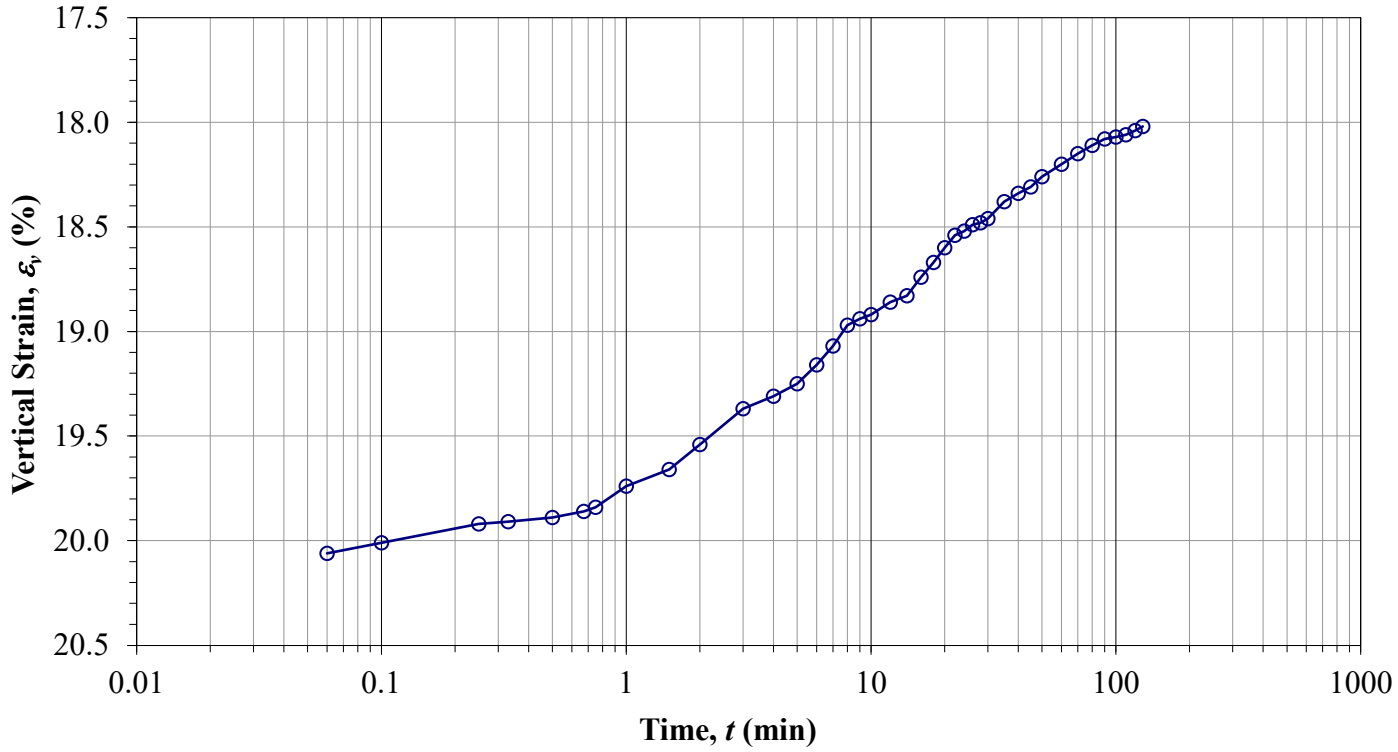
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-02
Sample: 9
Depth: 44'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/15/2021
By: EH

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

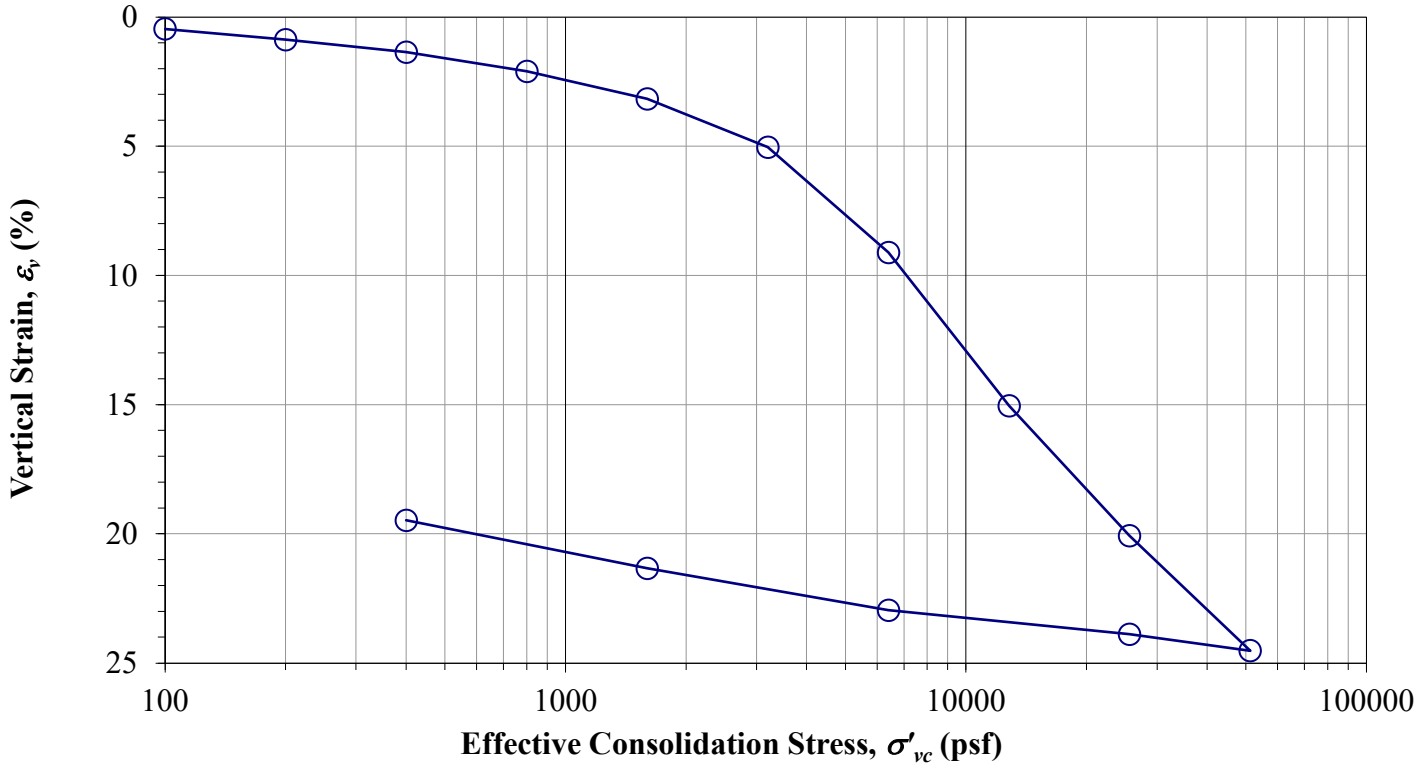
Test method:	B	
Inundation stress (psf), timing:	100	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.925	0.745
Sample diameter, D (in.)	2.418	2.418
Wt. rings + wet soil (g)	172.94	162.62
Wt. rings/tare (g)	45.44	45.44
Total unit wt., γ (pcf)	114.4	130.52
Wet soil + tare (g)	310.17	238.30
Dry soil + tare (g)	261.70	215.27
Tare (g)	128.49	124.41
Water content, ω (%)	36.4	25.3
Dry unit wt., γ_d (pcf)	83.8	104.1
Saturation, S	0.97	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9250	1.0103
100	0.0042	0.46	0.9208	1.0012
200	0.0081	0.87	0.9169	0.9928
400	0.0126	1.36	0.9124	0.9830
800	0.0194	2.10	0.9056	0.9681
1600	0.0293	3.17	0.8957	0.9467
3200	0.0466	5.04	0.8784	0.9090
6400	0.0843	9.11	0.8407	0.8271
12800	0.1392	15.05	0.7858	0.7078
25600	0.1856	20.06	0.7394	0.6070
51200	0.2268	24.52	0.6982	0.5174
25600	0.2209	23.88	0.7041	0.5302
6400	0.2123	22.95	0.7127	0.5489
1600	0.1973	21.33	0.7277	0.5815
400	0.1802	19.48	0.7448	0.6187



Entered: _____
Reviewed: _____

One-Dimensional Consolidation Properties of Soils

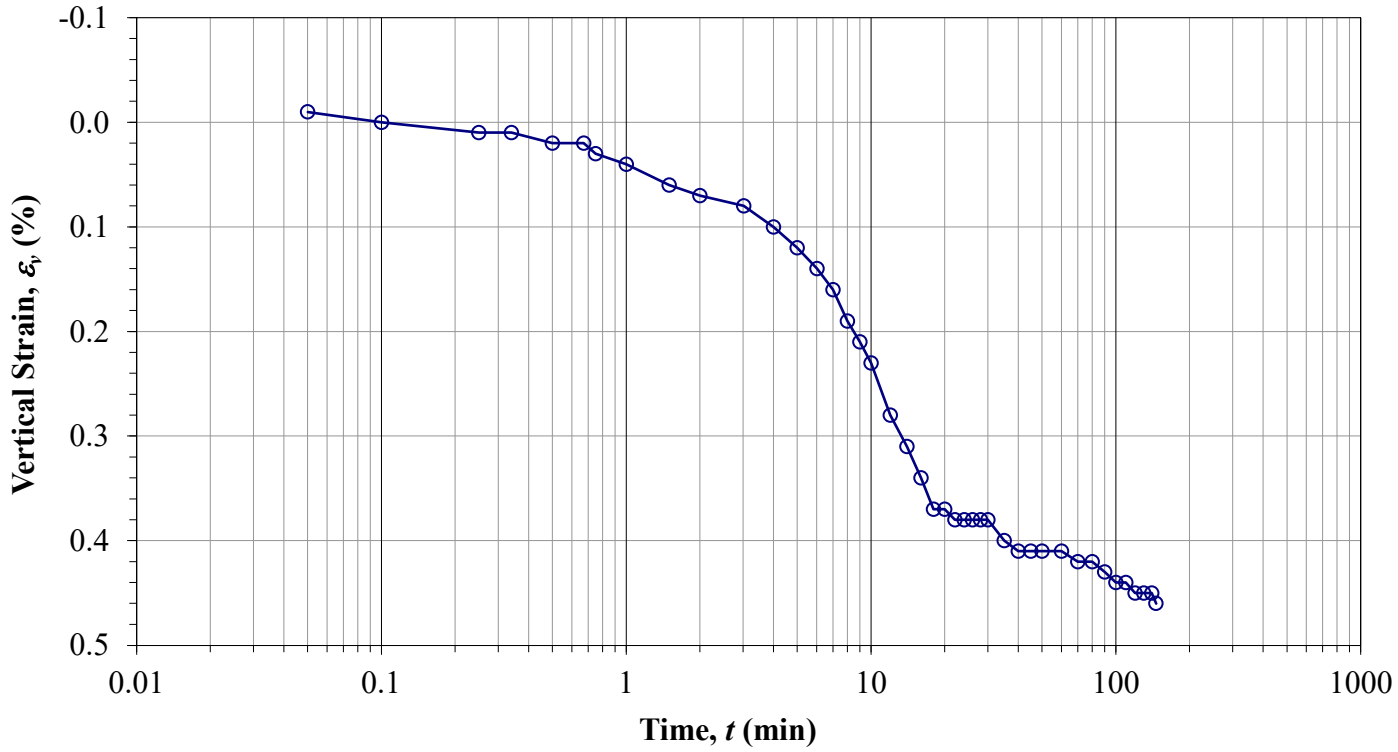
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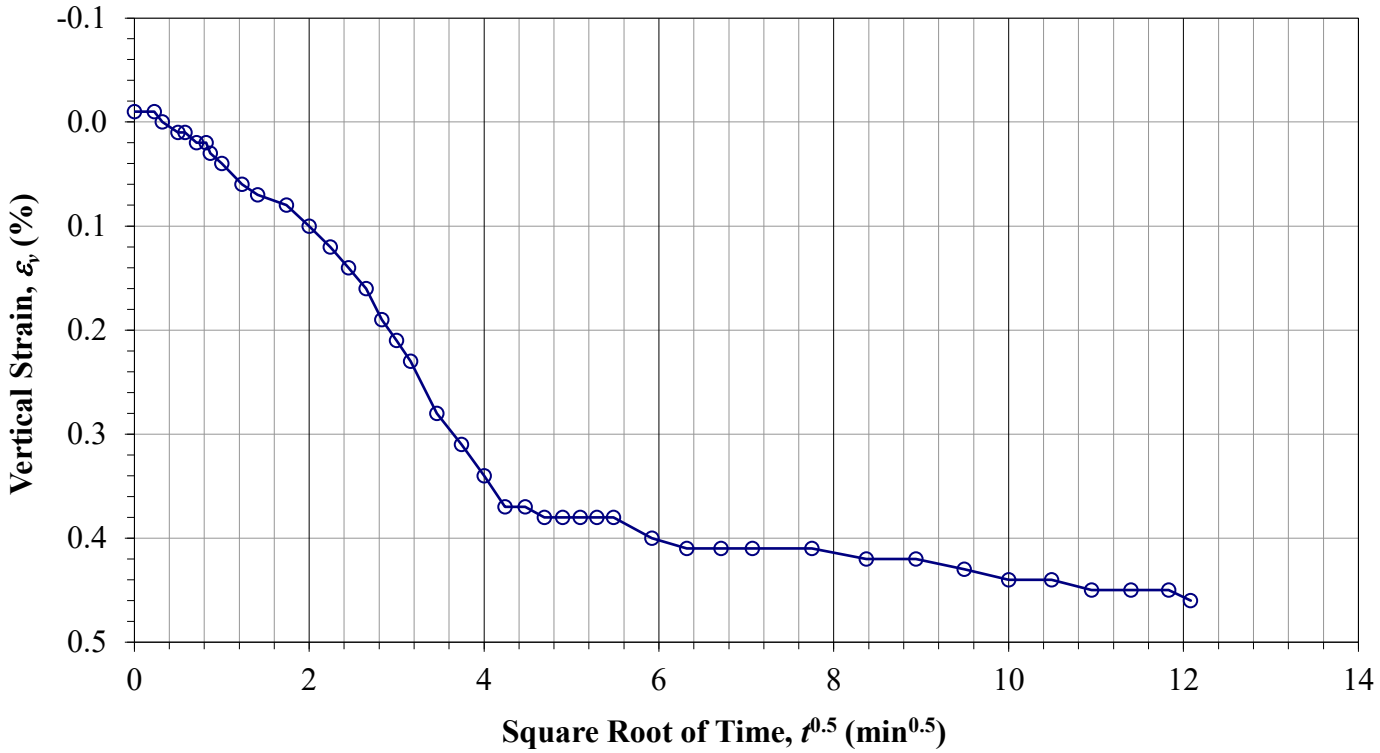
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 1 of 14
Stress: 100 psf





One-Dimensional Consolidation Properties of Soils

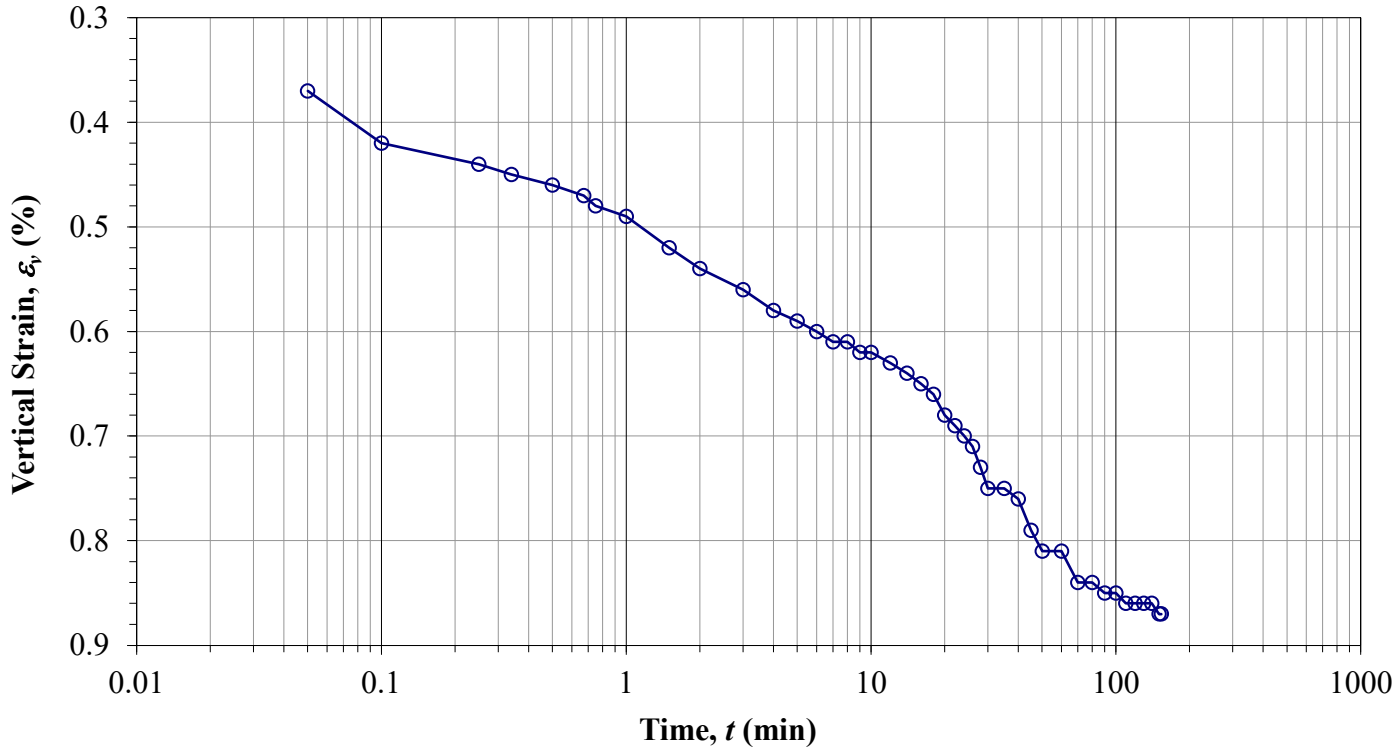
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

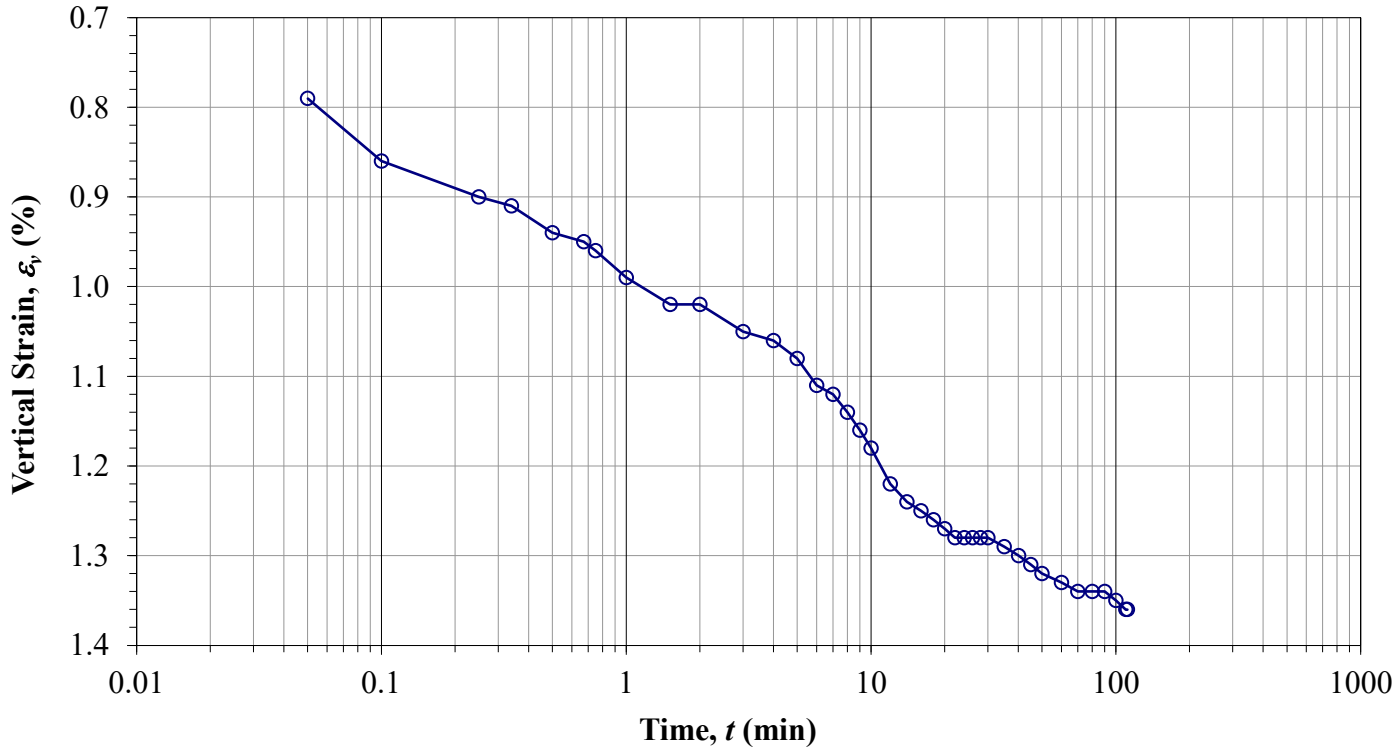
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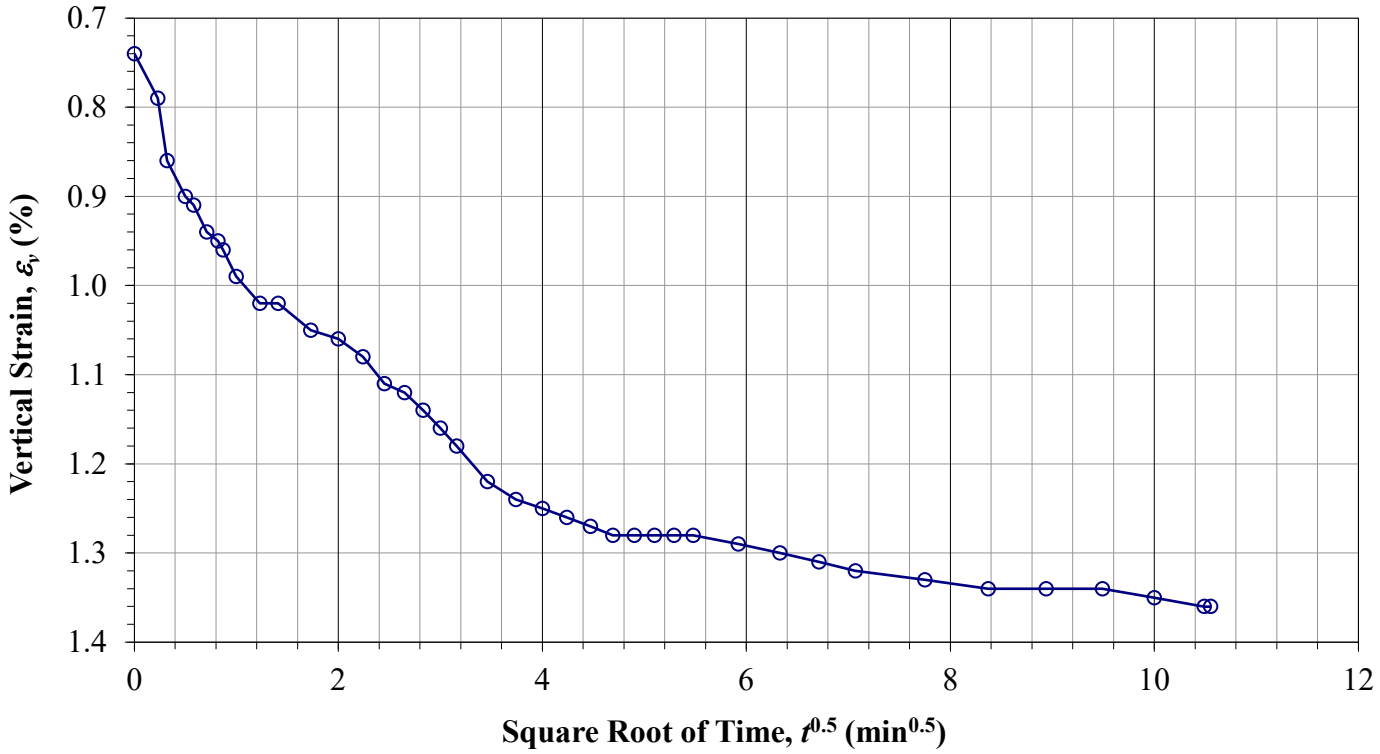
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 3 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

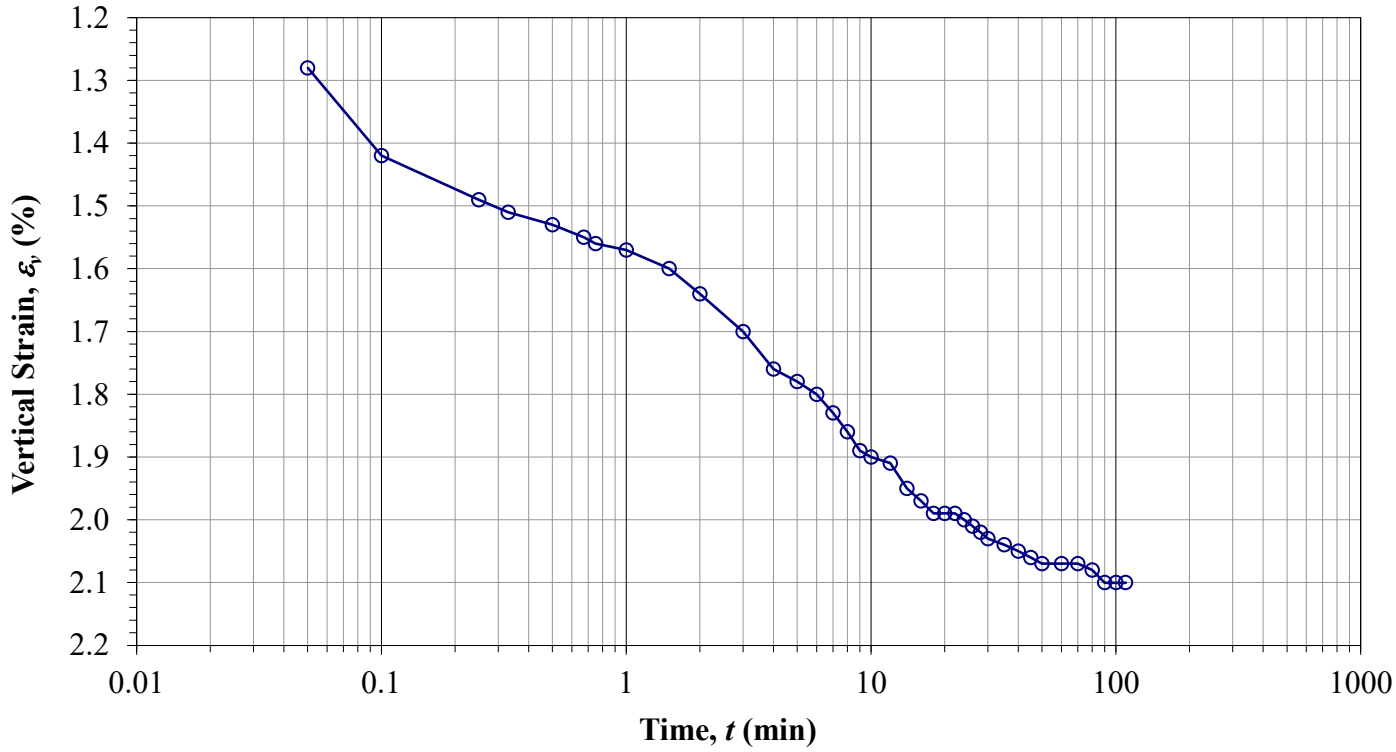
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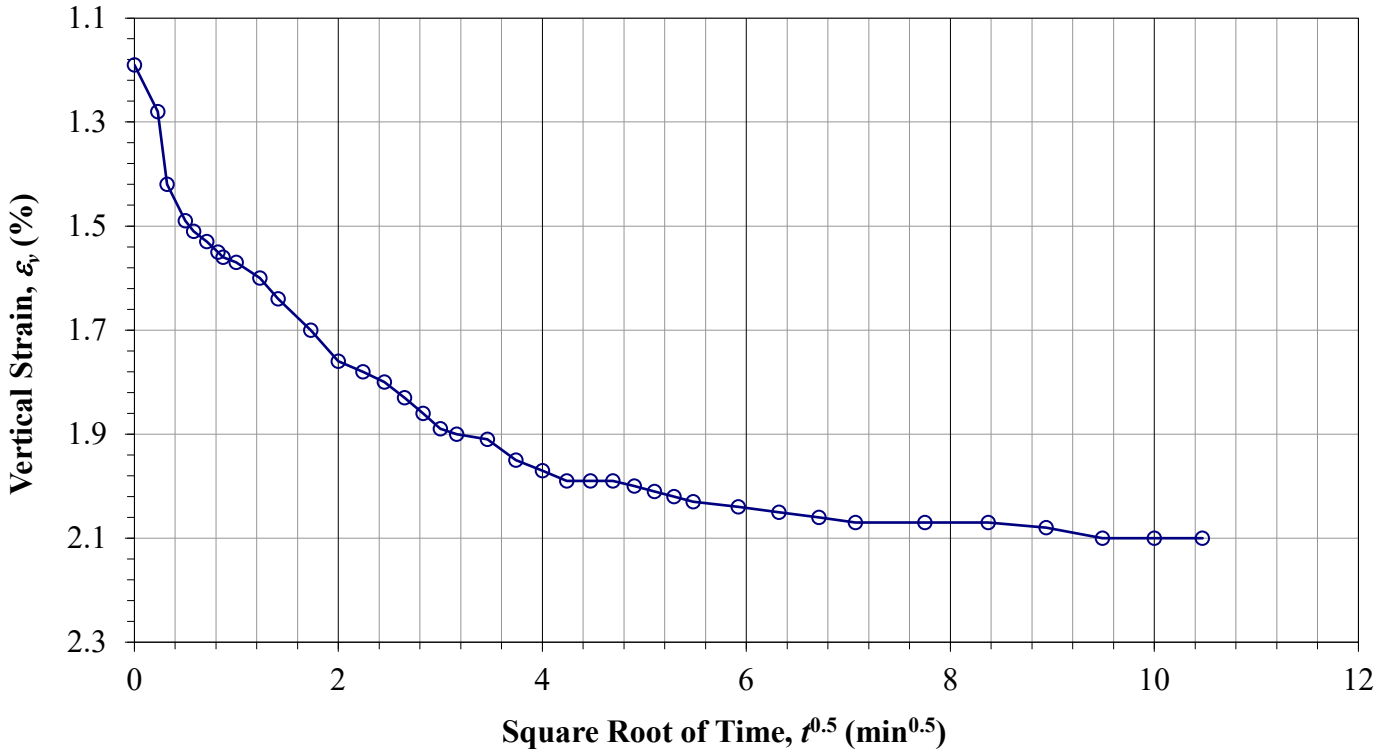
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

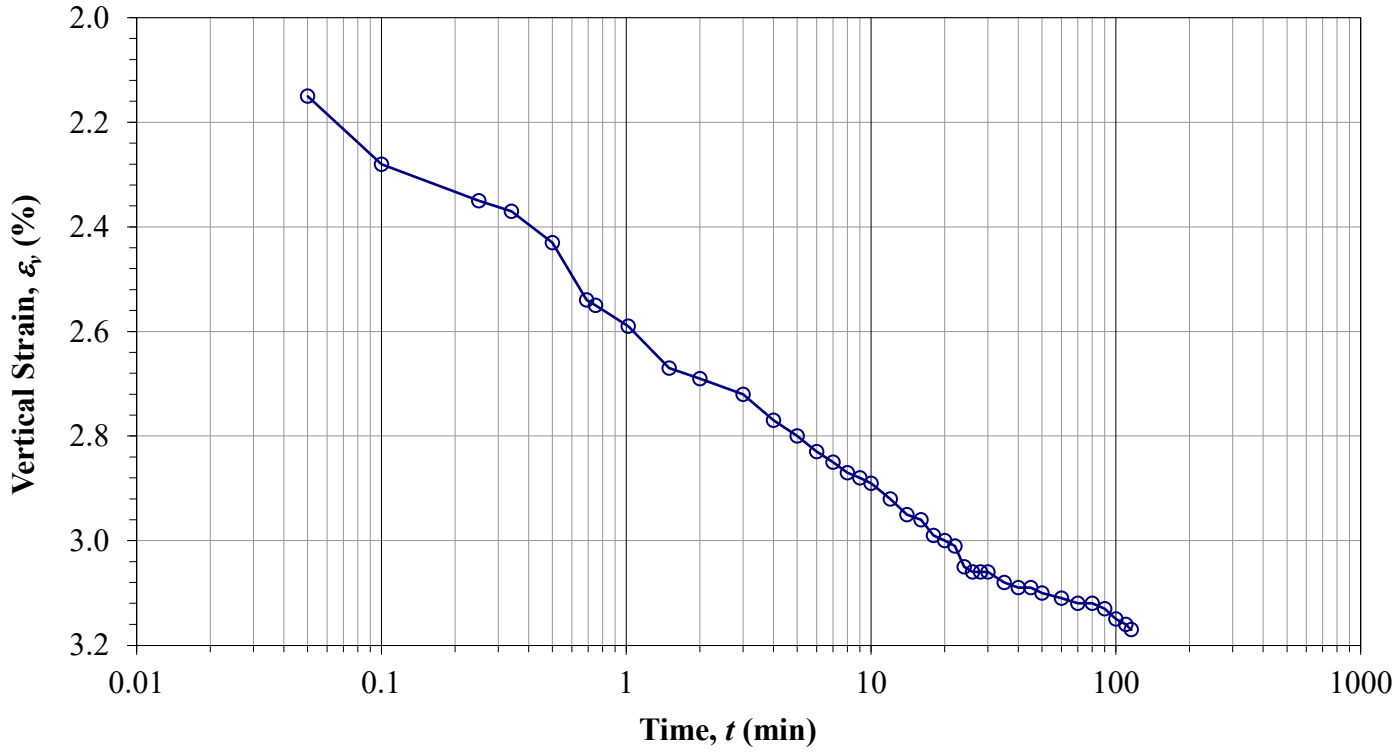
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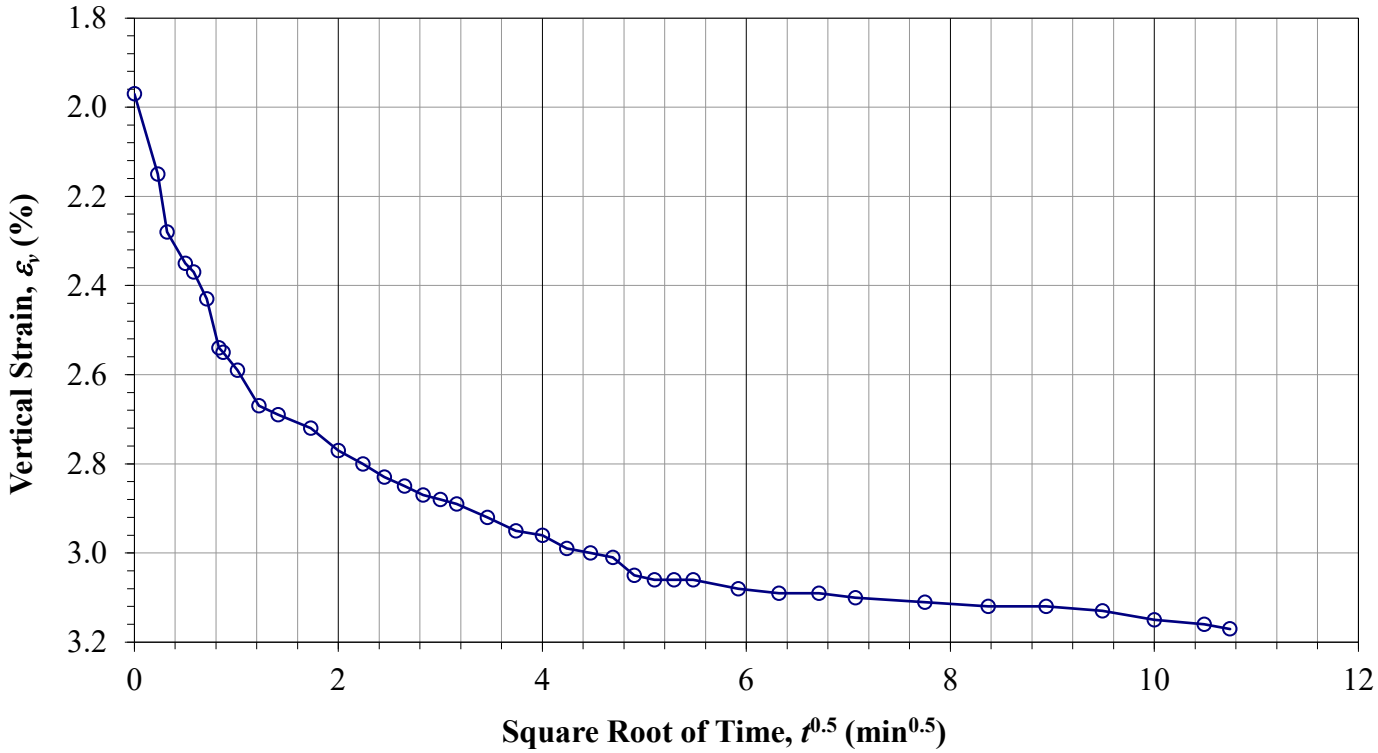
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 5 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

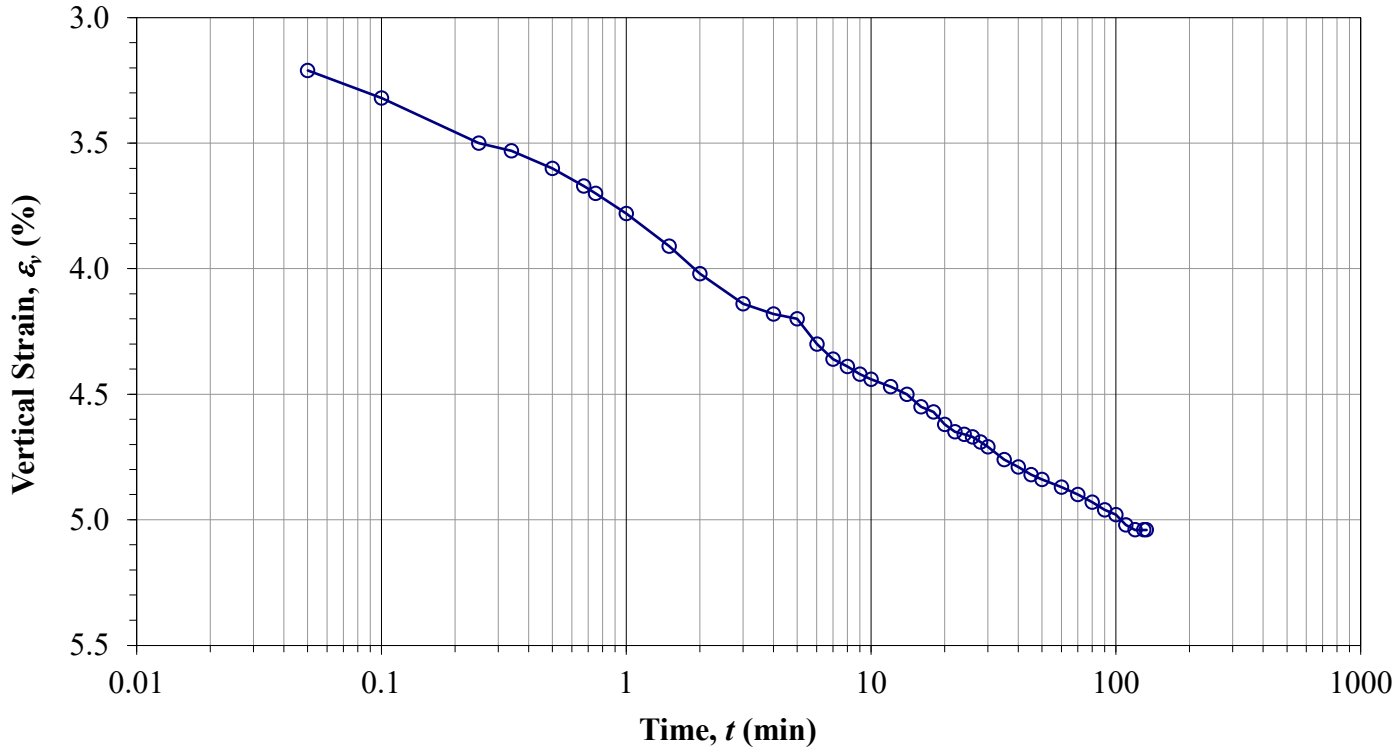
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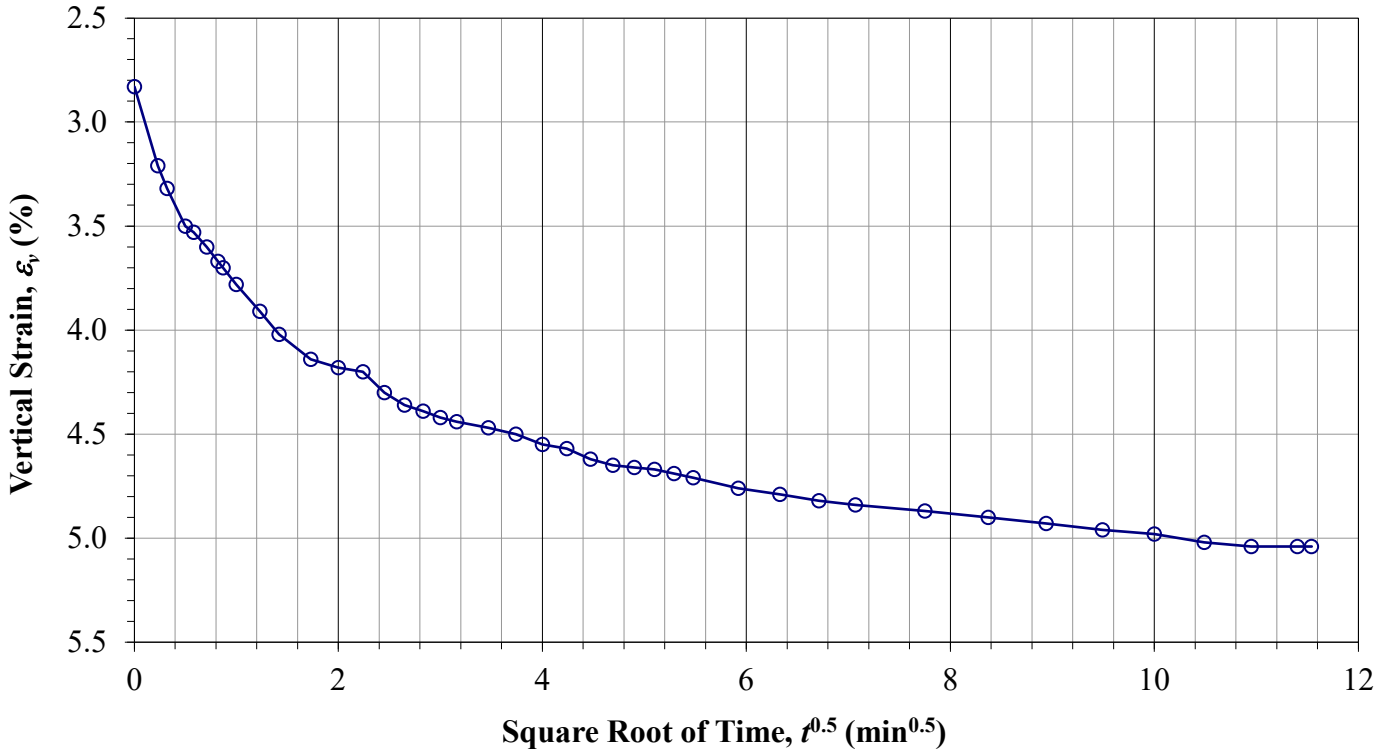
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 6 of 14
Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

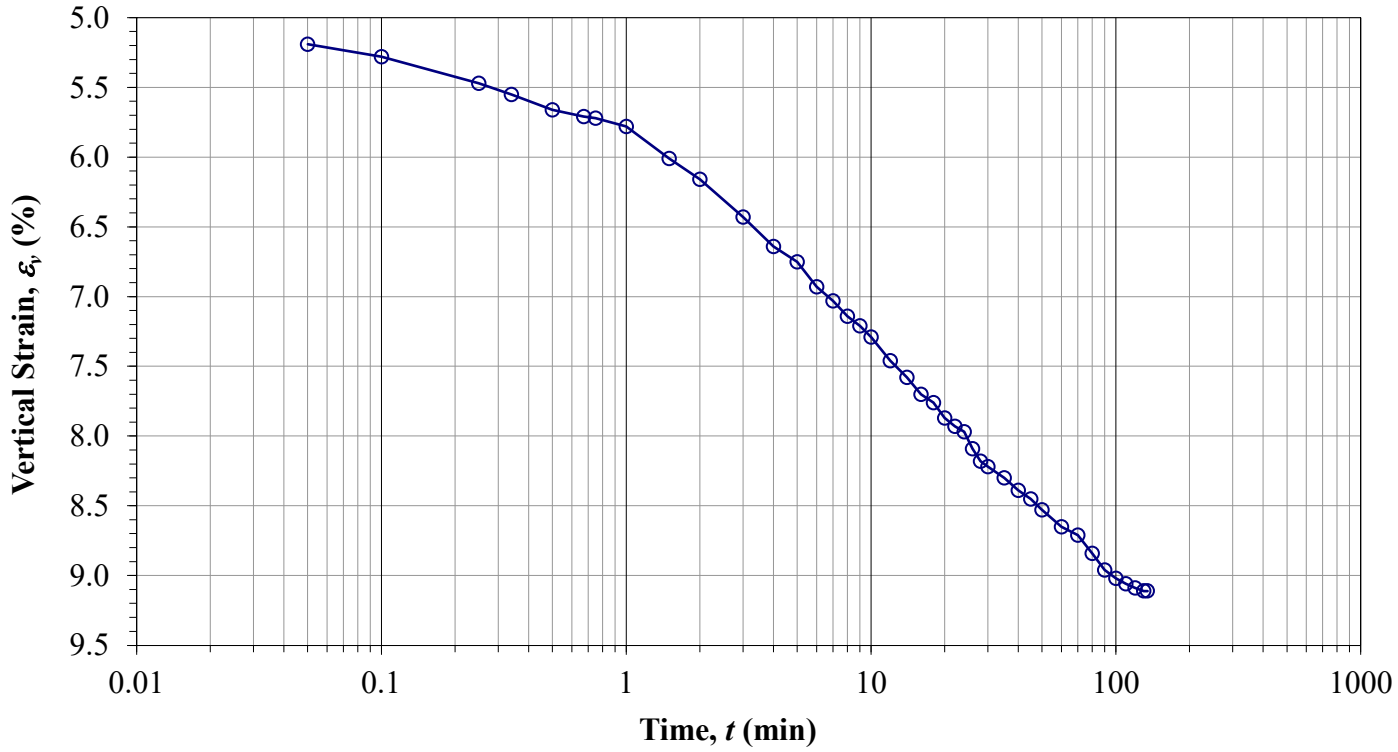
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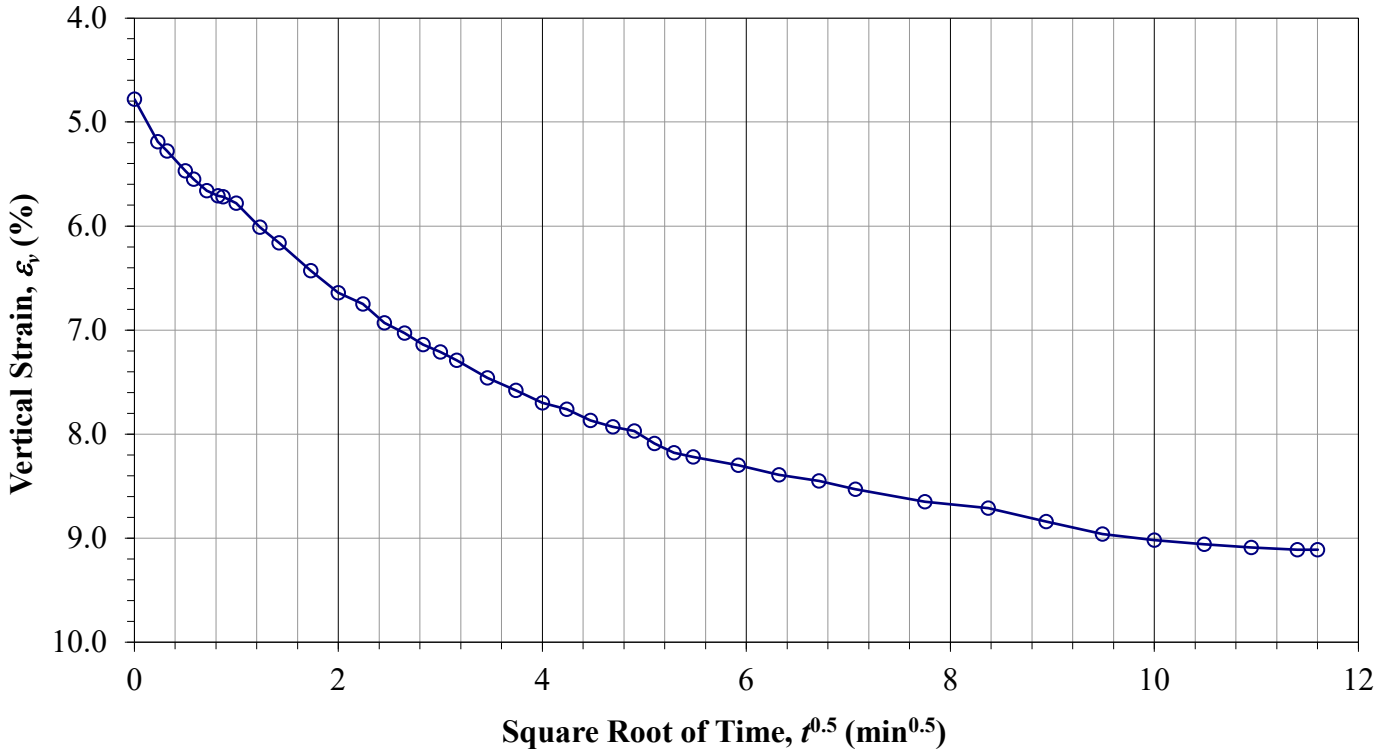
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 7 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

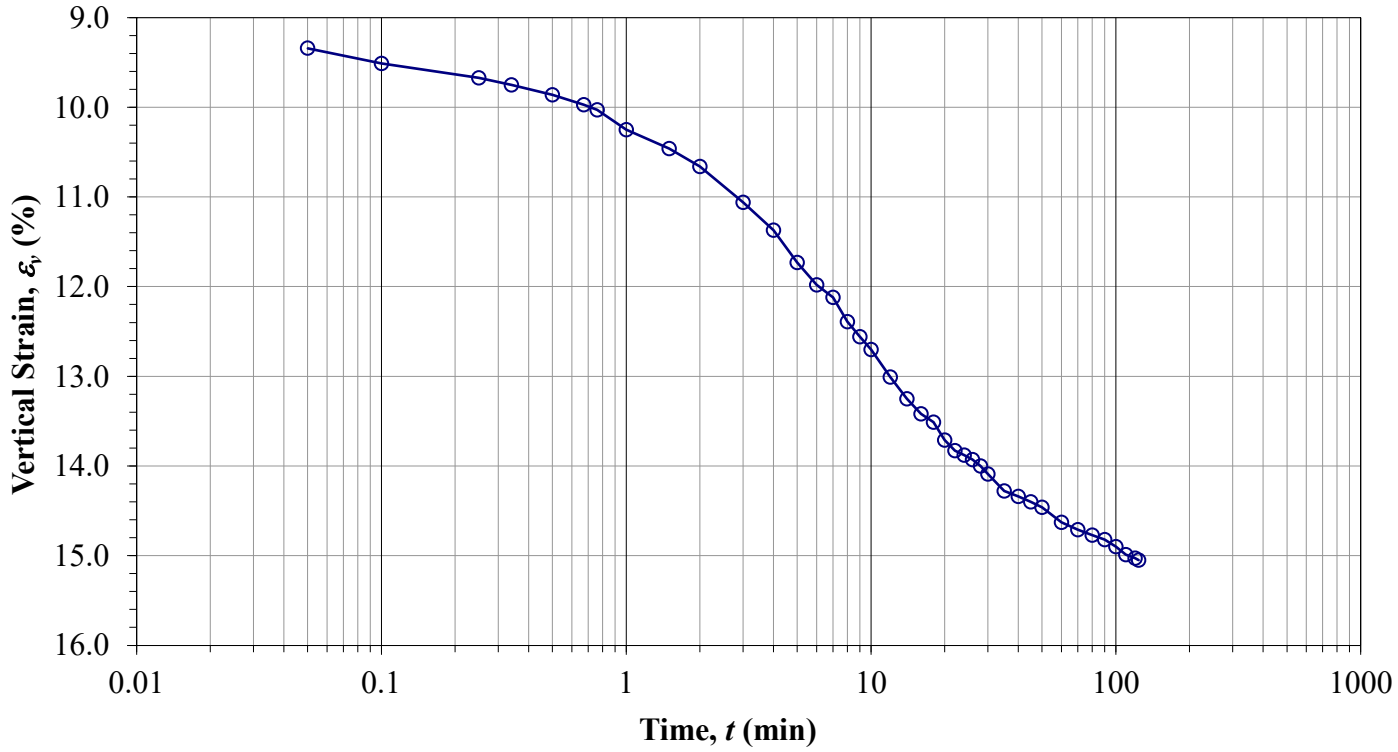
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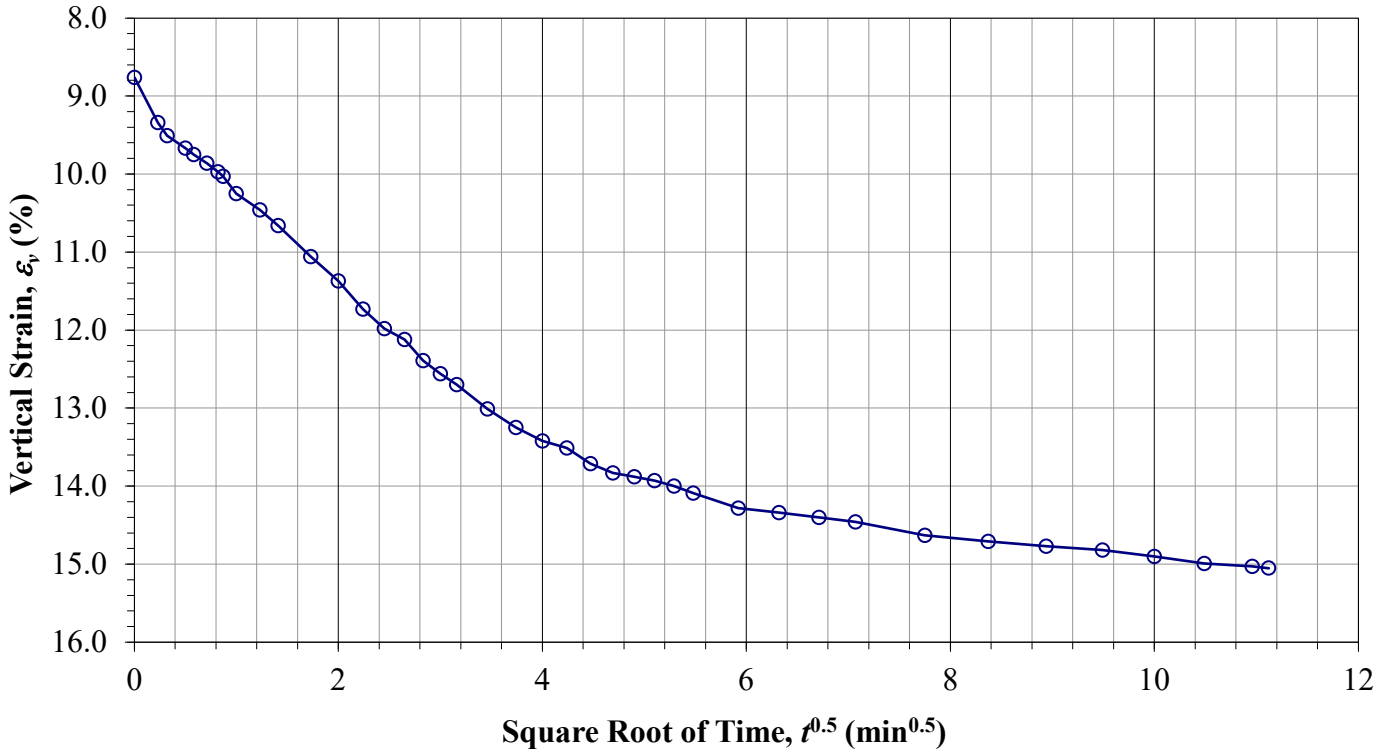
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 8 of 14
Stress: 12800 psf





One-Dimensional Consolidation Properties of Soils

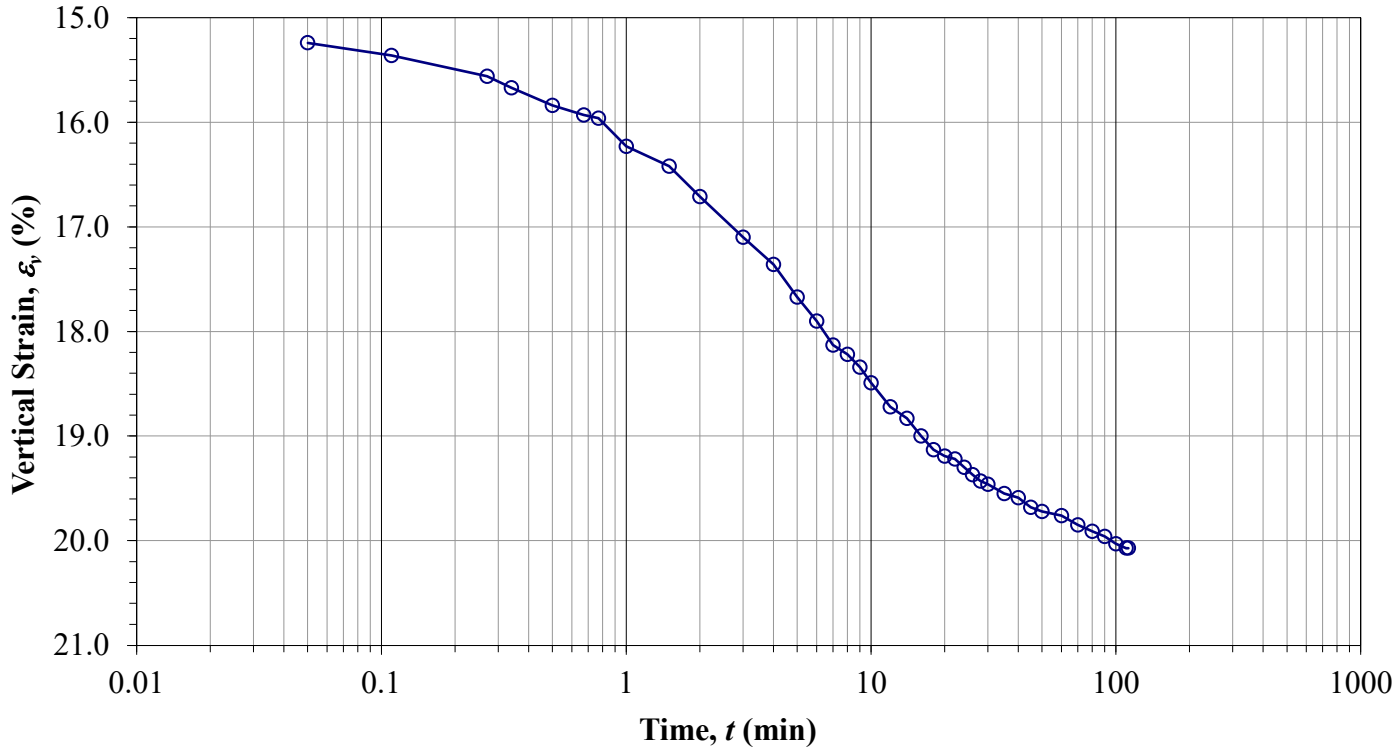
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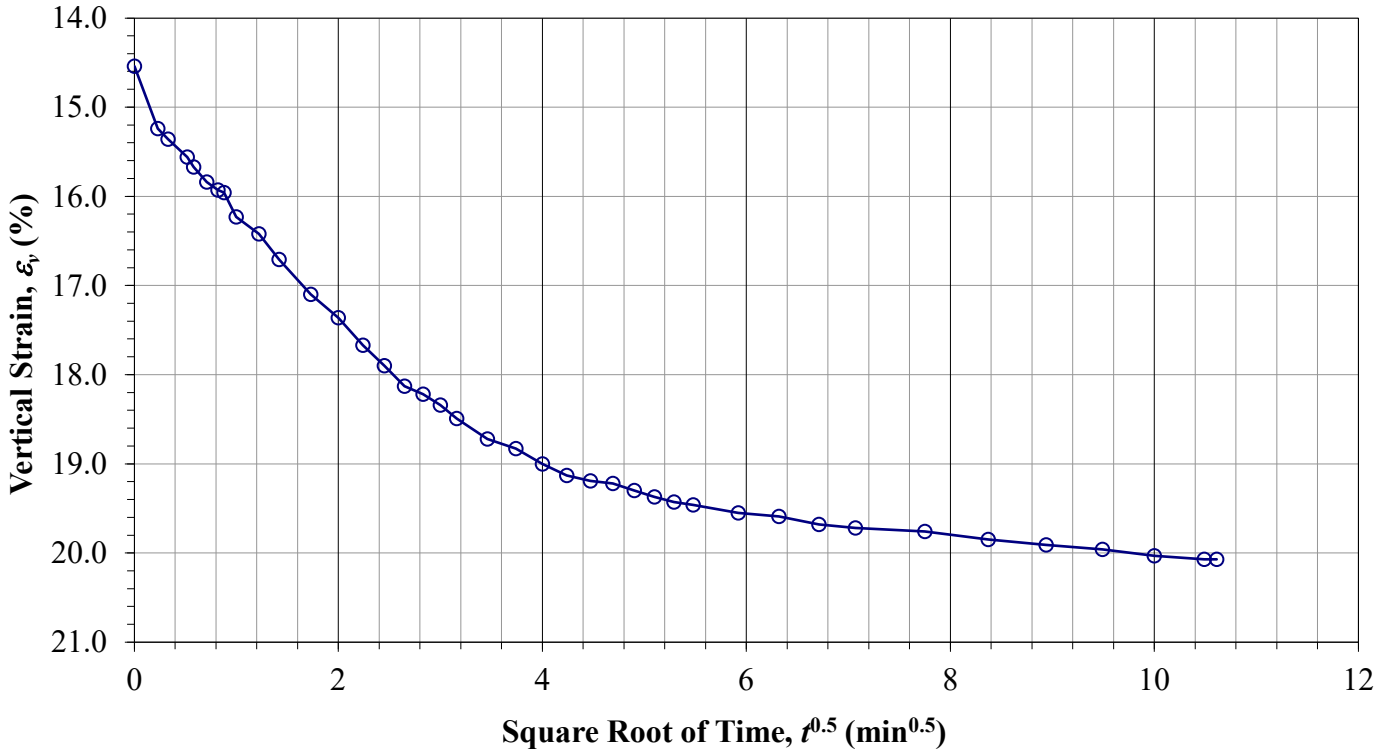
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 9 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

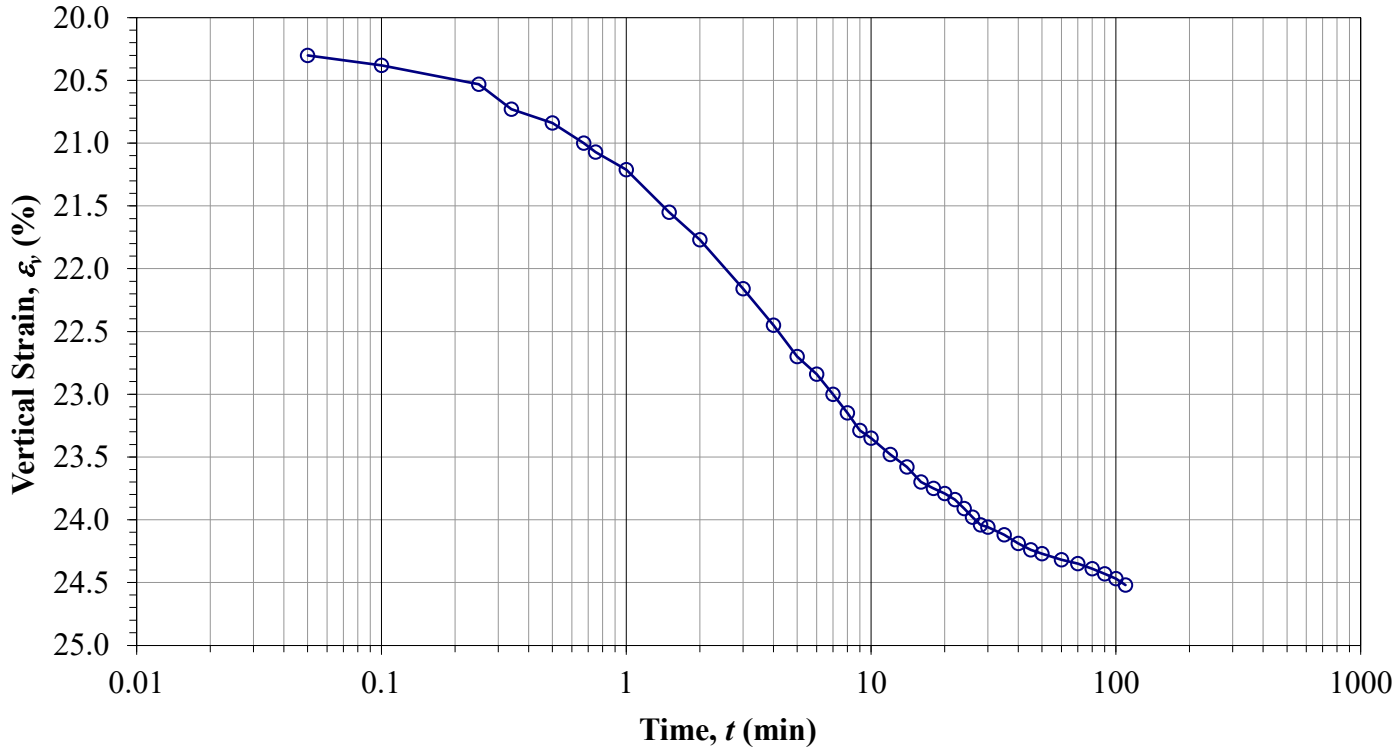
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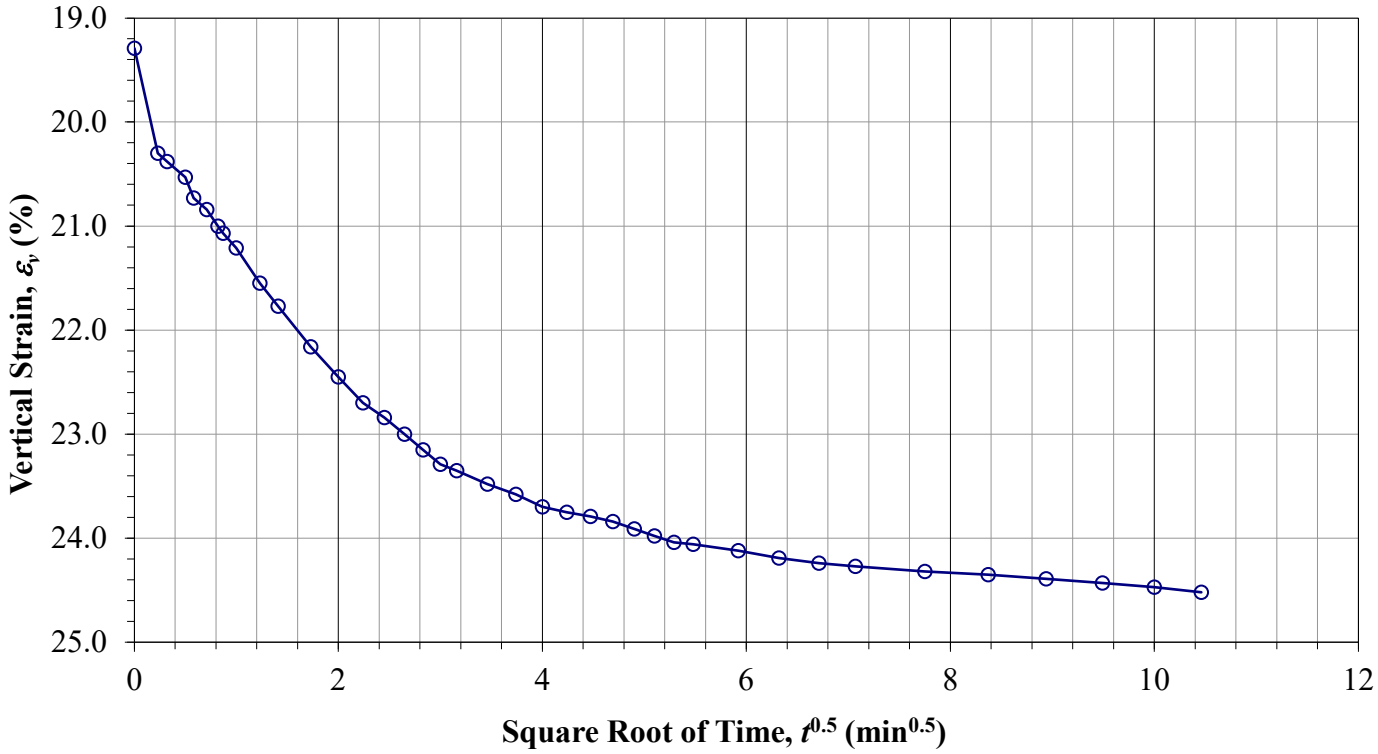
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 10 of 14
Stress: 51200 psf





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One-Dimensional Consolidation Properties of Soils

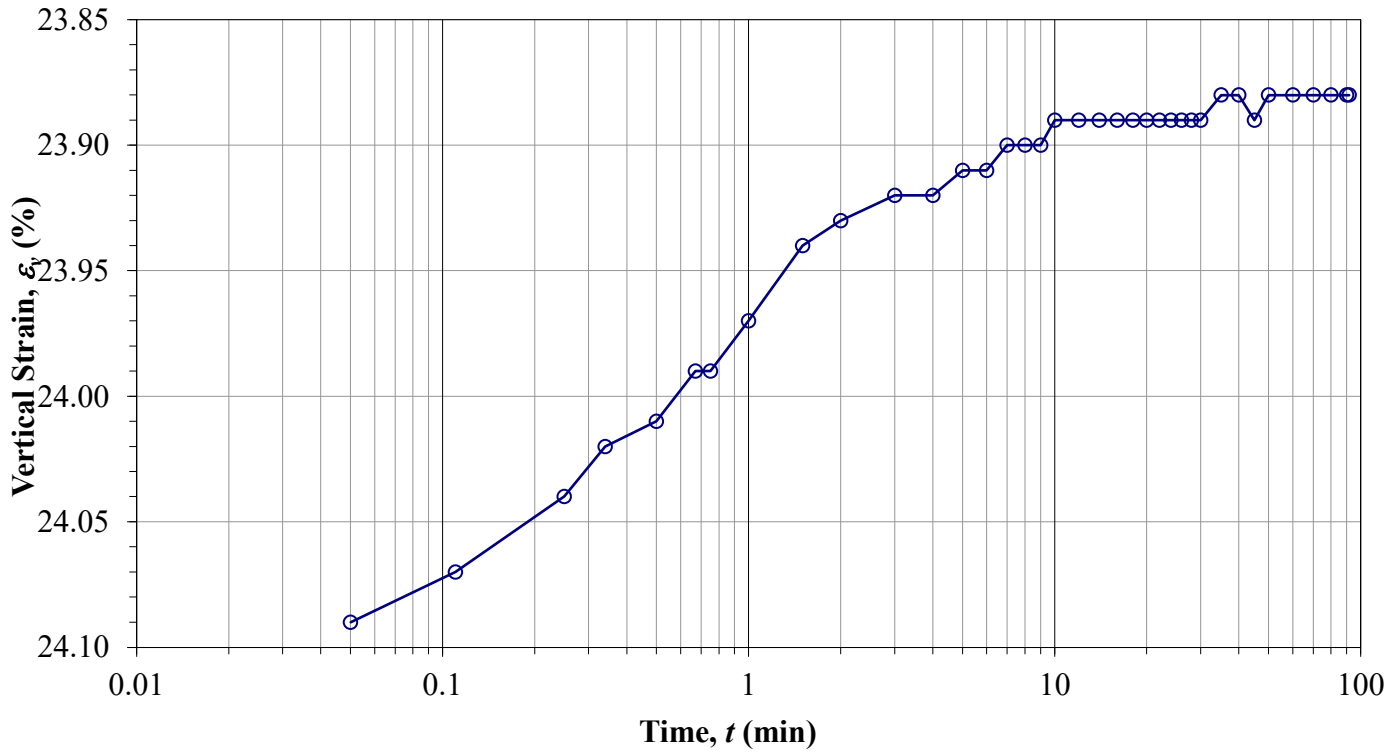
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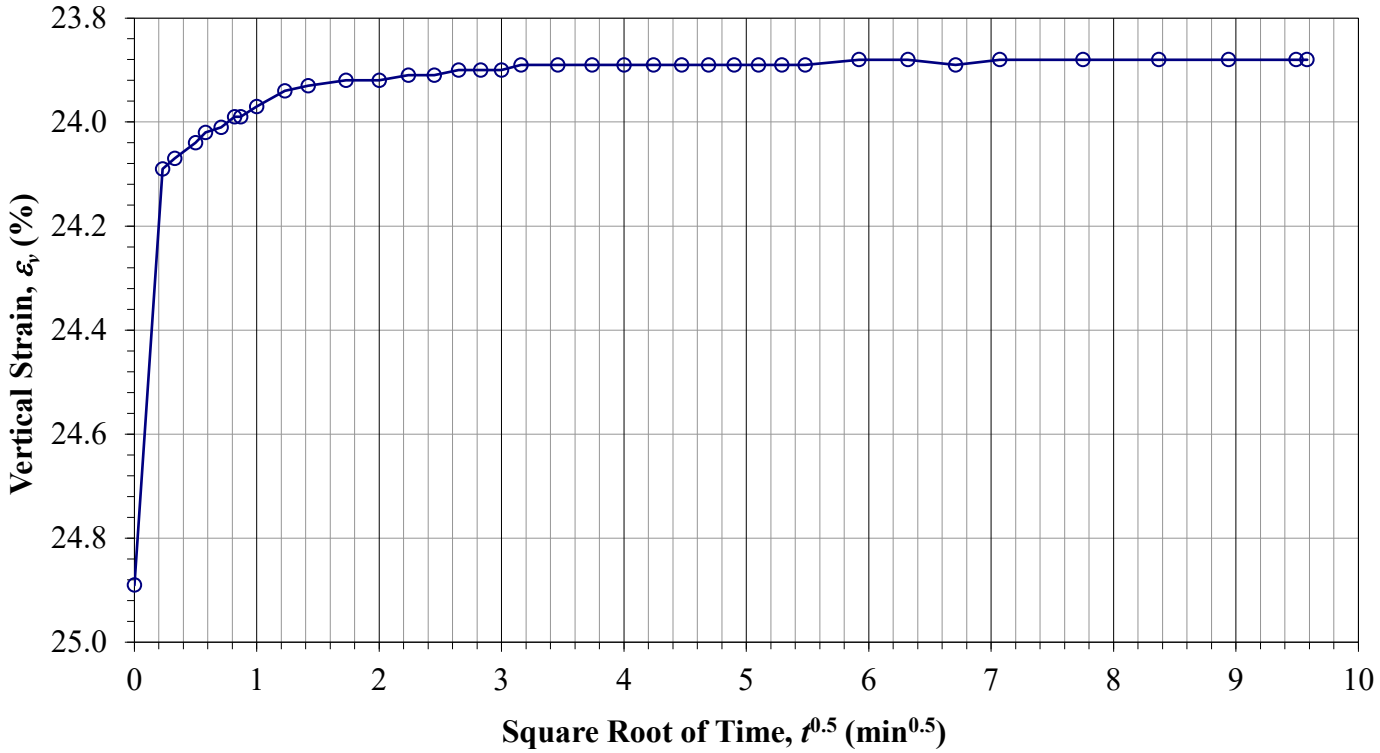
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 11 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

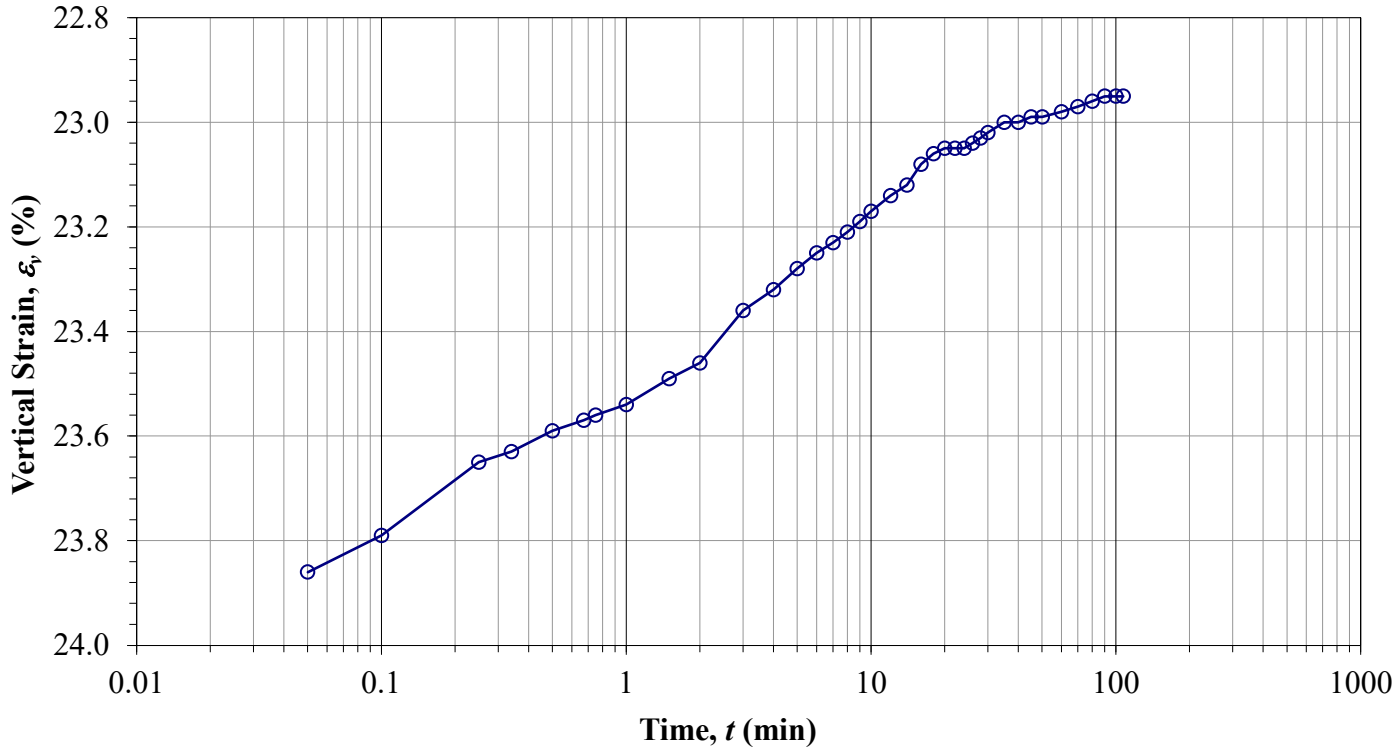
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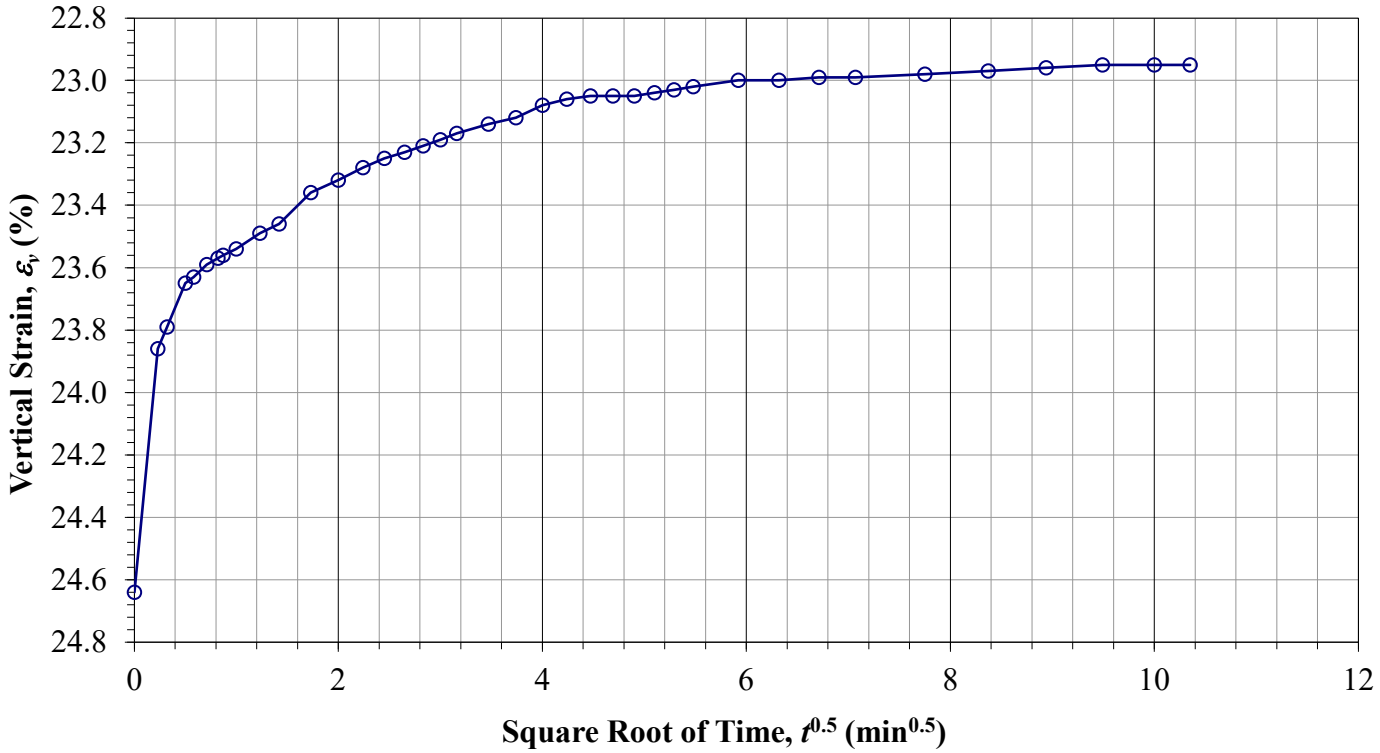
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 12 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

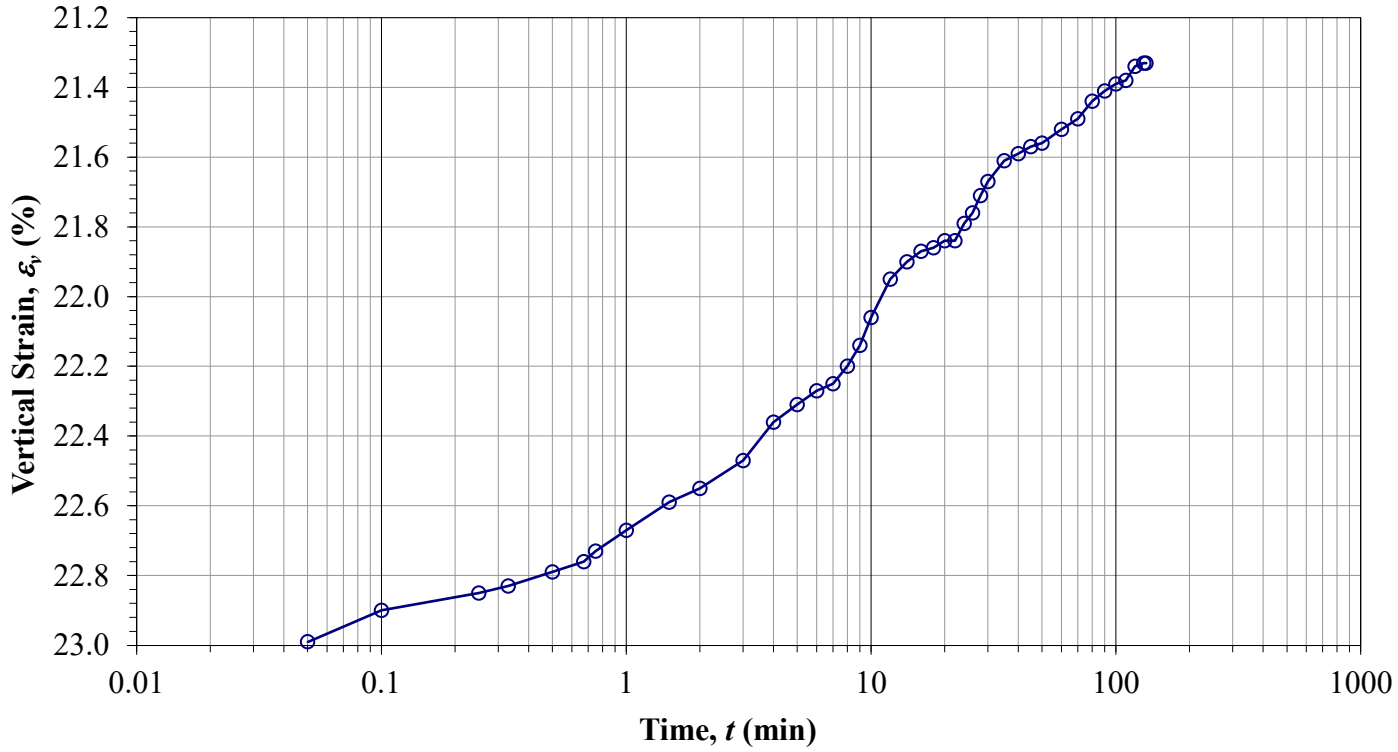
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 13 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

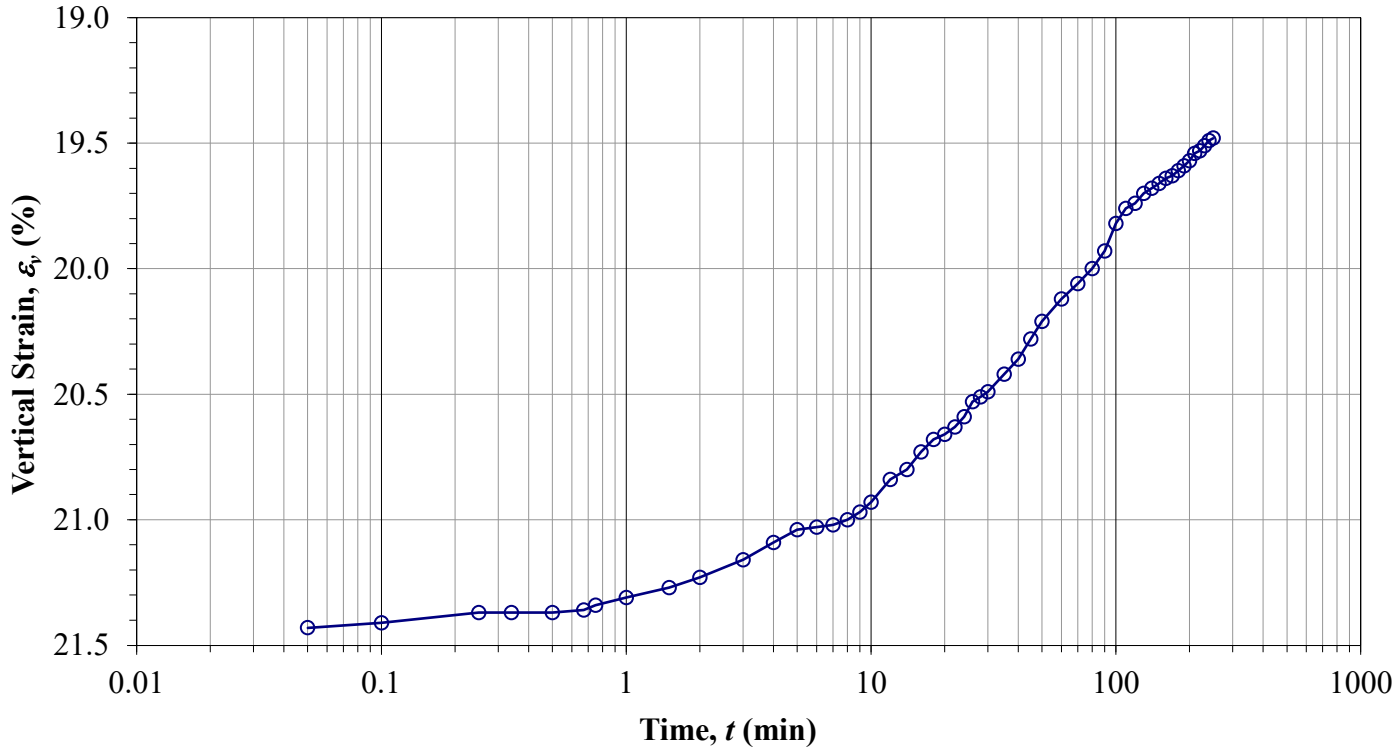
(ASTM D2435)

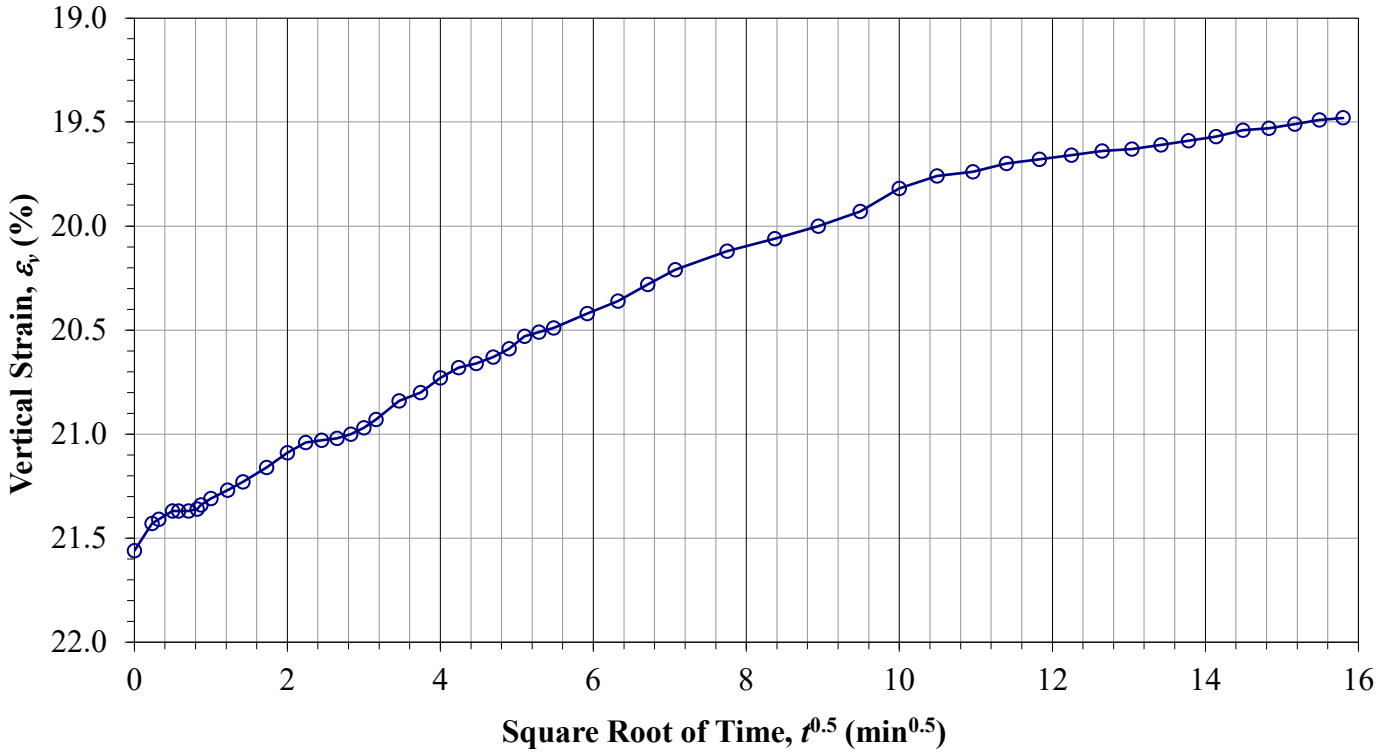
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-05
Sample: 13
Depth: 65'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: JAB

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

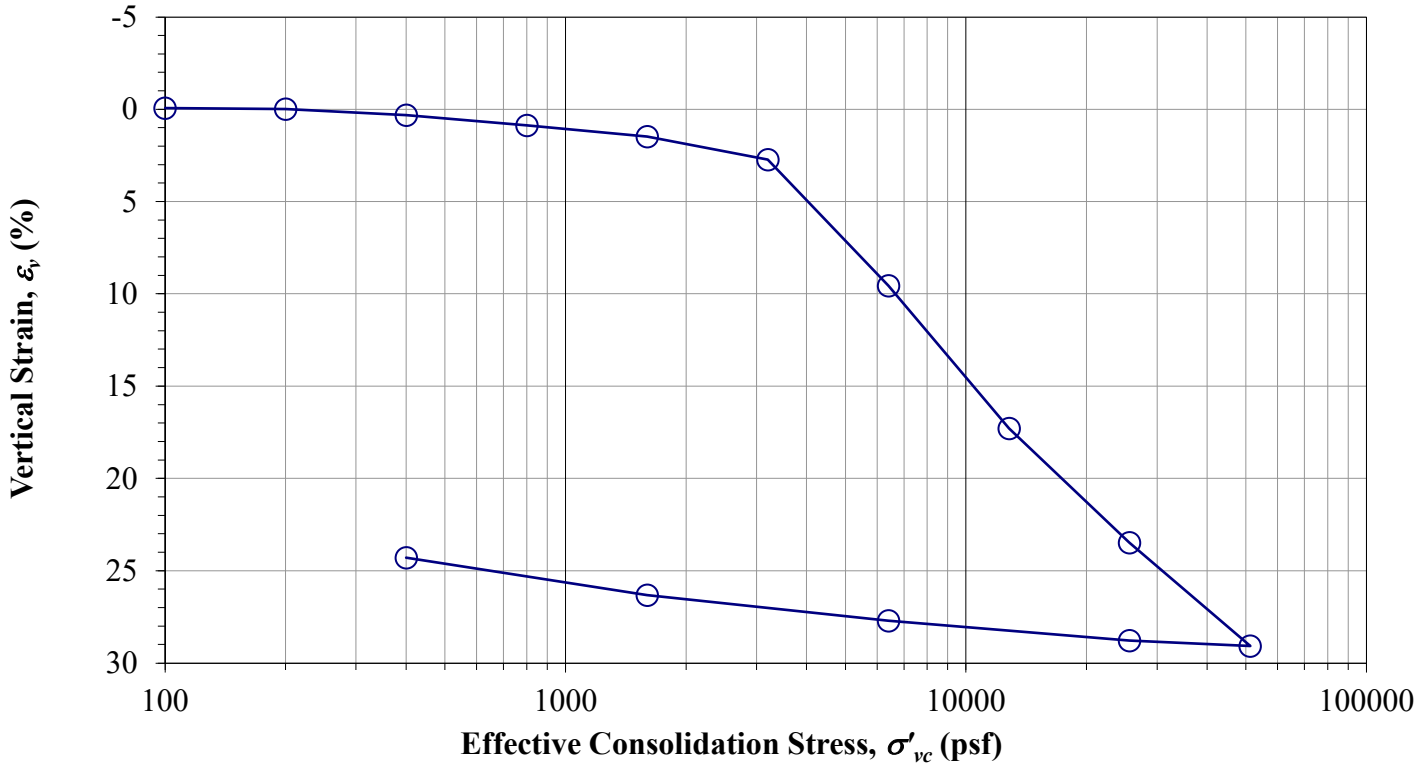
Test method:	B	
Inundation stress (psf), timing:	100	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.916	0.693
Sample diameter, D (in.)	2.414	2.414
Wt. rings + wet soil (g)	161.52	146.34
Wt. rings/tare (g)	45.16	45.16
Total unit wt., γ (pcf)	105.7	121.45
Wet soil + tare (g)	393.41	312.06
Dry soil + tare (g)	318.73	286.88
Tare (g)	179.60	212.00
Water content, ω (%)	53.7	33.6
Dry unit wt., γ_d (pcf)	68.8	90.9
Saturation, S	1.00	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9160	1.4498
100	-0.0006	-0.06	0.9166	1.4514
200	-0.0002	-0.02	0.9162	1.4503
400	0.0029	0.32	0.9131	1.4421
800	0.0079	0.87	0.9081	1.4286
1600	0.0135	1.47	0.9025	1.4137
3200	0.0251	2.74	0.8909	1.3828
6400	0.0876	9.56	0.8284	1.2156
12800	0.1584	17.29	0.7576	1.0262
25600	0.2151	23.48	0.7009	0.8745
51200	0.2663	29.07	0.6497	0.7375
25600	0.2637	28.78	0.6523	0.7446
6400	0.2539	27.71	0.6621	0.7709
1600	0.2411	26.32	0.6749	0.8050
400	0.2226	24.30	0.6935	0.8546



Entered: _____
Reviewed: _____

One-Dimensional Consolidation Properties of Soils

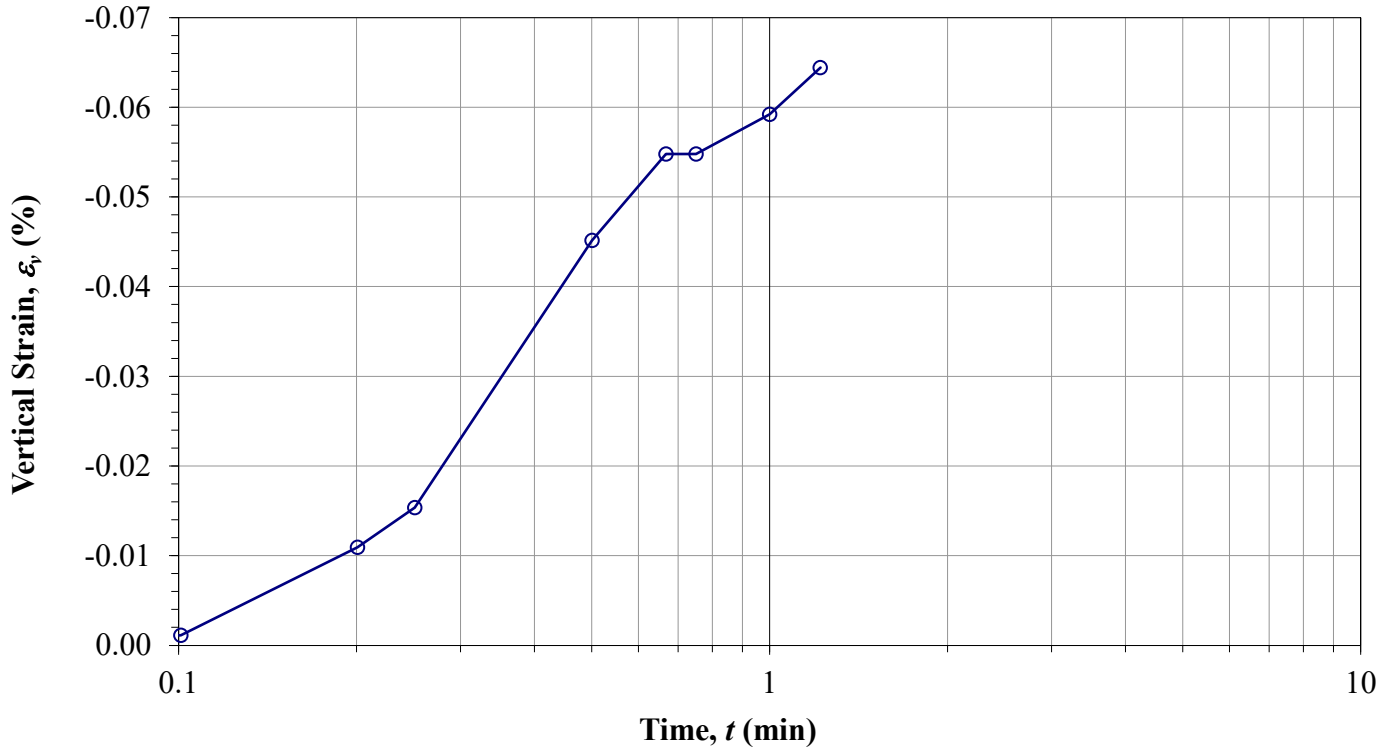
(ASTM D2435)

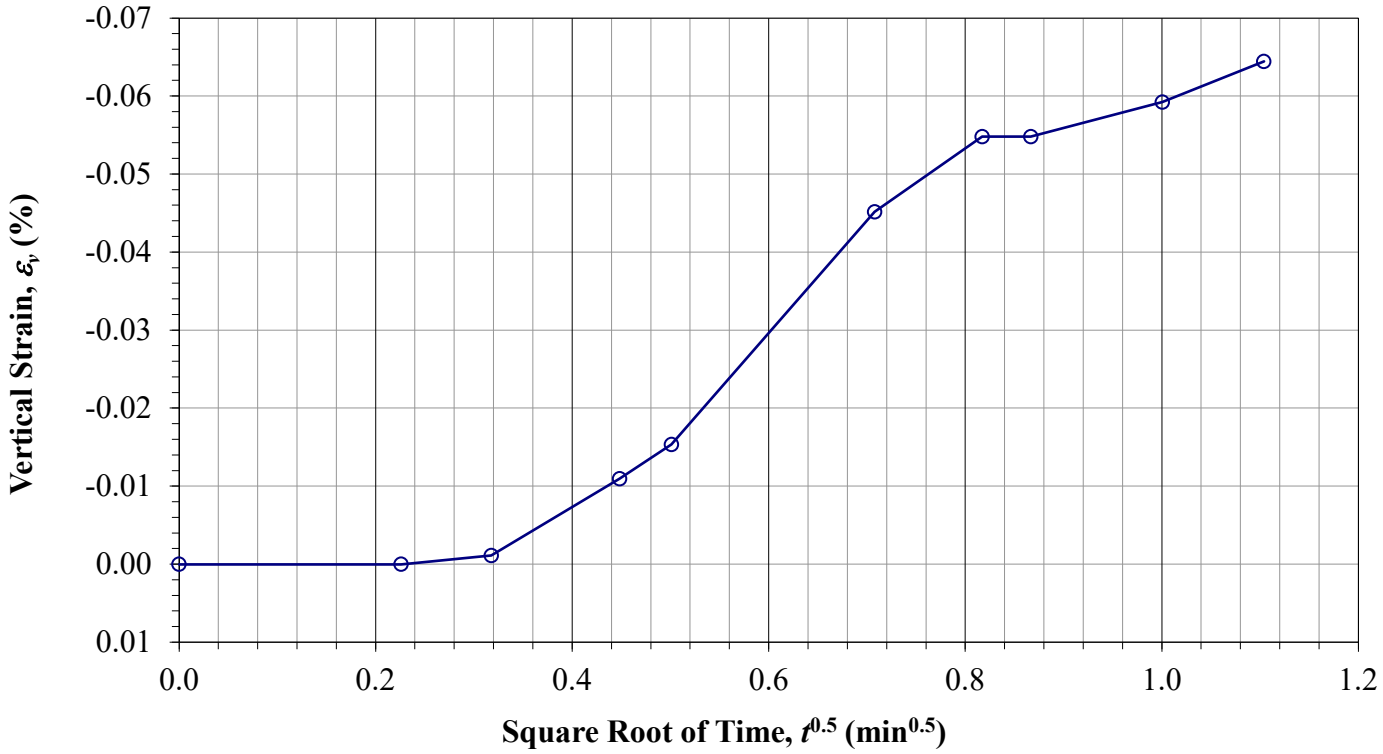
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 1 of 14
Stress: 100 psf





One-Dimensional Consolidation Properties of Soils

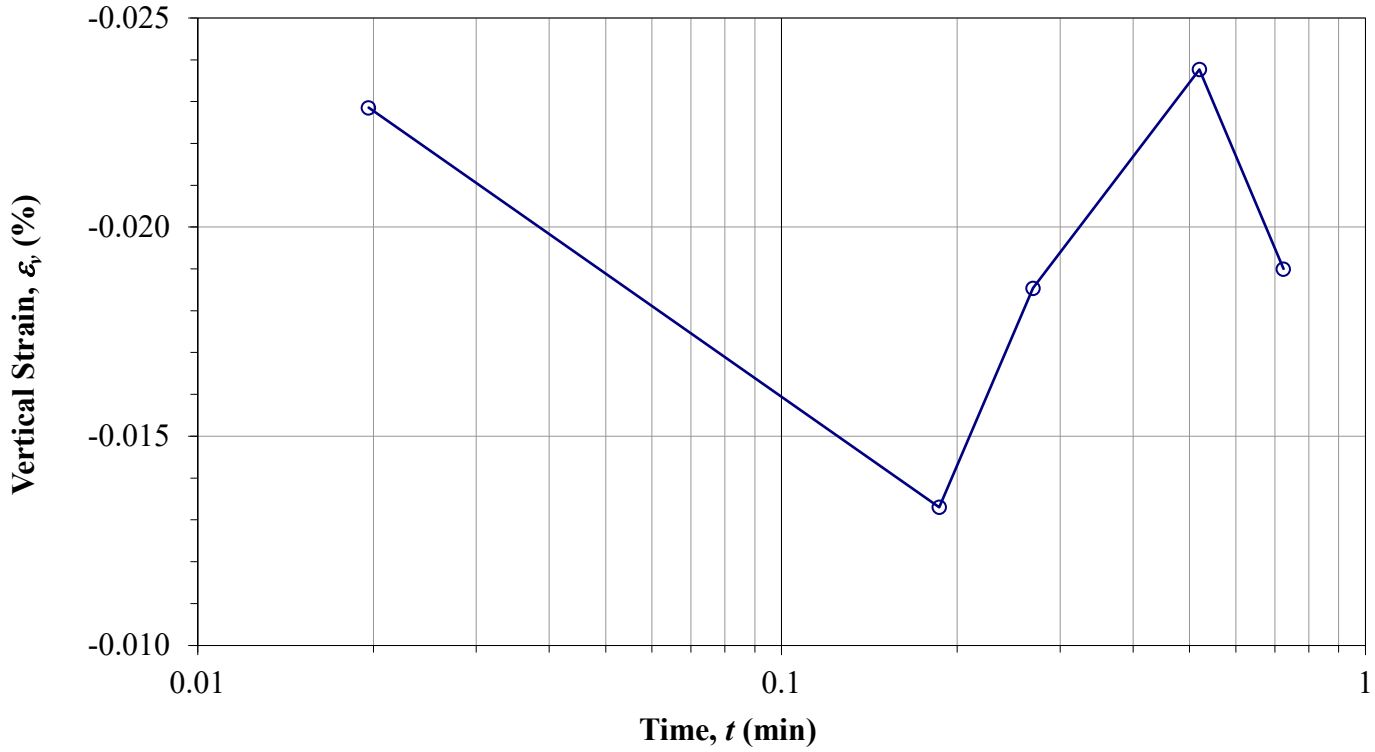
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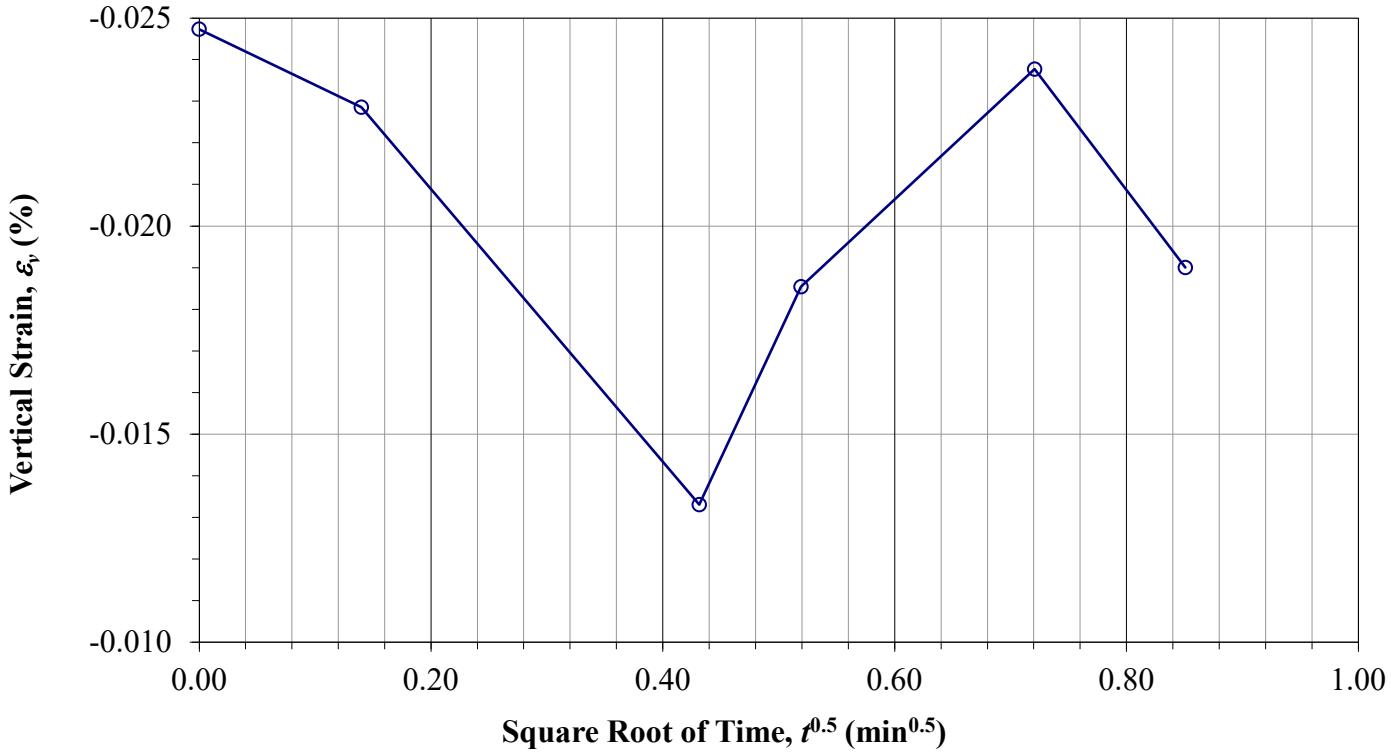
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

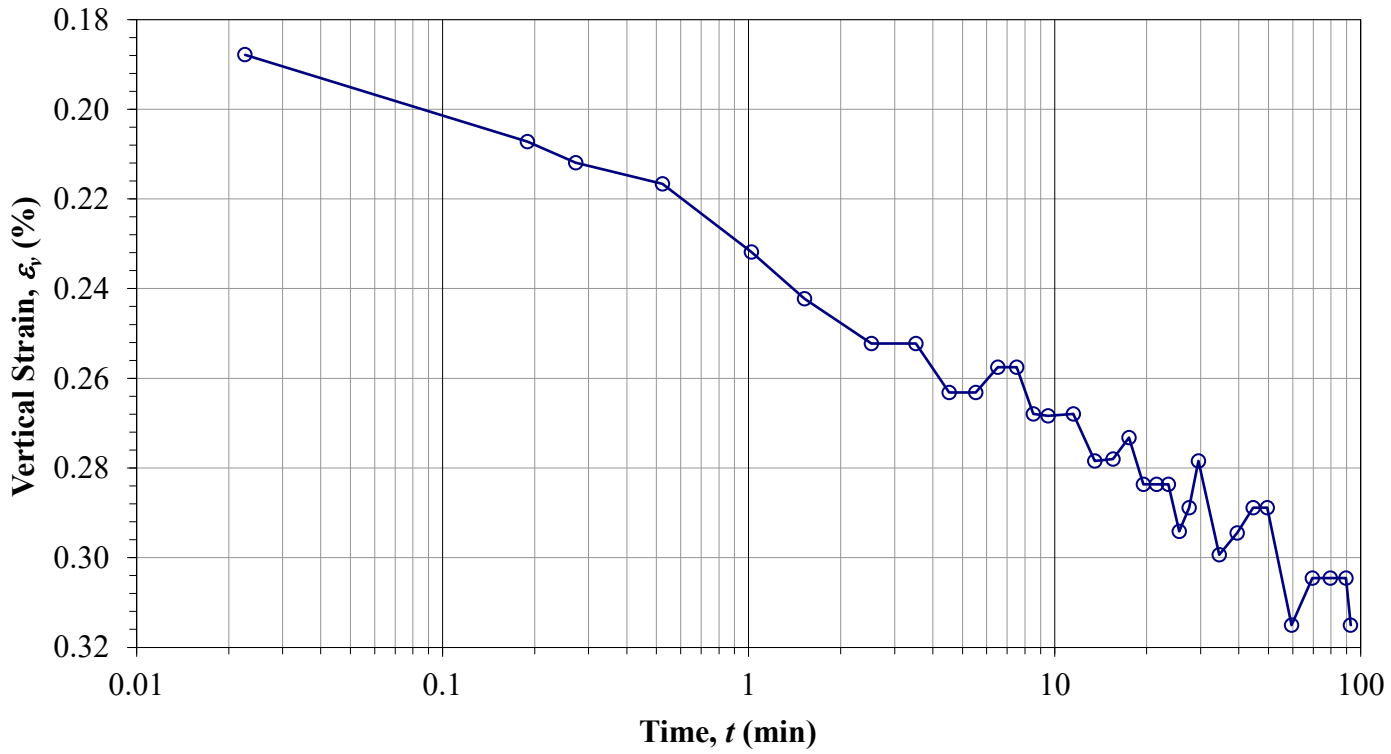
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 3 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

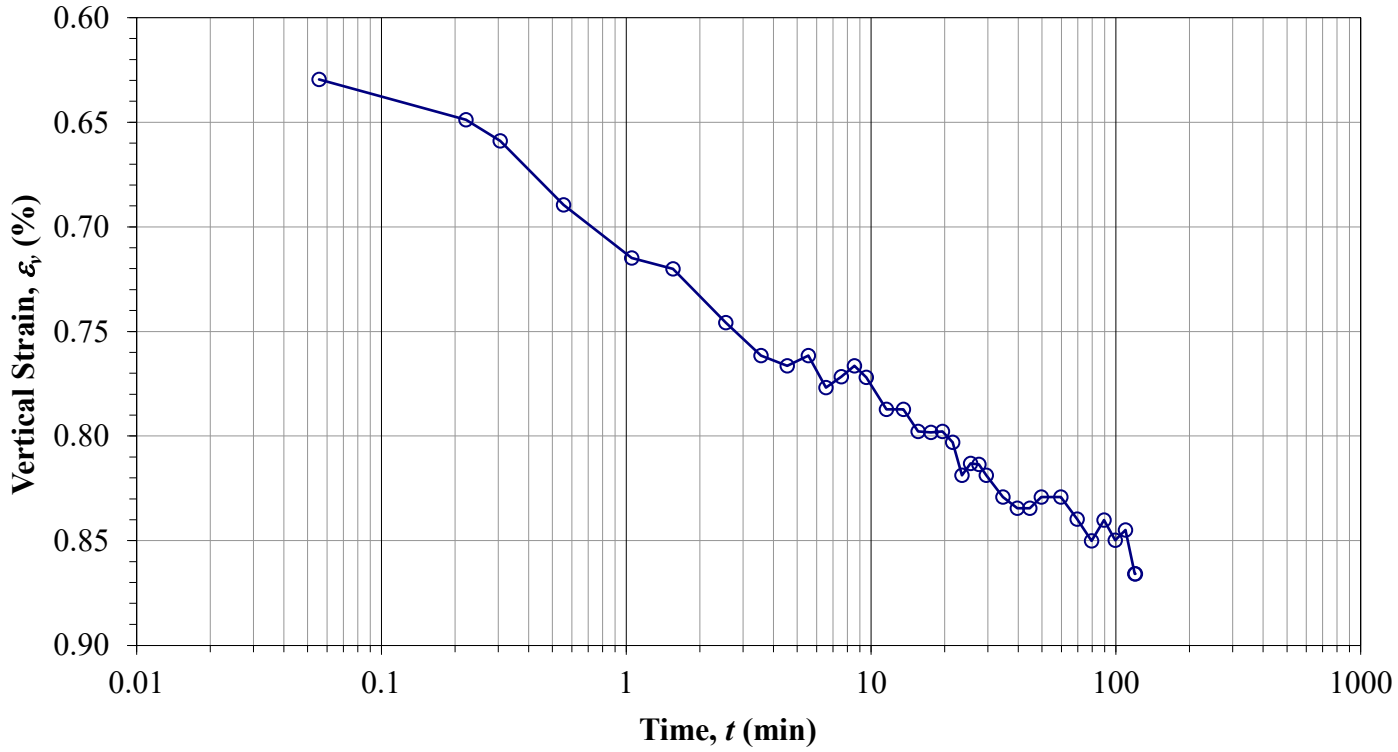
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

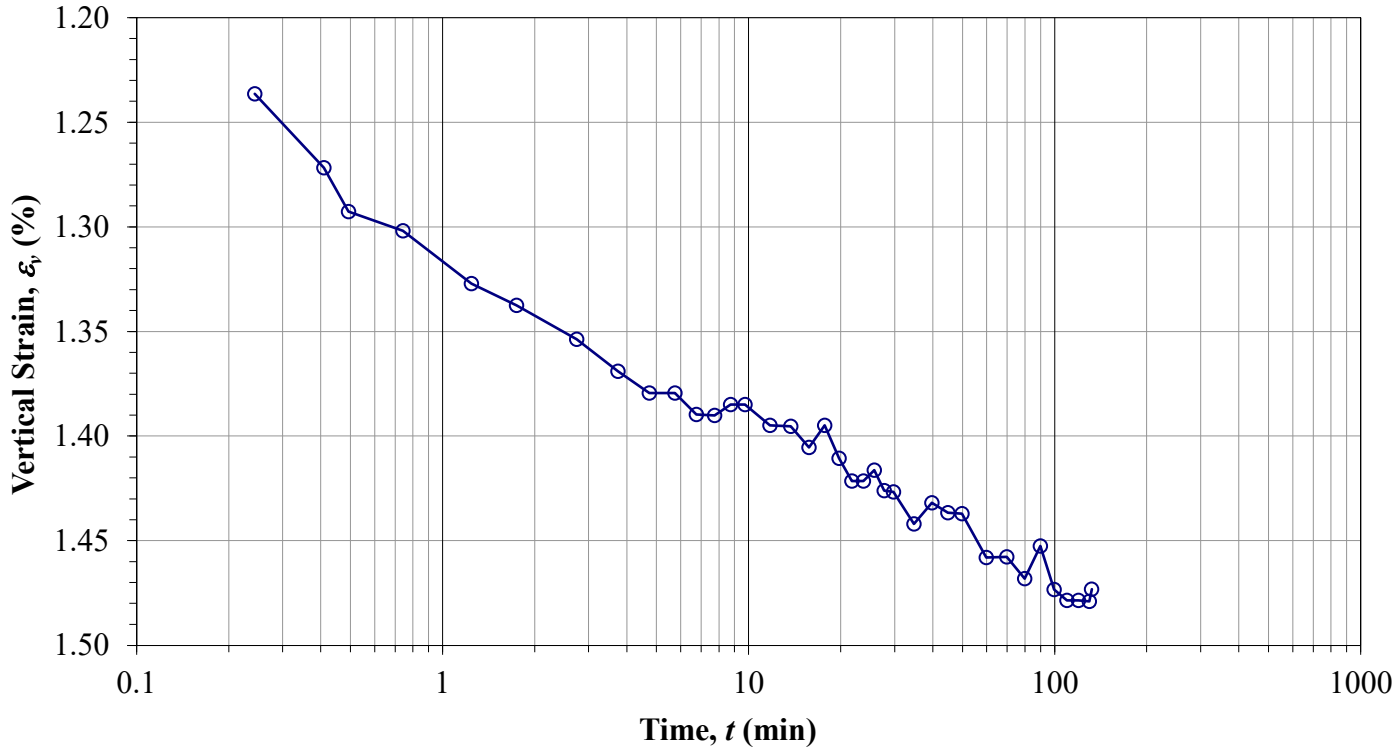
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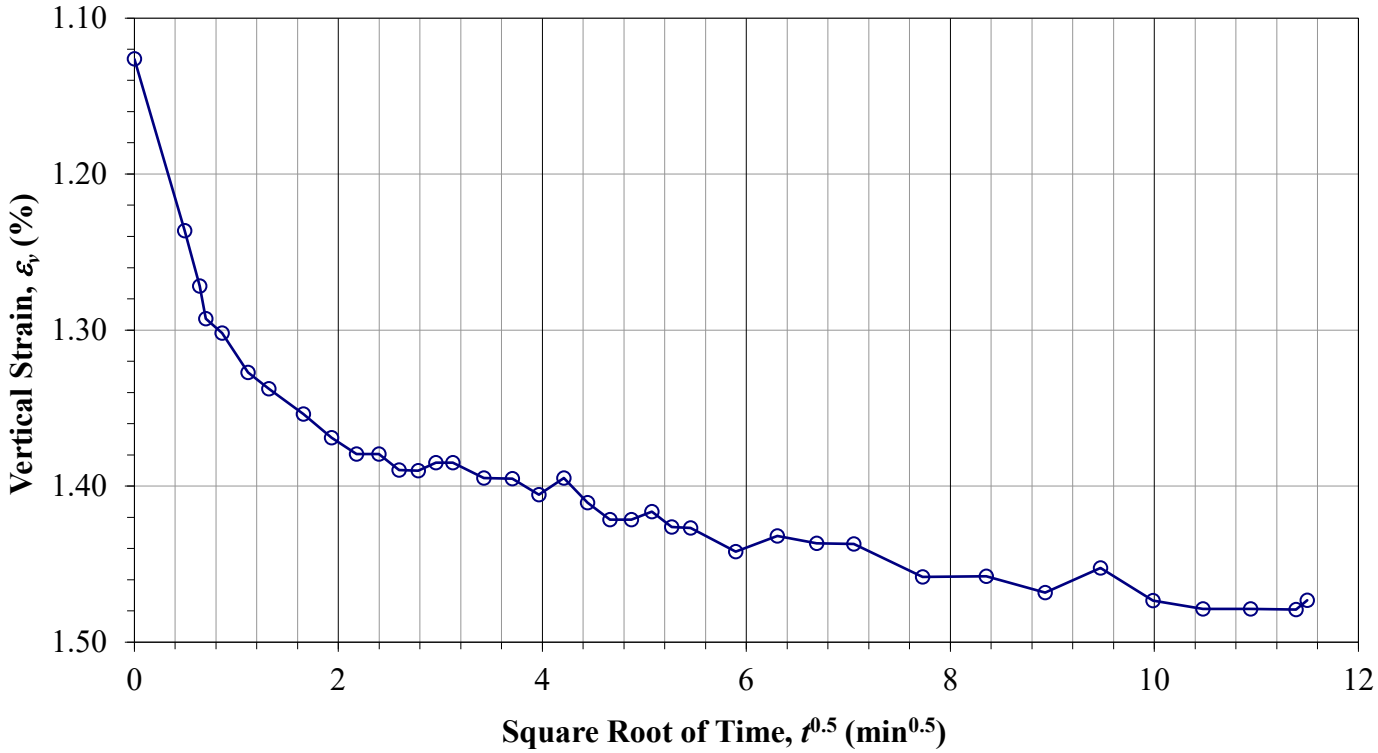
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 5 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

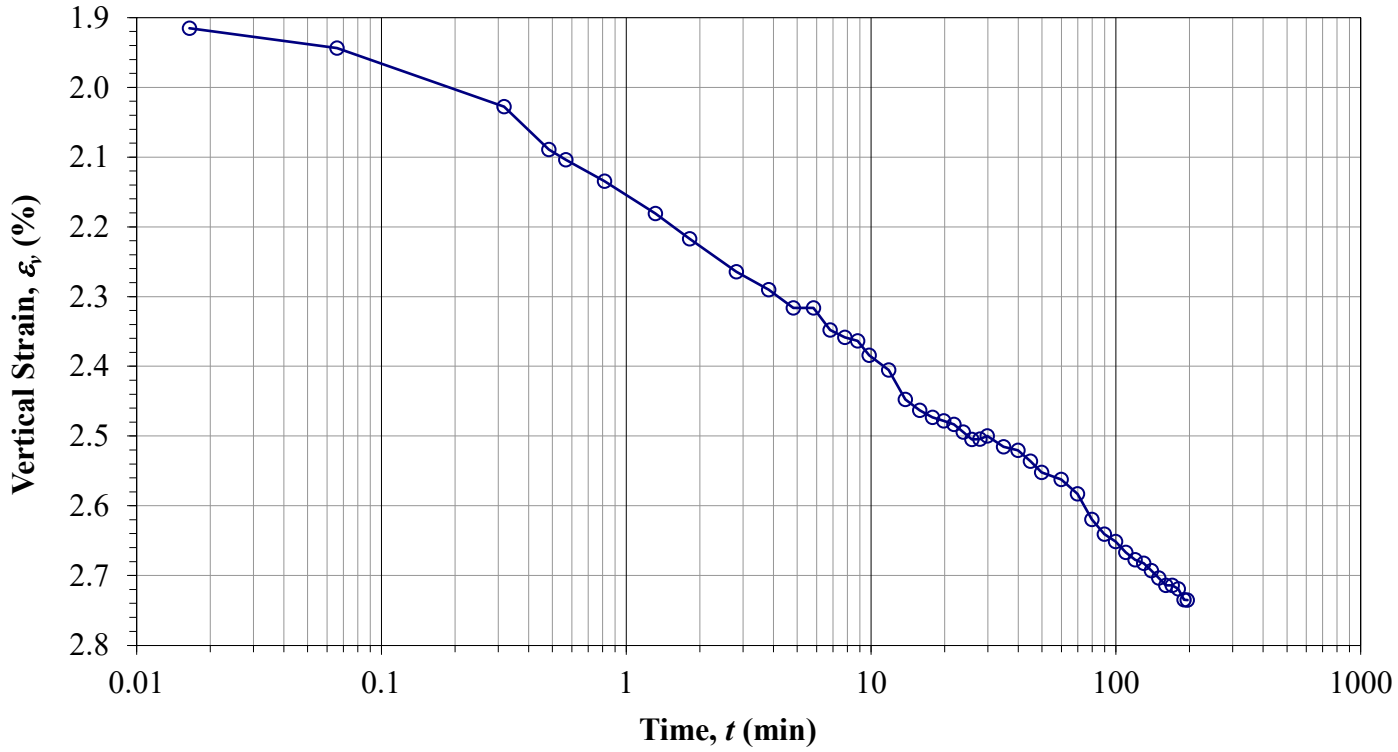
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 6 of 14
Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

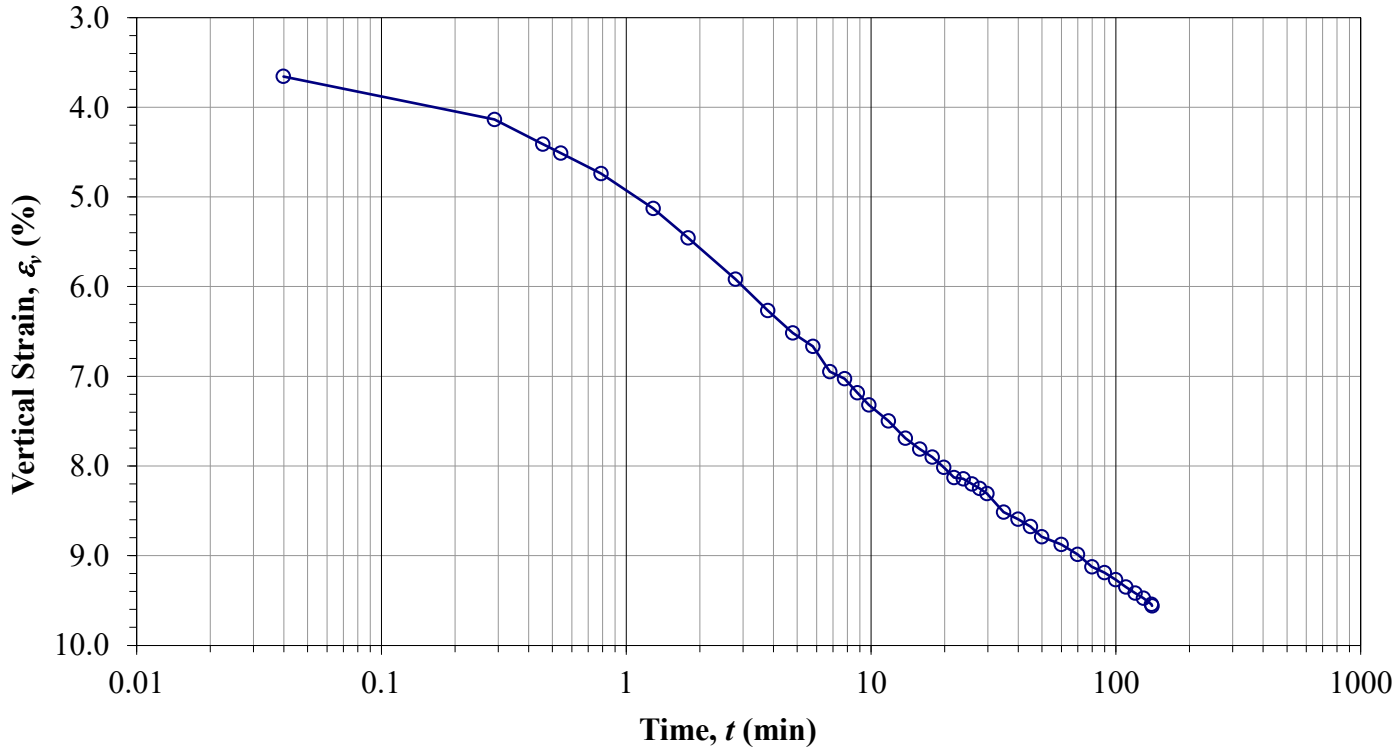
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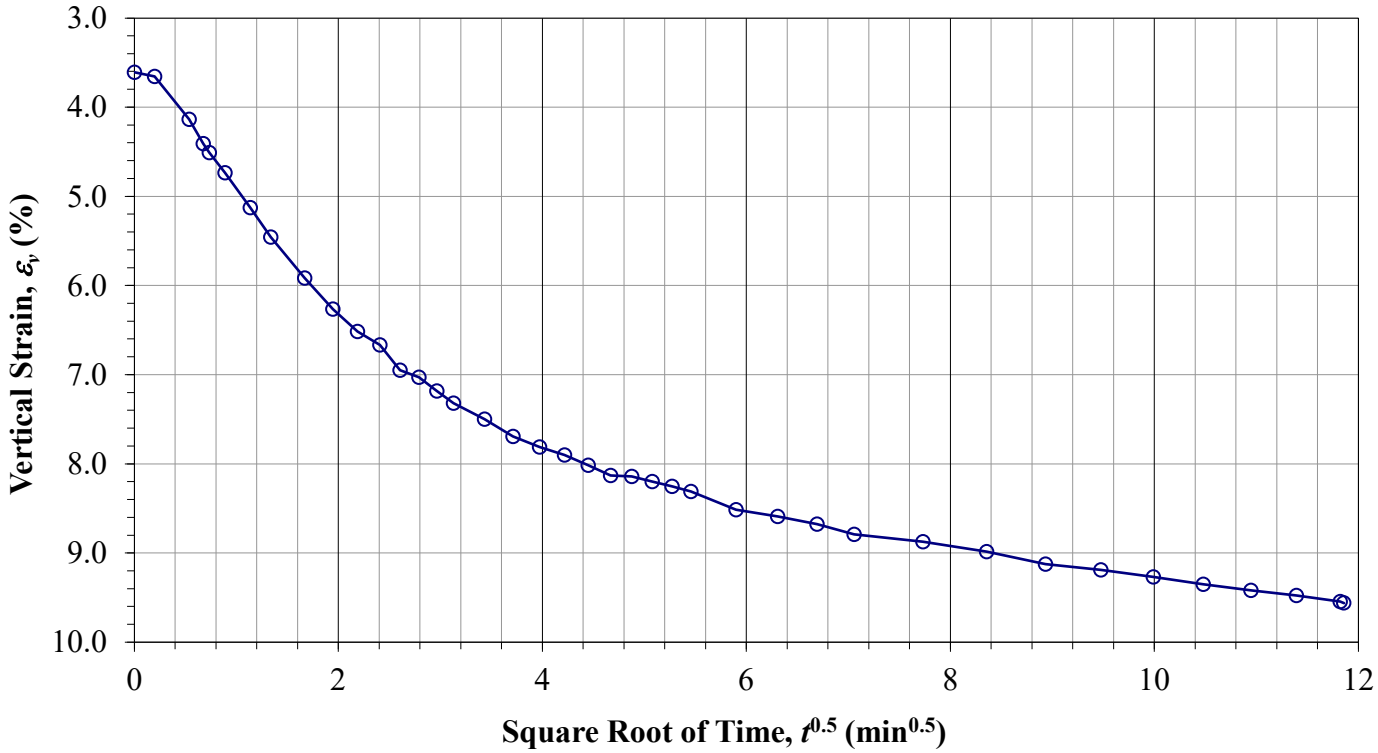
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 7 of 14
Stress: 6400 psf





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One-Dimensional Consolidation Properties of Soils

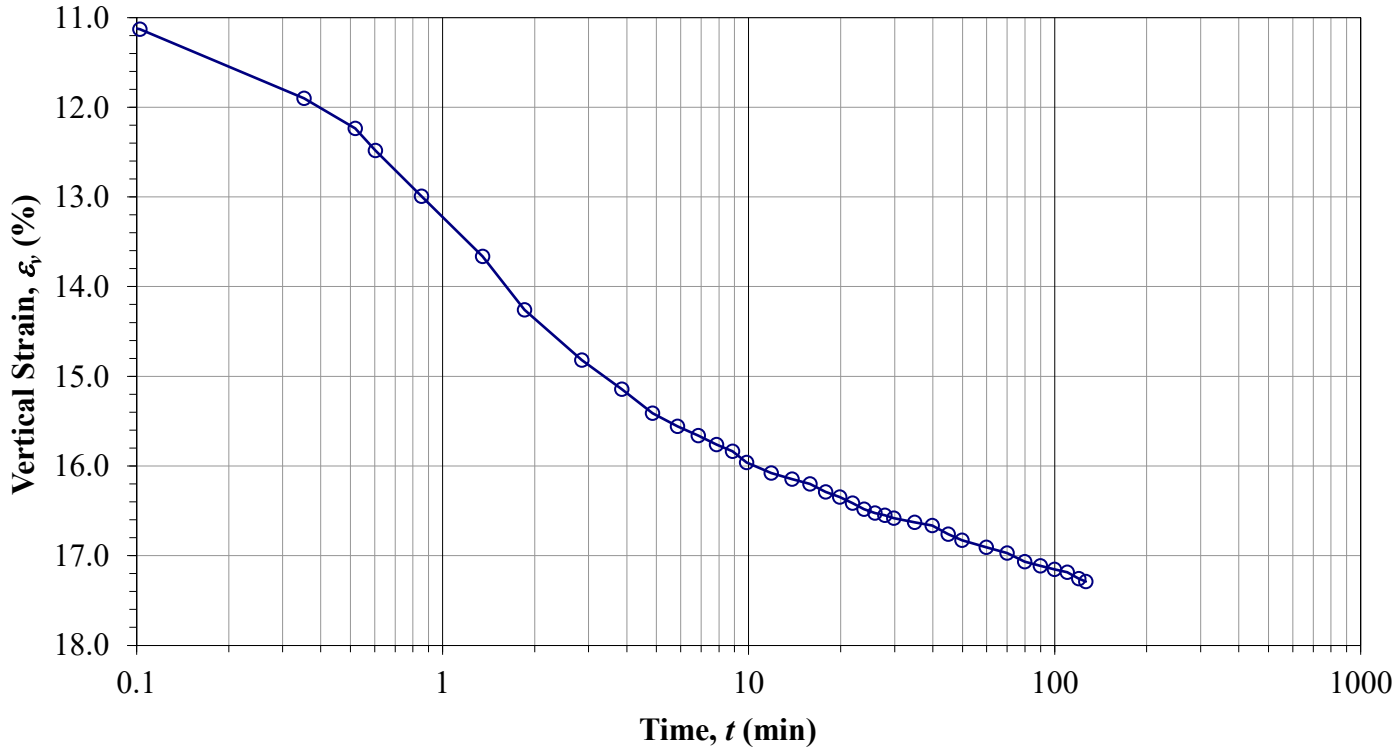
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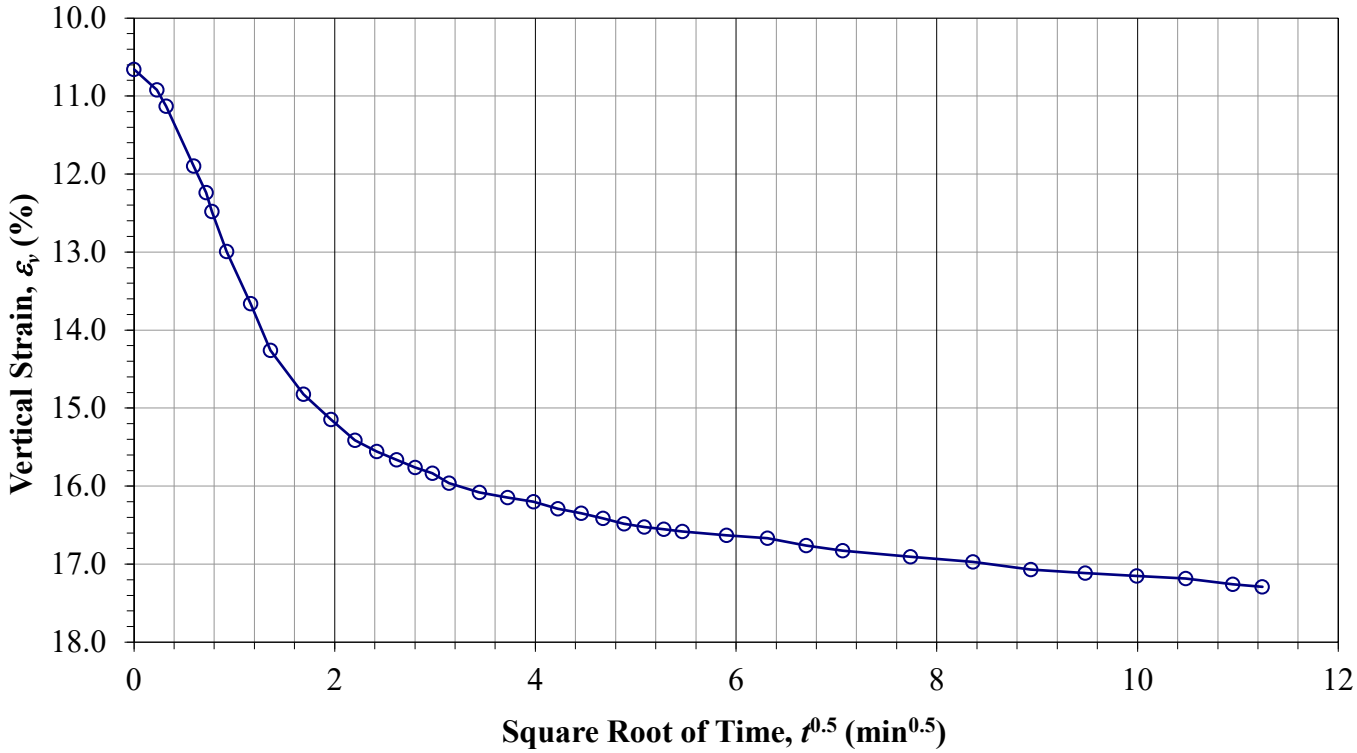
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 8 of 14
Stress: 12800 psf





One-Dimensional Consolidation Properties of Soils

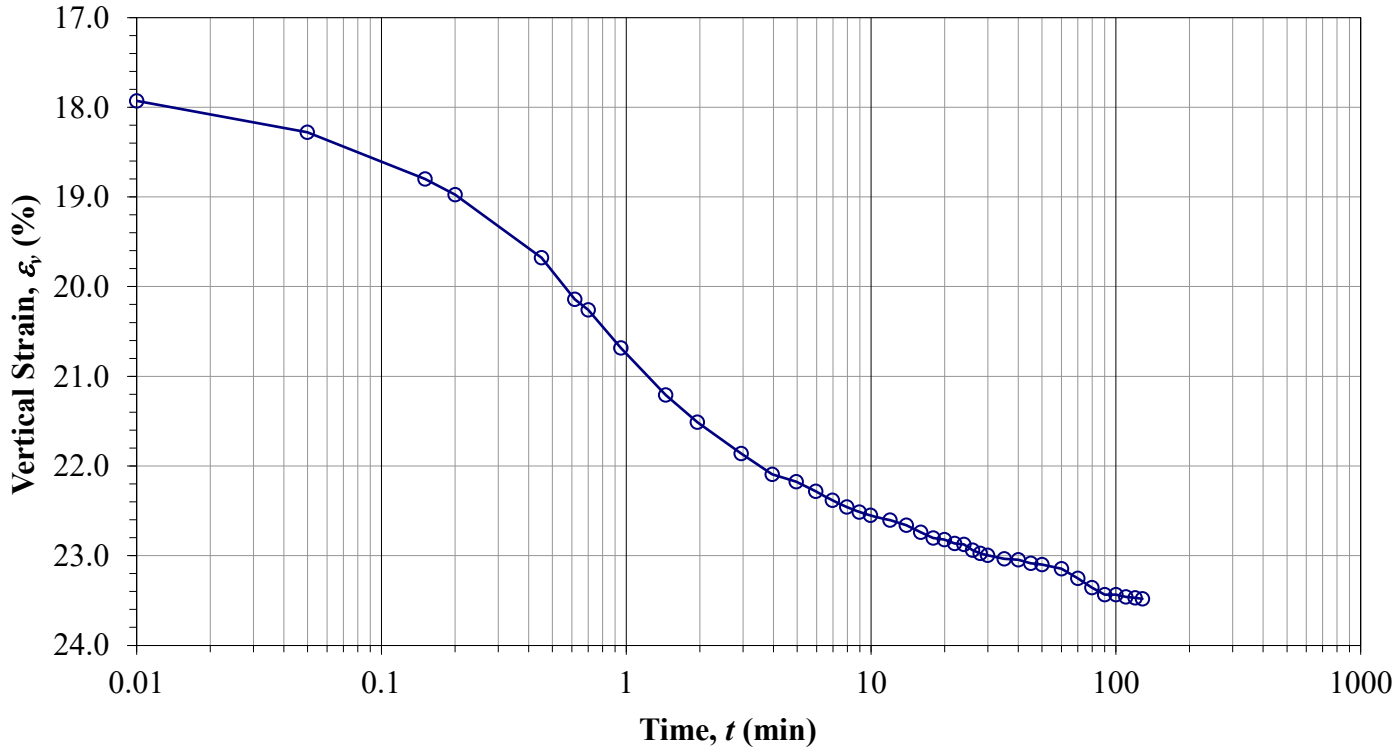
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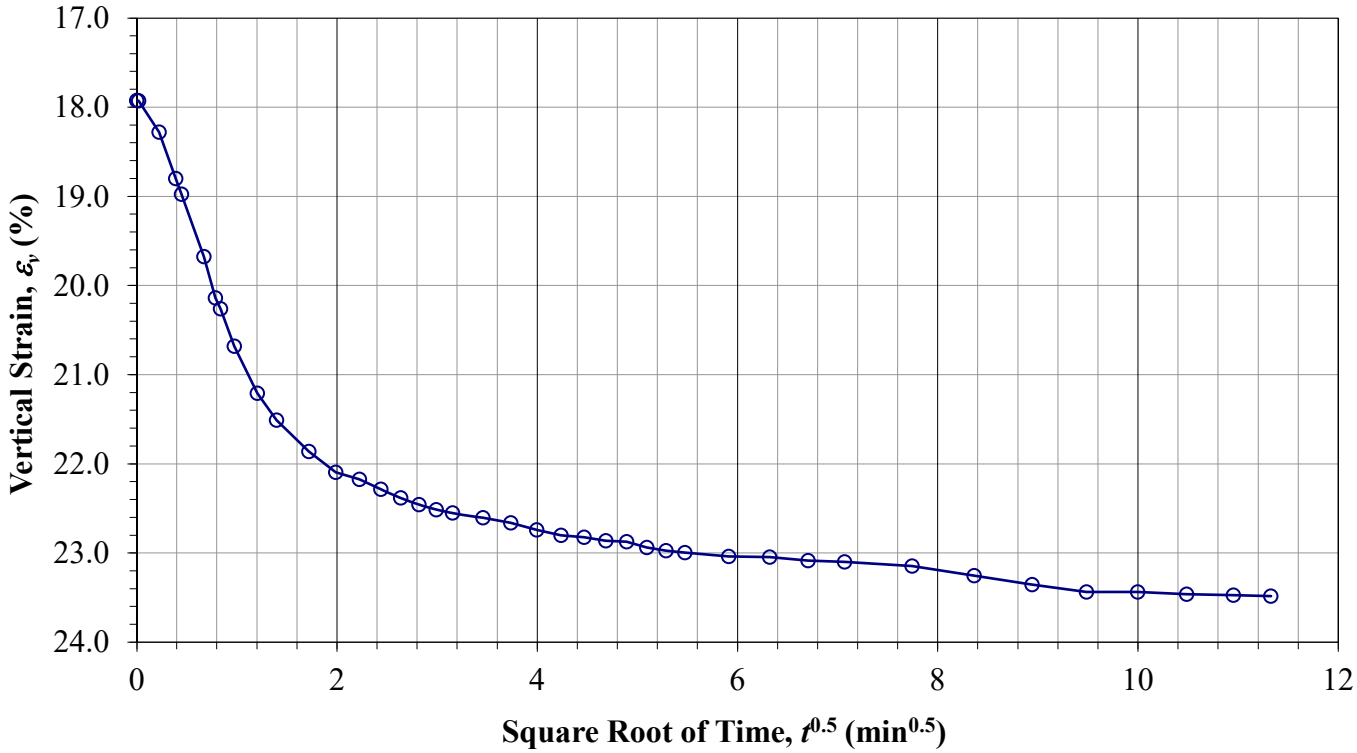
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 9 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

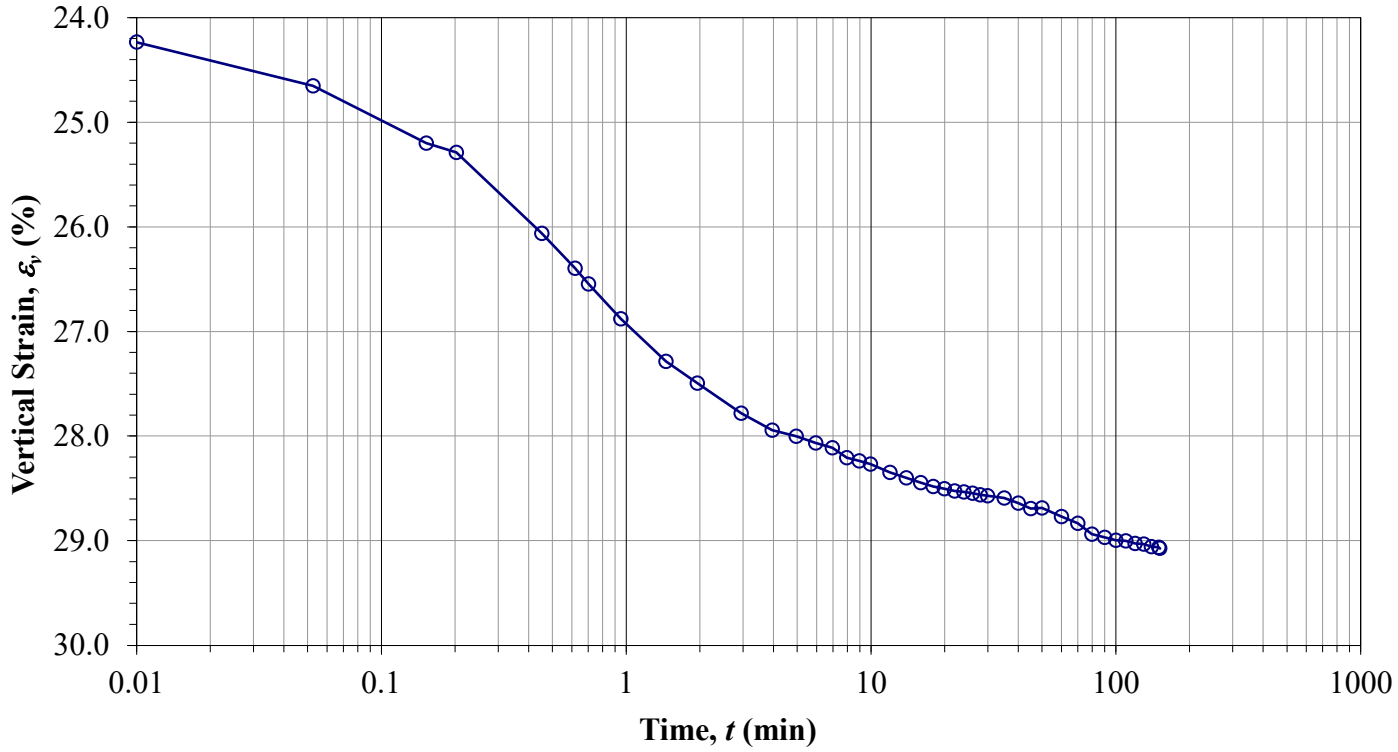
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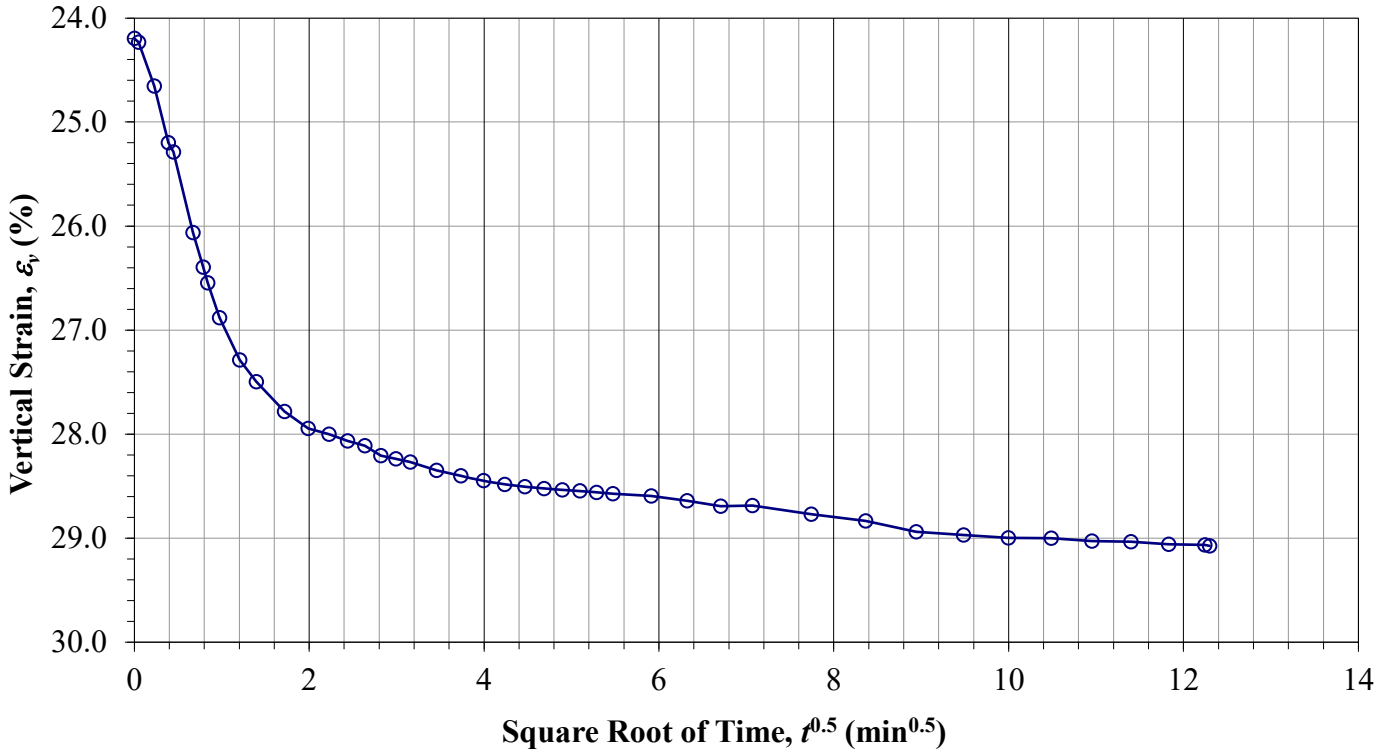
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 10 of 14
Stress: 51200 psf





One-Dimensional Consolidation Properties of Soils

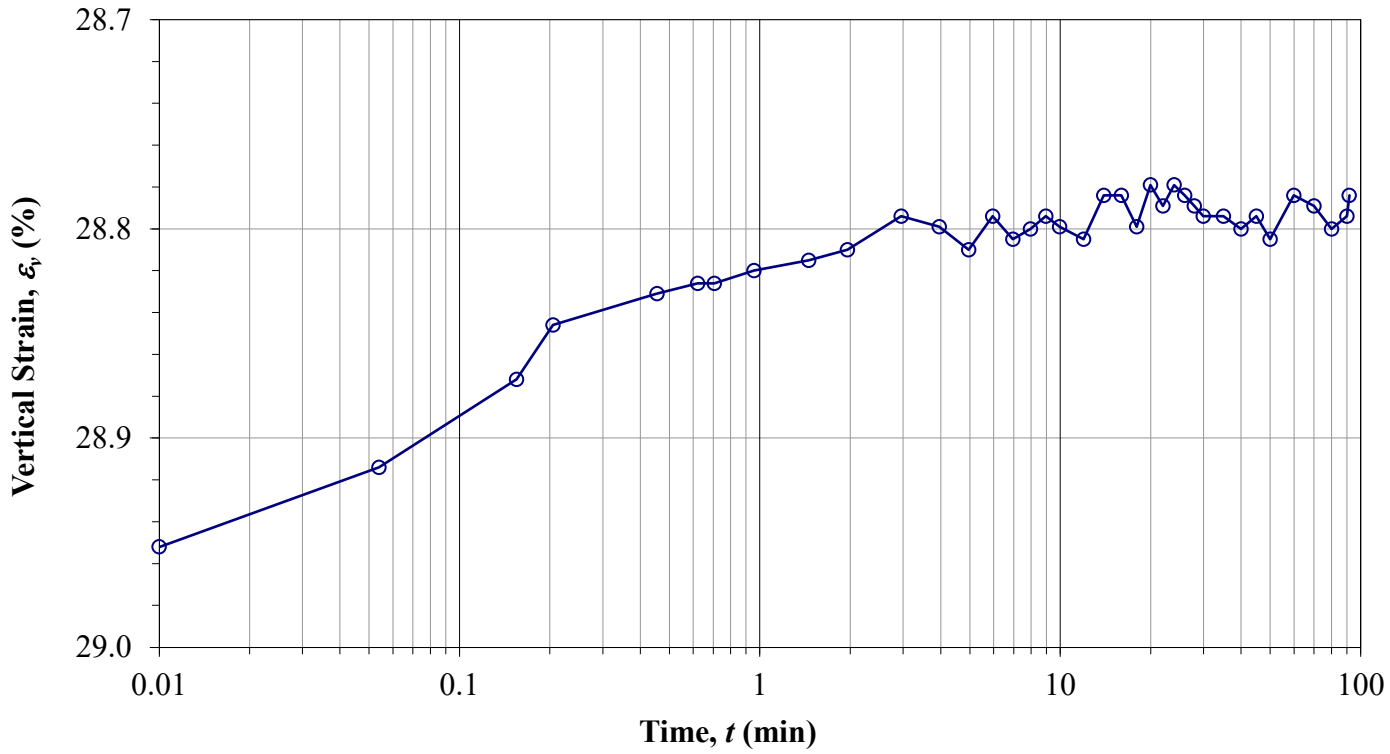
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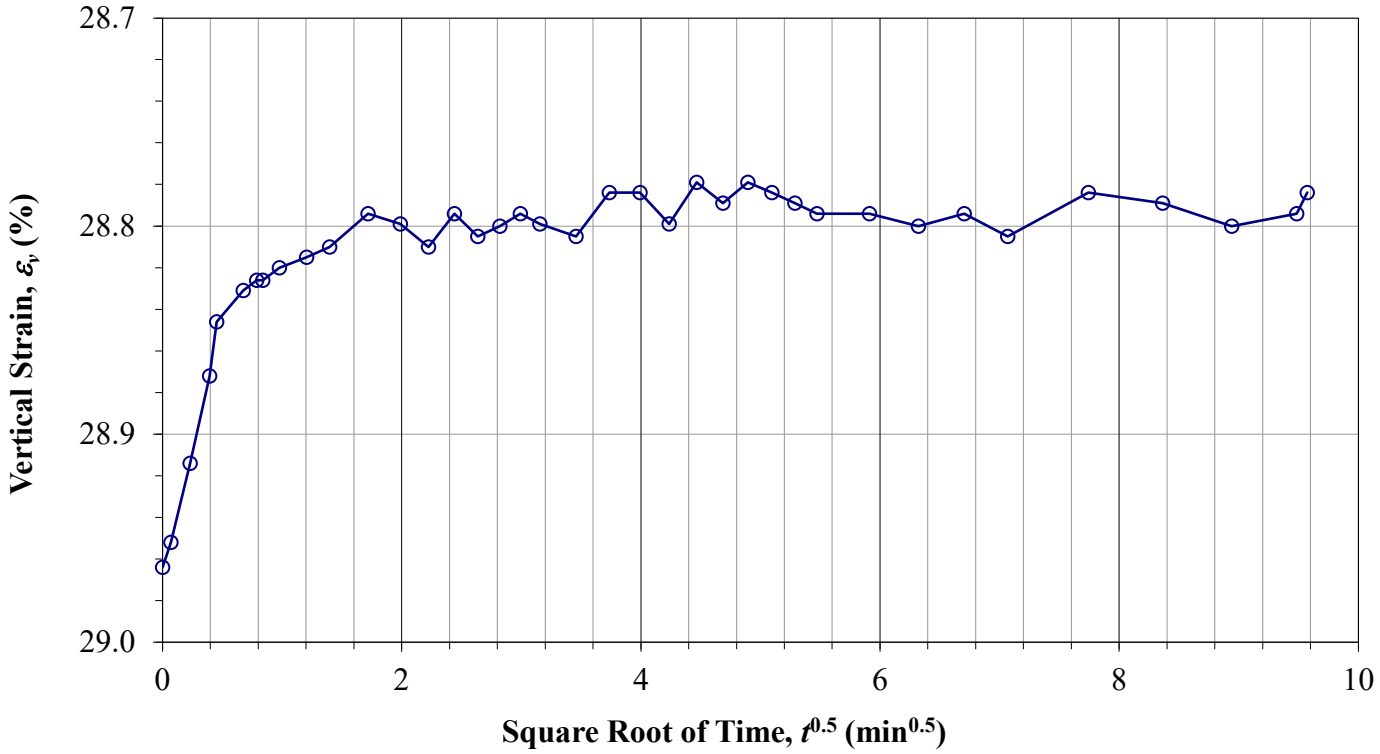
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 11 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

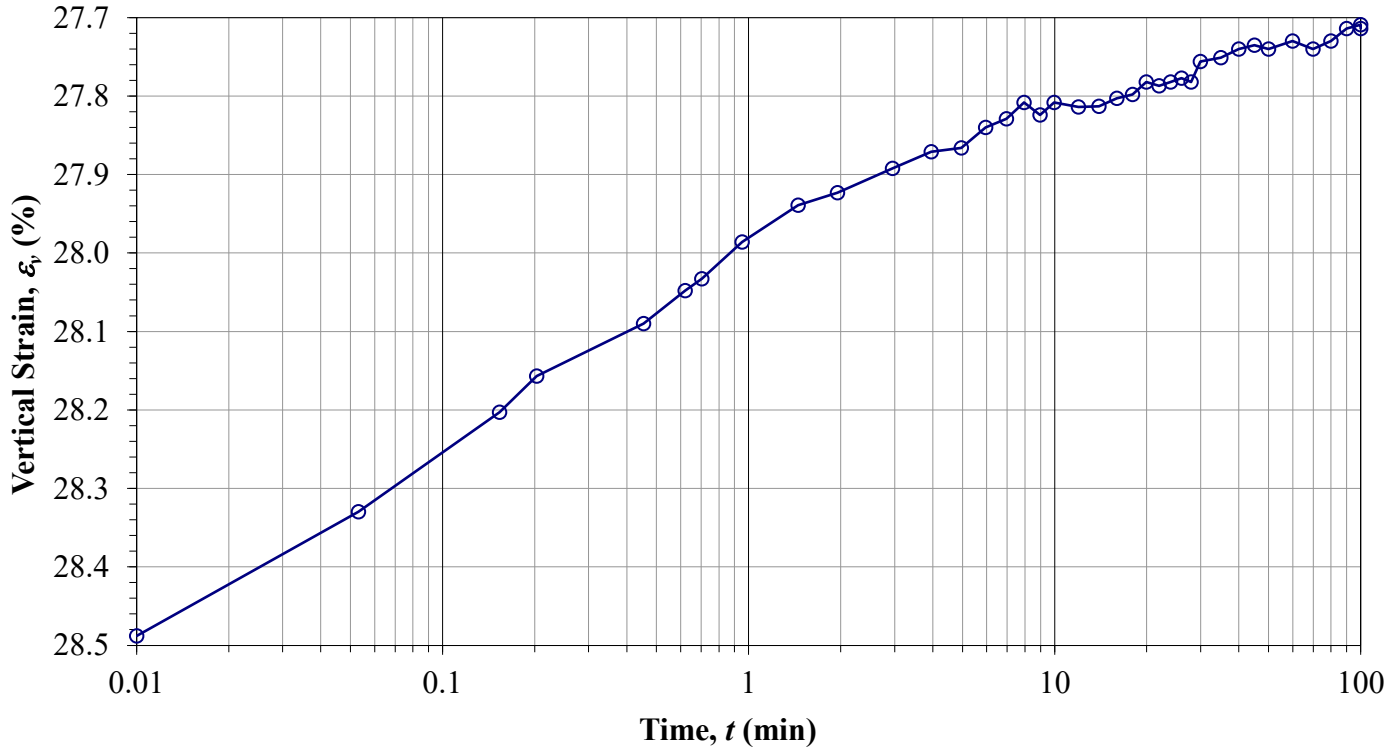
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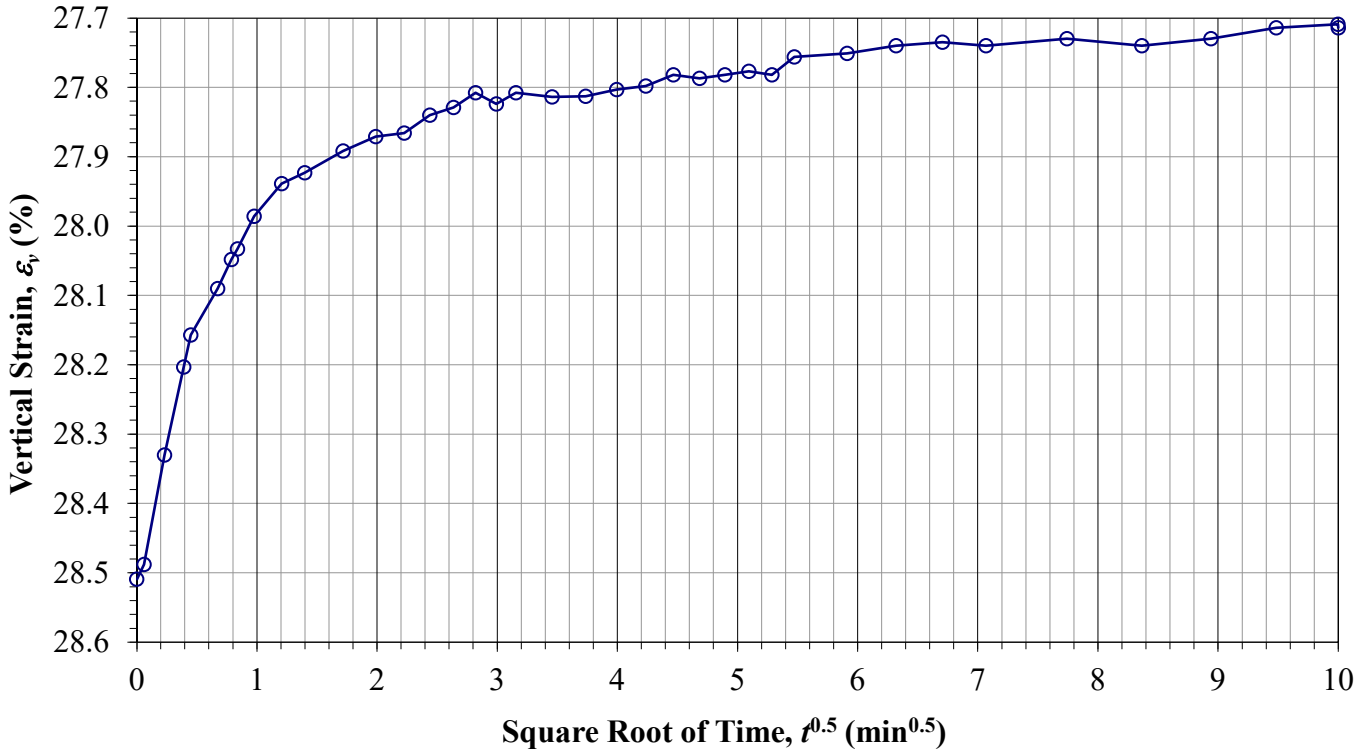
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 12 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

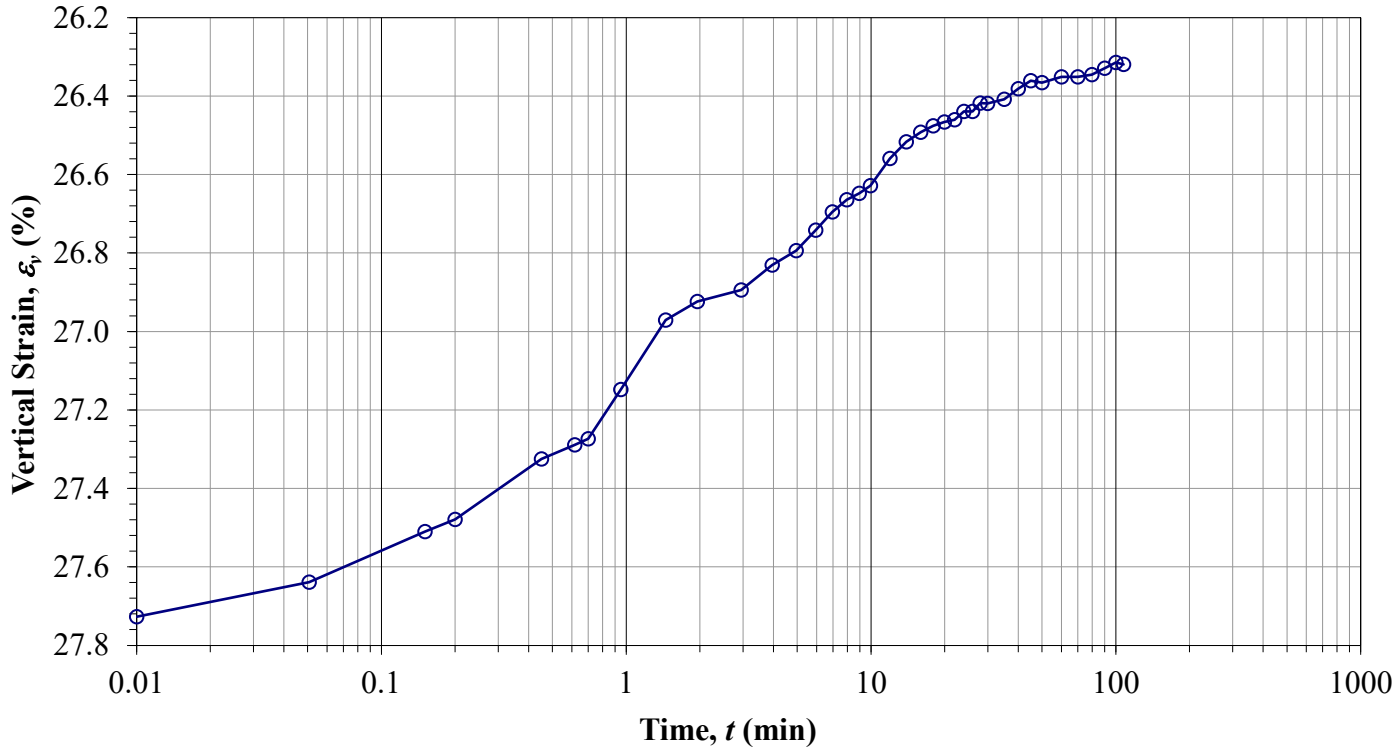
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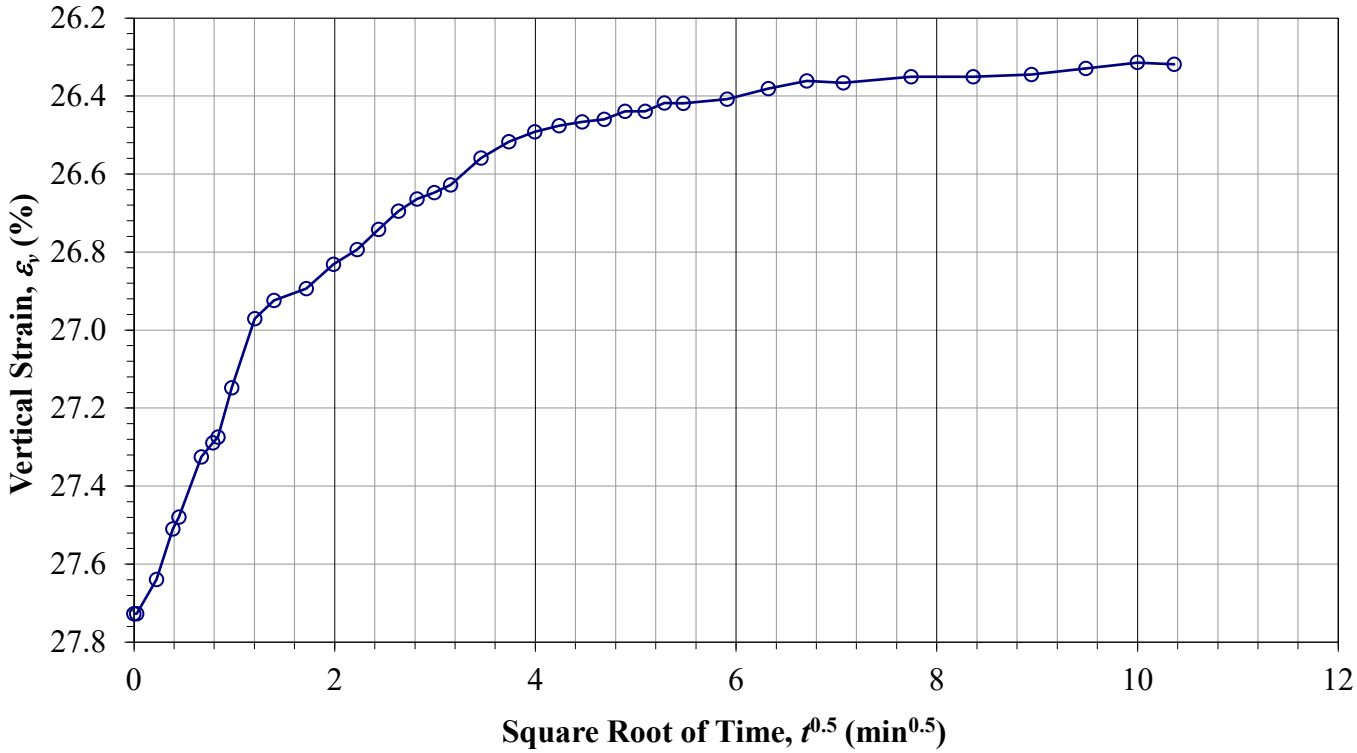
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 13 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

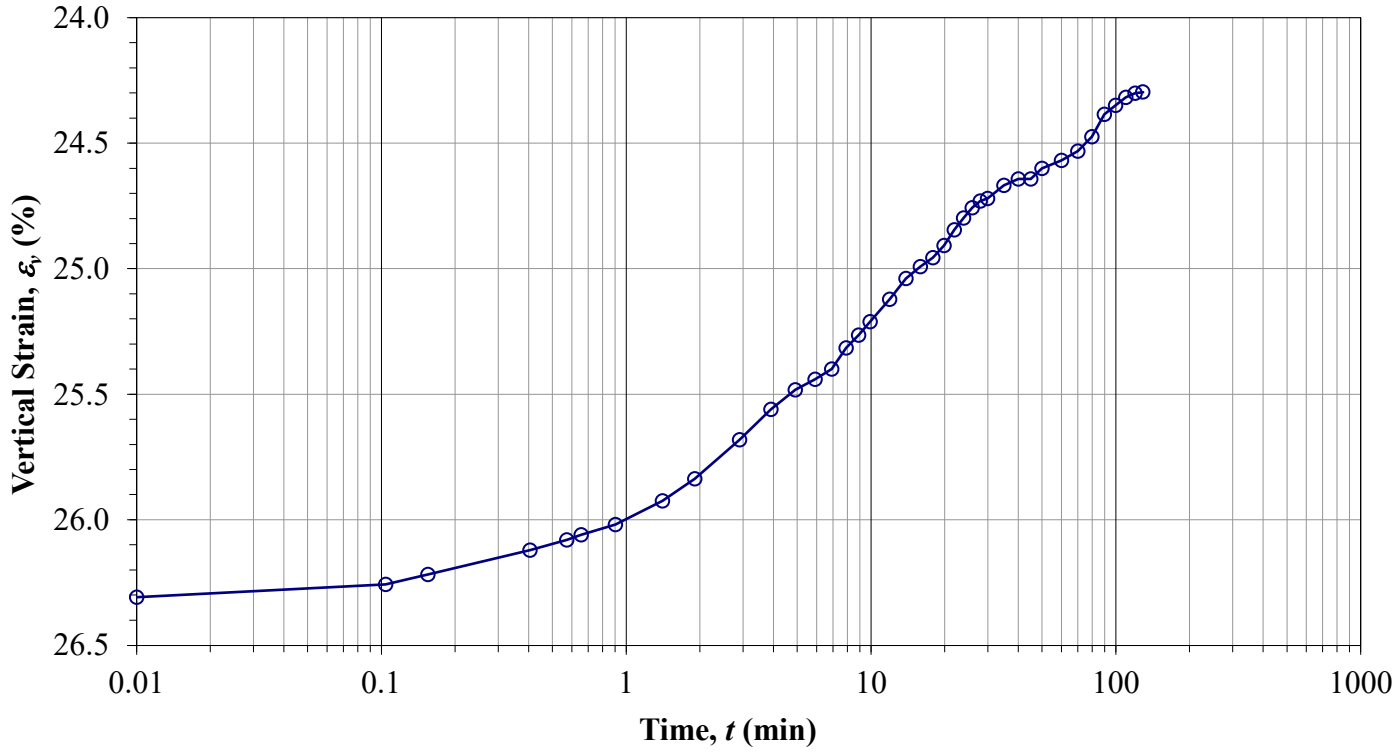
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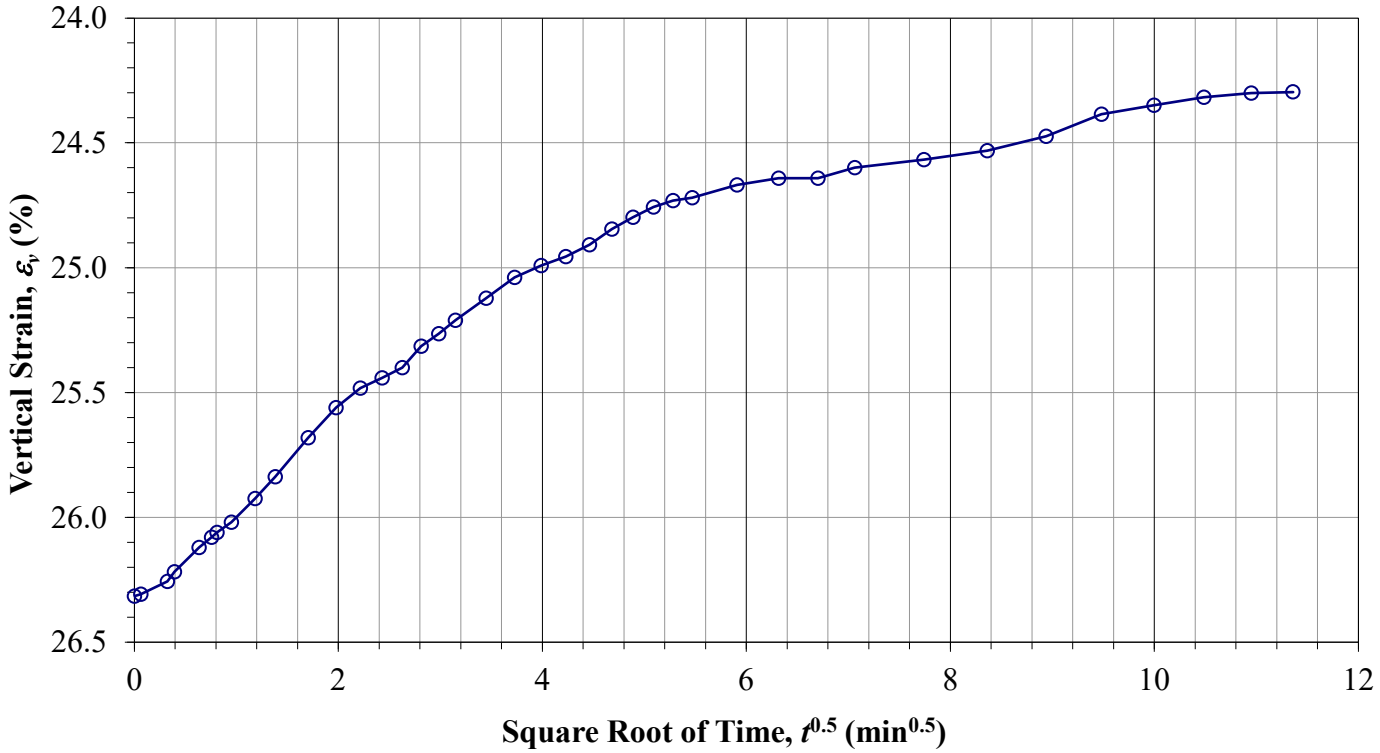
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-06
Sample: 7
Depth: 28'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: EH

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'
Sample Description: Brown clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

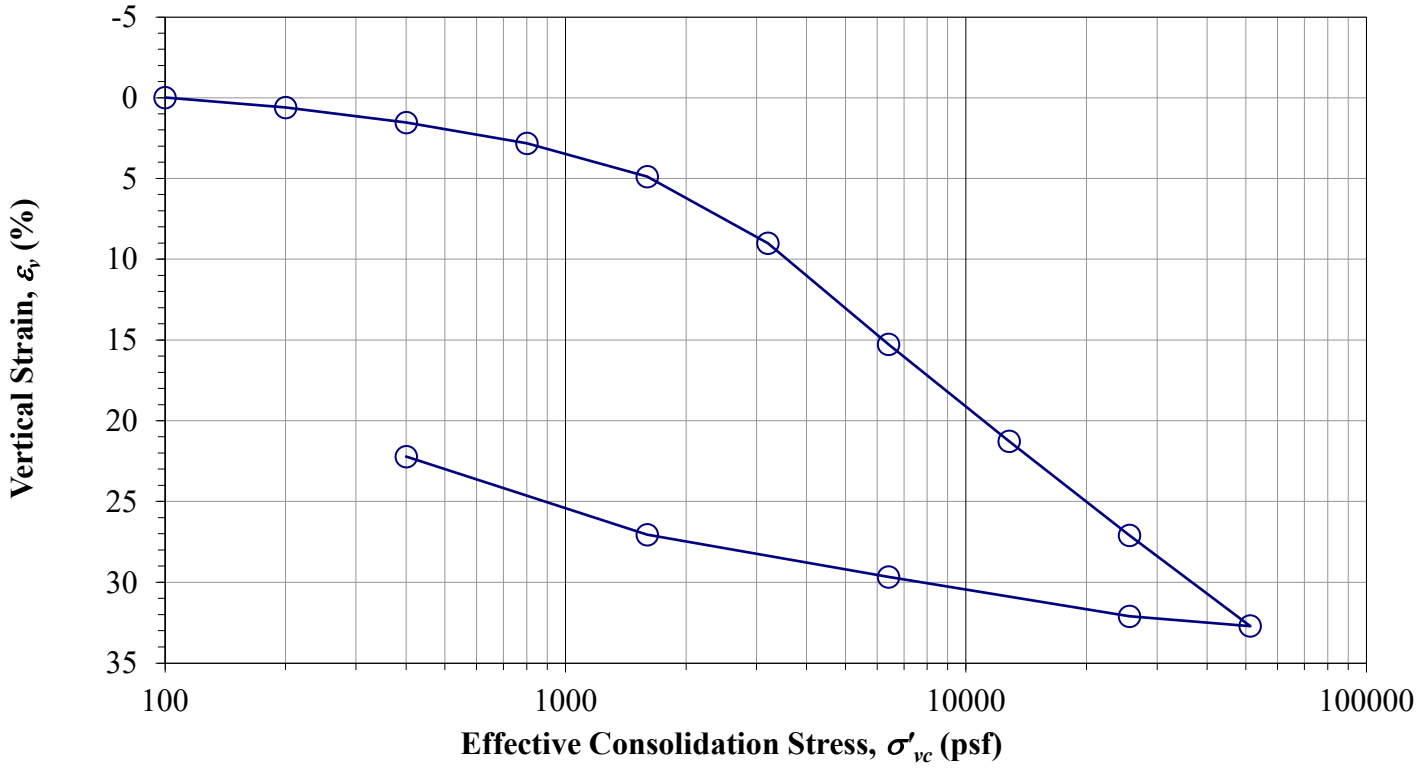
Test method:	B	
Inundation stress (psf), timing:	100	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.907	0.706
Sample diameter, D (in.)	2.420	2.420
Wt. rings + wet soil (g)	161.78	152.63
Wt. rings/tare (g)	44.10	44.10
Total unit wt., γ (pcf)	107.5	127.41
Wet soil + tare (g)	347.04	225.47
Dry soil + tare (g)	277.76	199.25
Tare (g)	122.67	120.80
Water content, ω (%)	44.7	33.4
Dry unit wt., γ_d (pcf)	74.3	95.5
Saturation, S	0.95	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9070	1.2692
100	-0.0001	-0.01	0.9071	1.2695
200	0.0054	0.60	0.9016	1.2556
400	0.0140	1.54	0.8930	1.2342
800	0.0257	2.83	0.8813	1.2050
1600	0.0443	4.89	0.8627	1.1583
3200	0.0817	9.01	0.8253	1.0647
6400	0.1384	15.26	0.7686	0.9229
12800	0.1929	21.27	0.7141	0.7865
25600	0.2457	27.09	0.6613	0.6545
51200	0.2967	32.71	0.6104	0.5270
25600	0.2912	32.10	0.6158	0.5407
6400	0.2691	29.67	0.6379	0.5958
1600	0.2453	27.05	0.6617	0.6554
400	0.2015	22.21	0.7055	0.7651



Comments: Test specimen swelled upon inundation and at 100 psf load step.

Entered: _____
Reviewed: _____

One-Dimensional Consolidation Properties of Soils

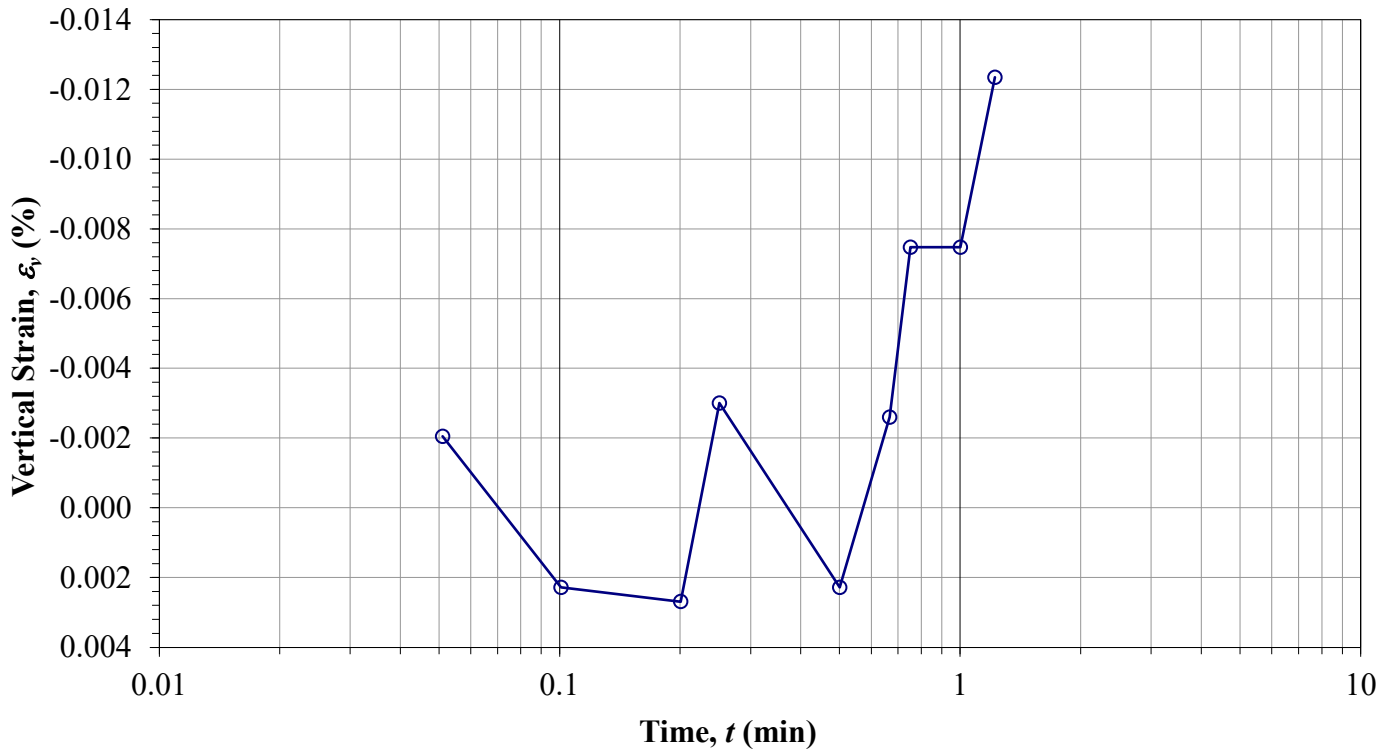
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 1 of 14
Stress: 100 psf





One-Dimensional Consolidation Properties of Soils

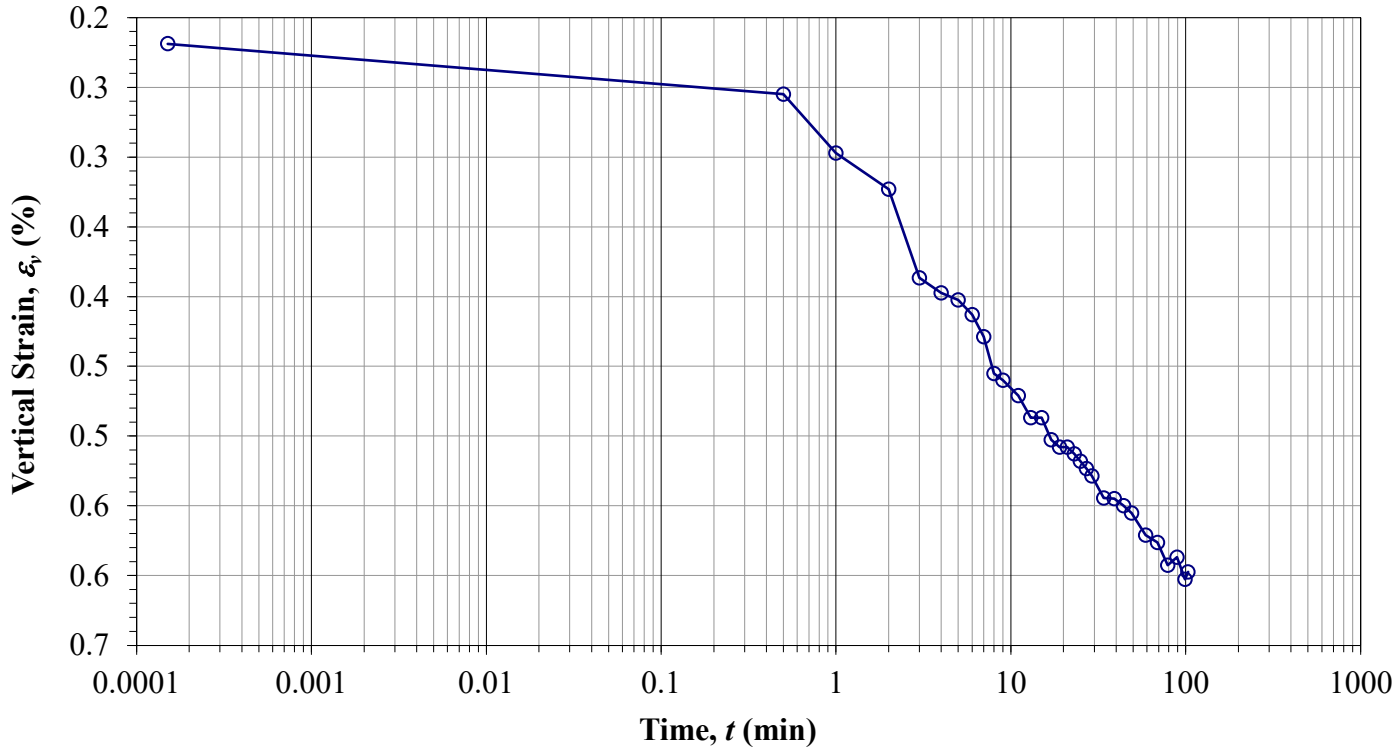
(ASTM D2435)

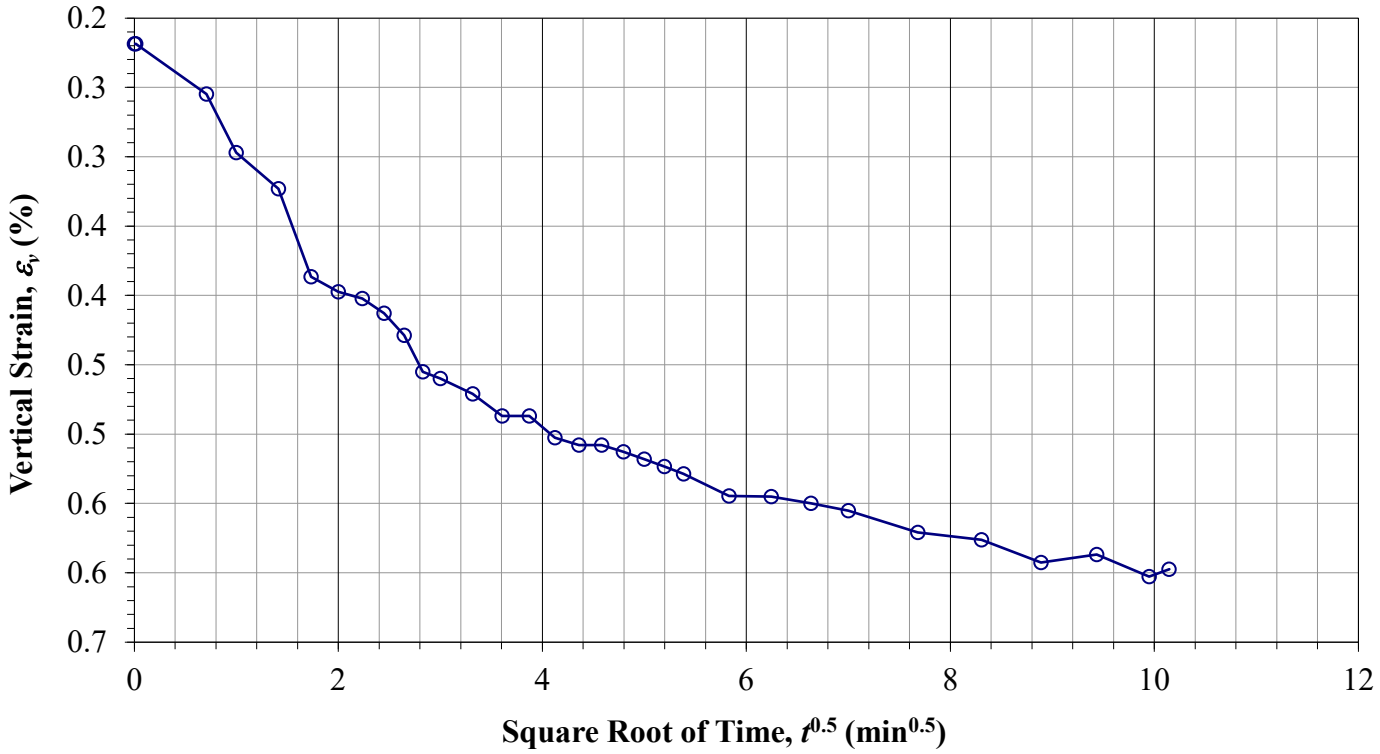
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

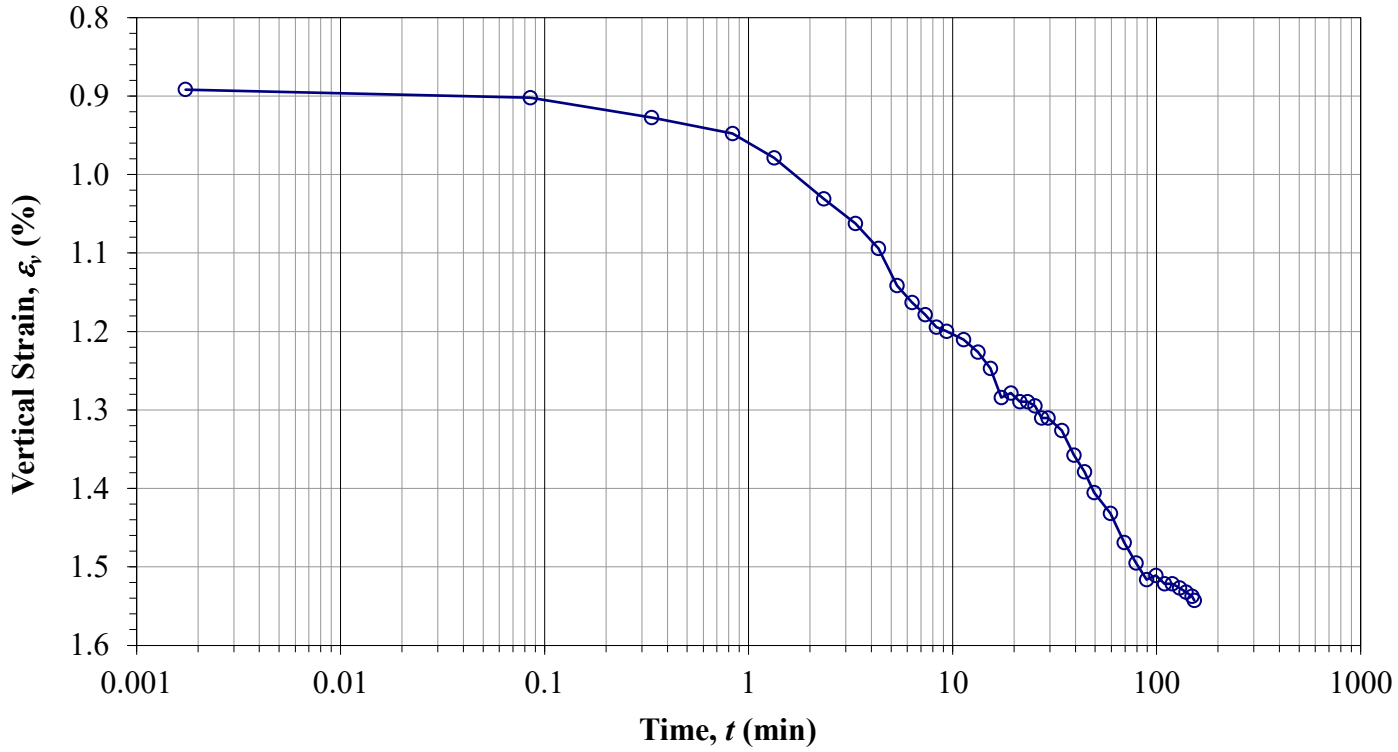
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 3 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

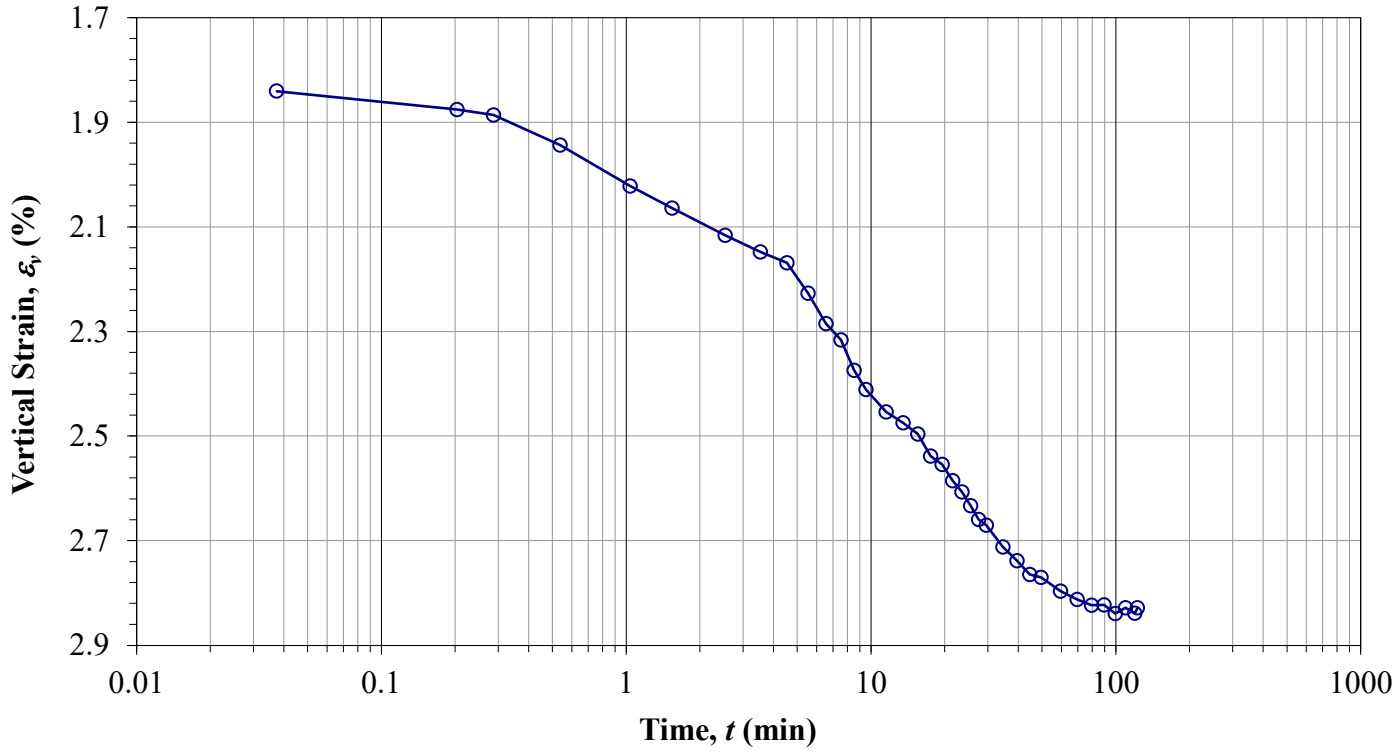
(ASTM D2435)

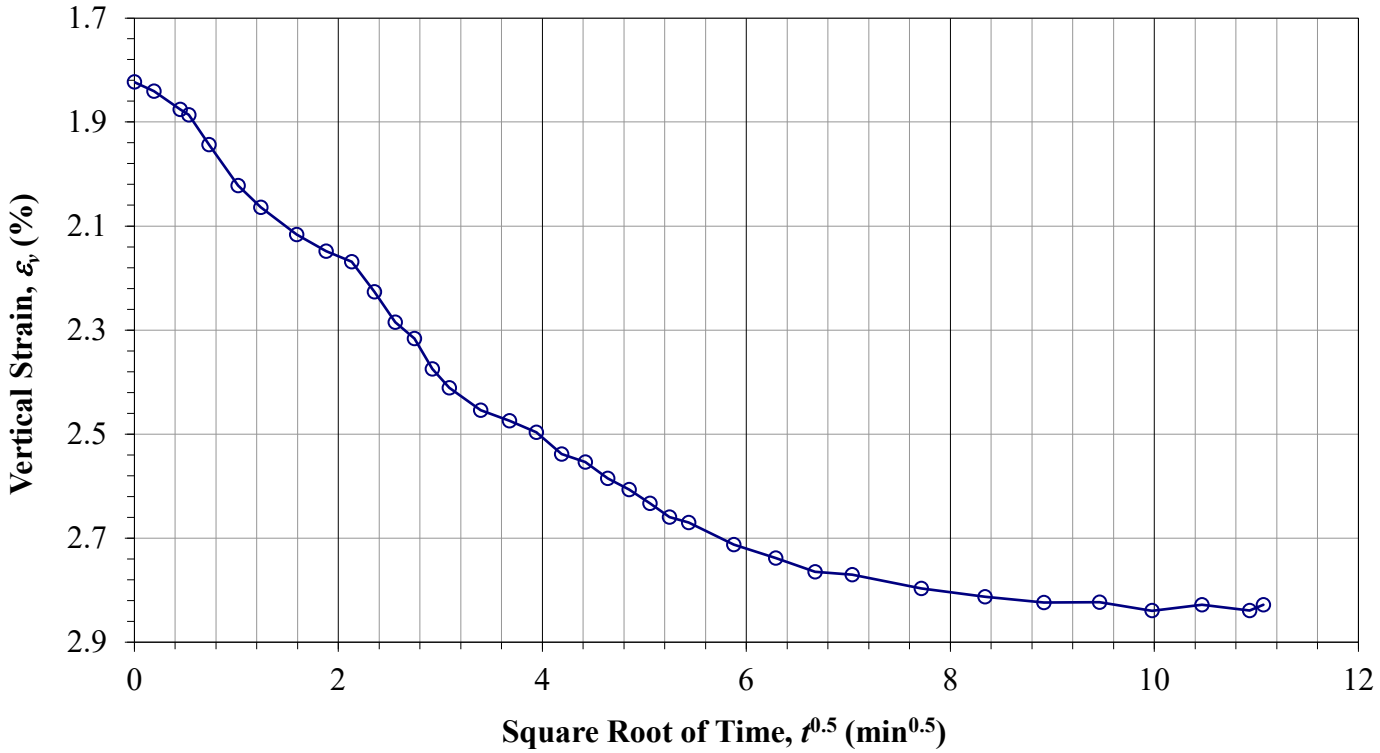
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

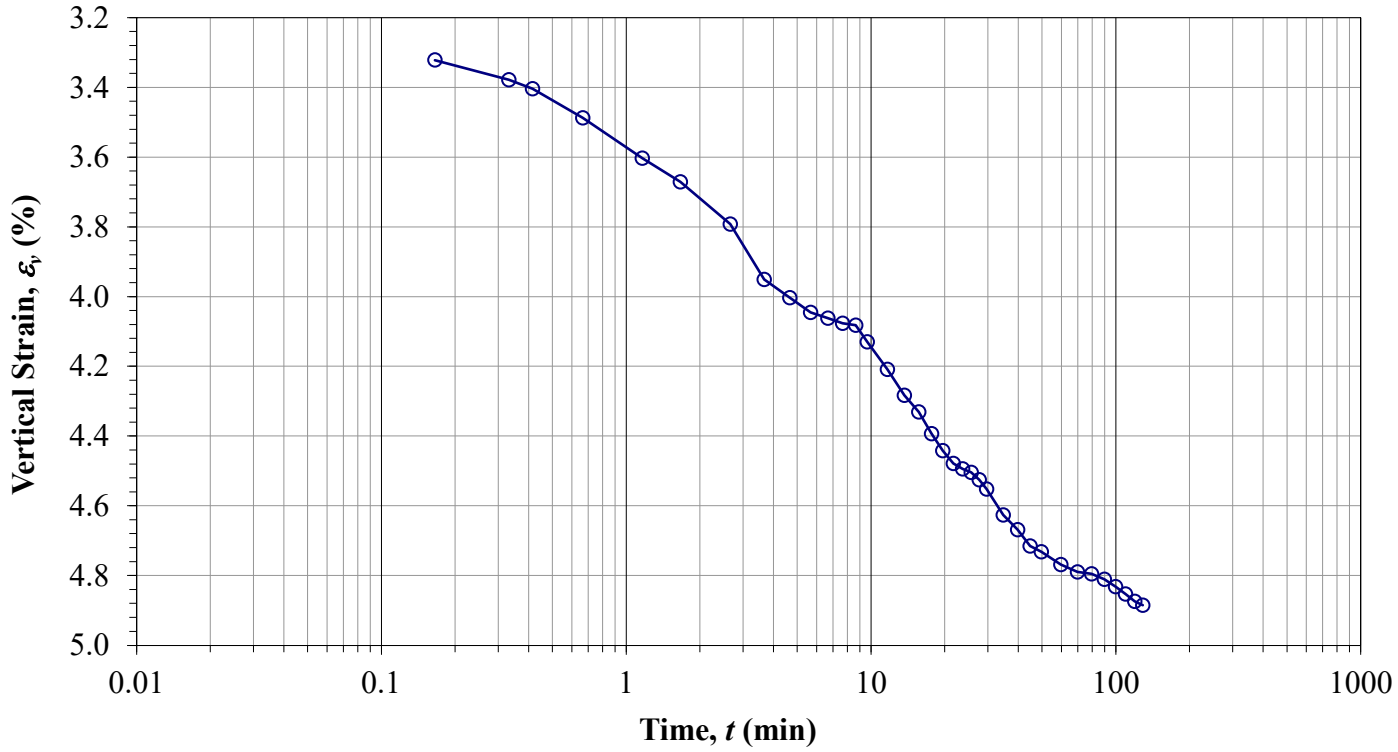
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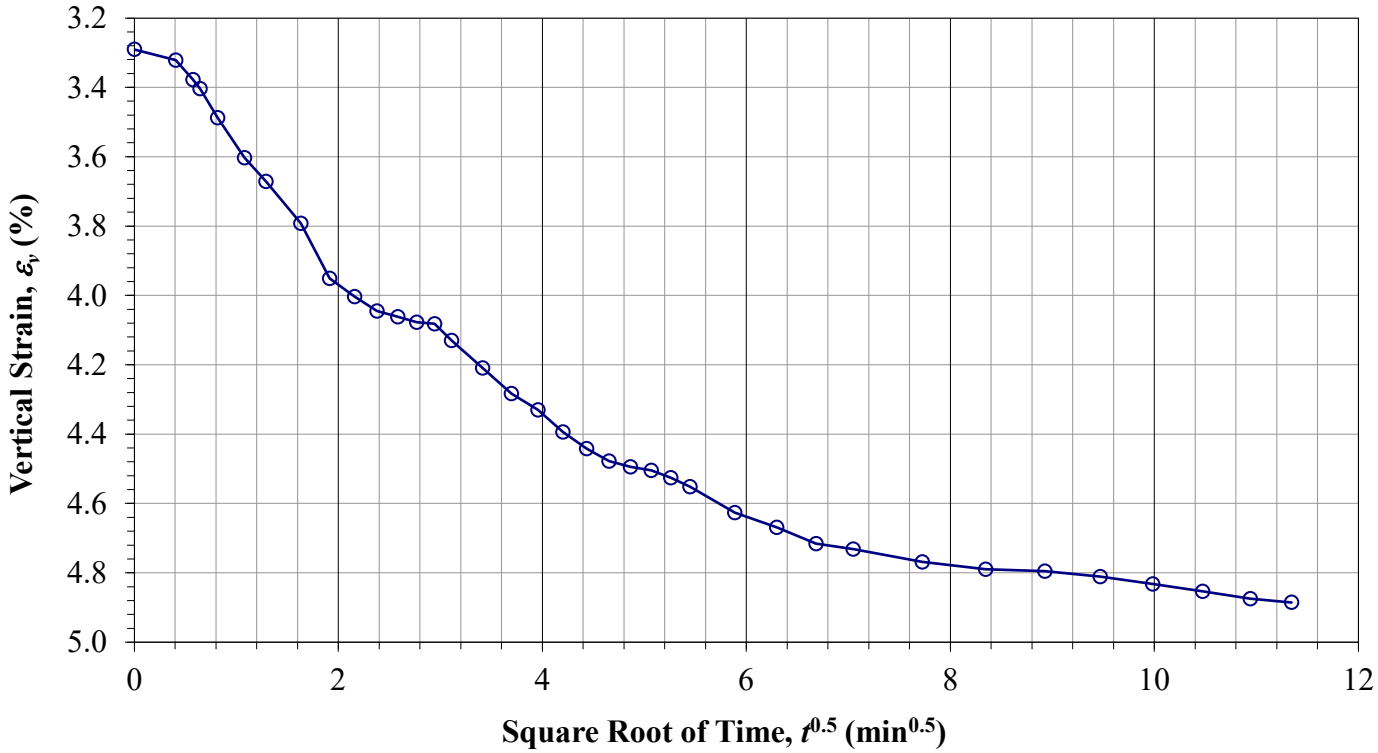
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 5 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

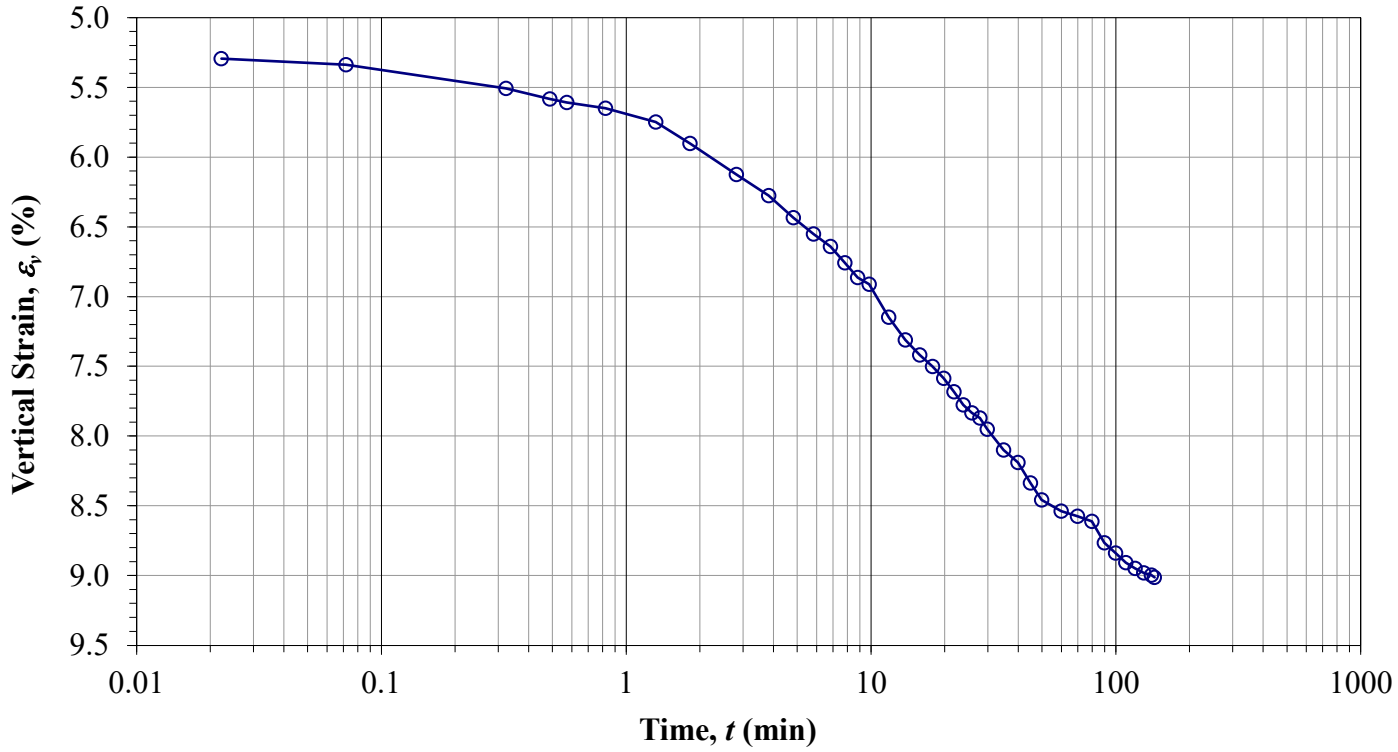
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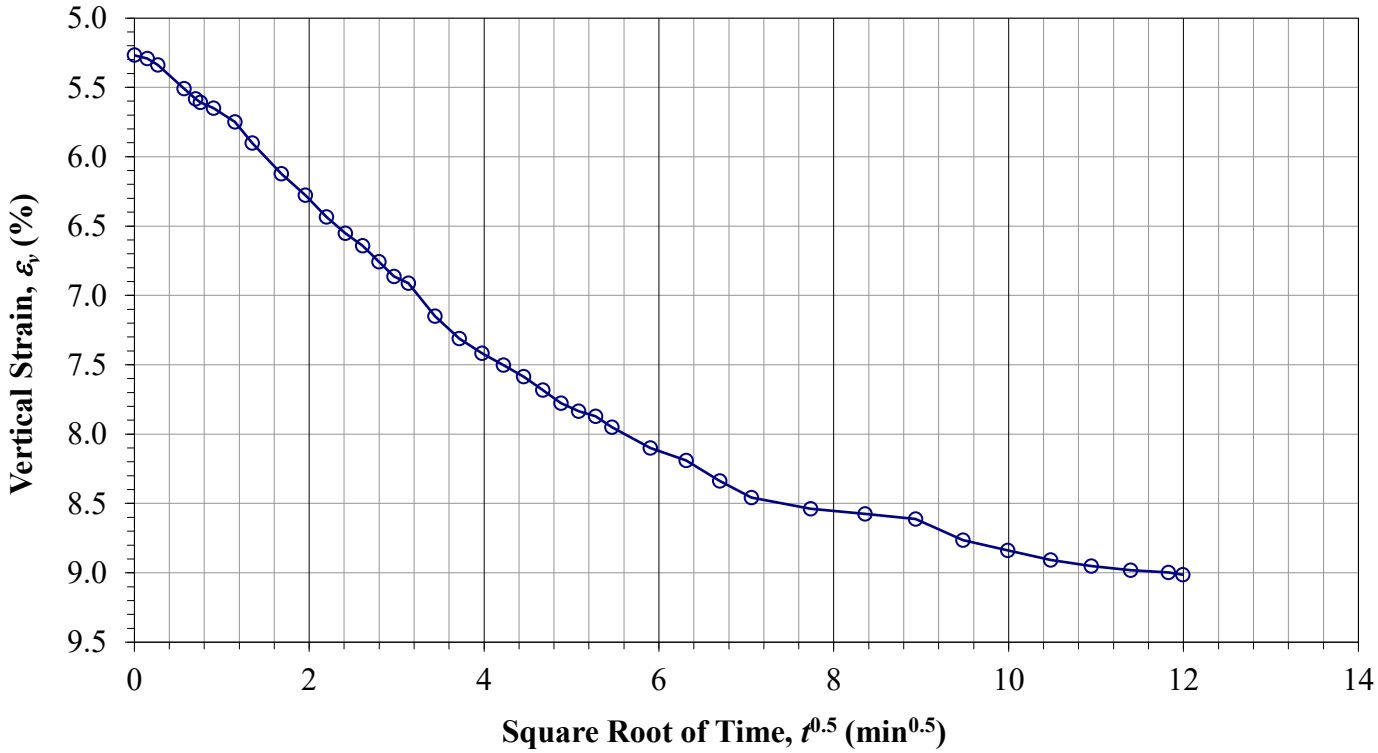
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 6 of 14
Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

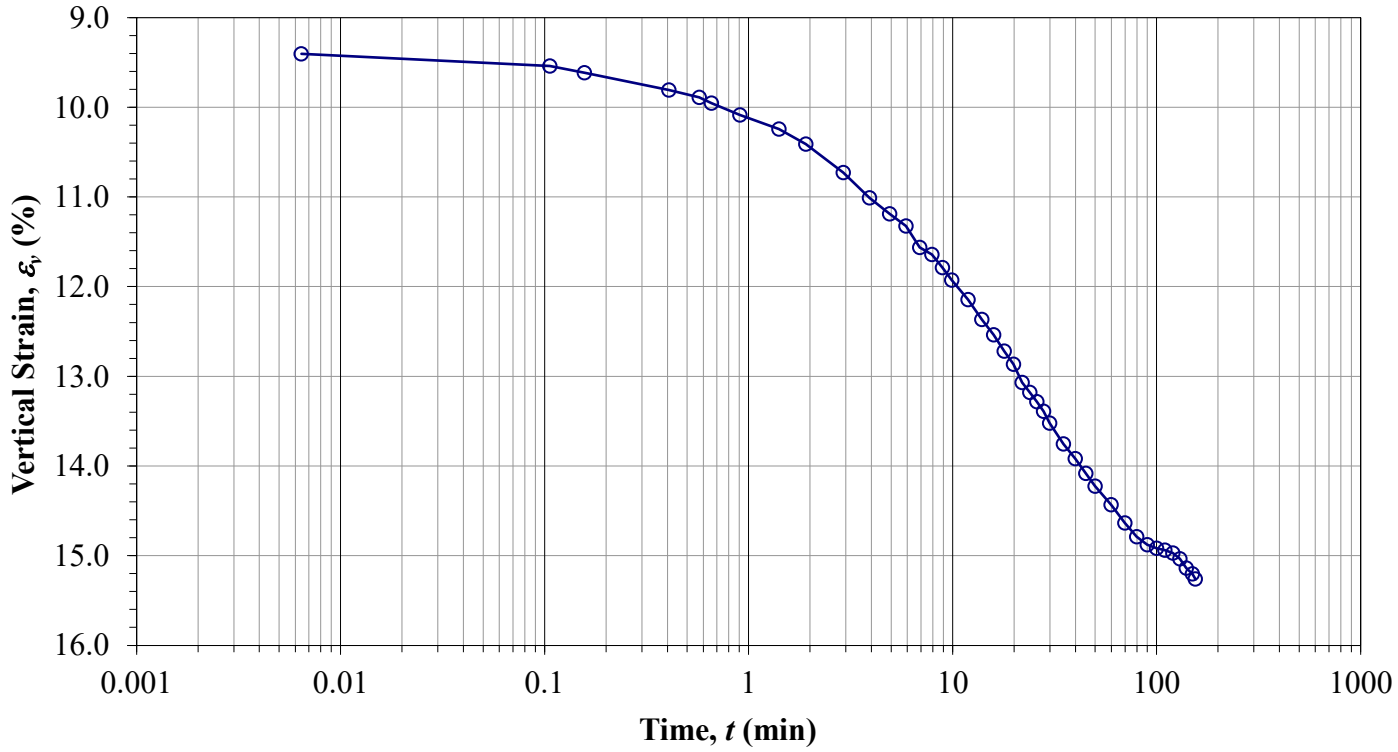
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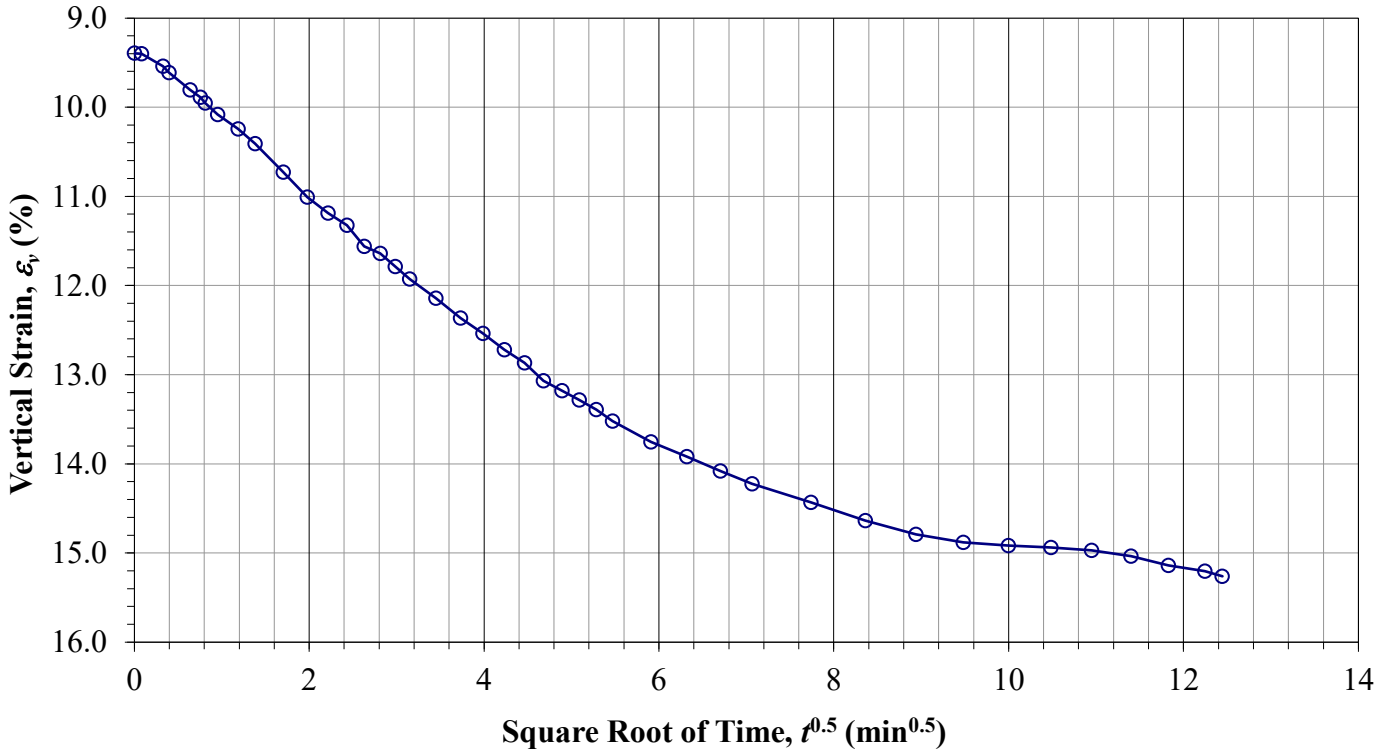
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 7 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

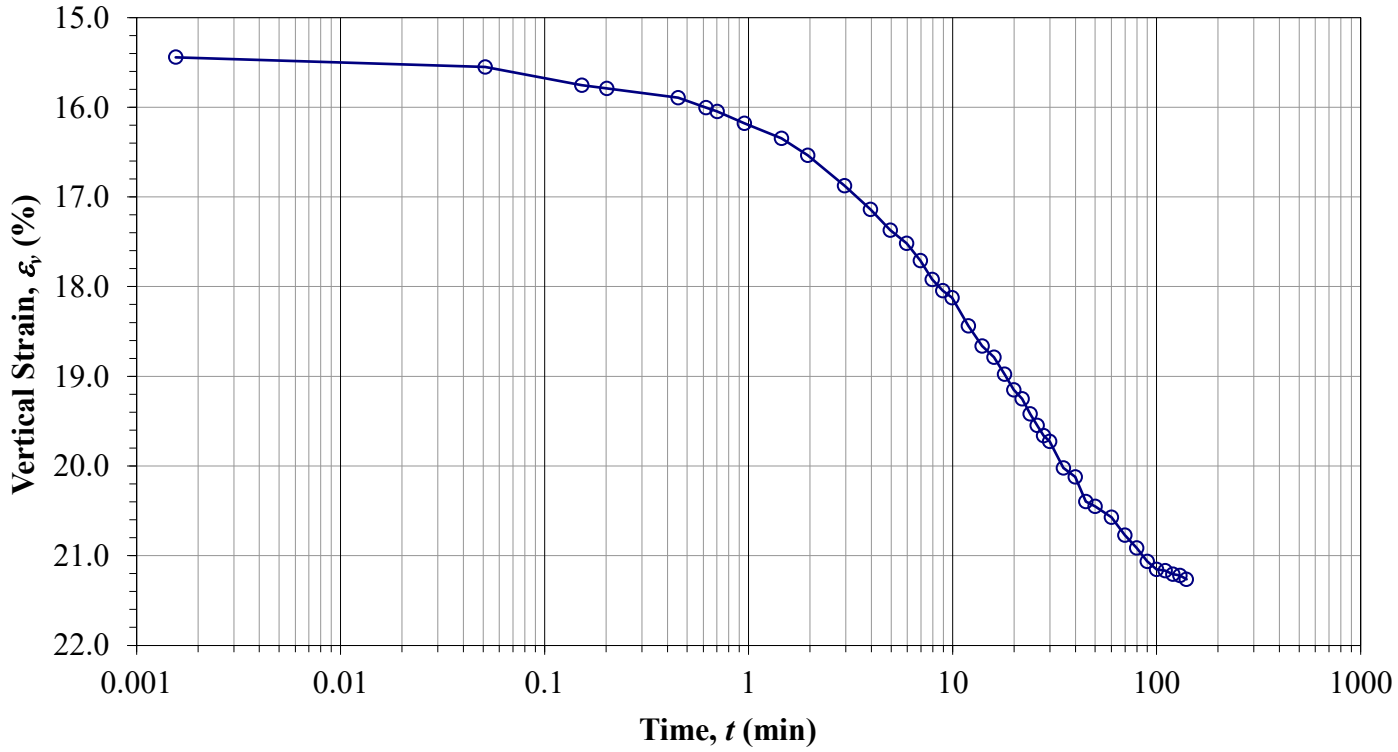
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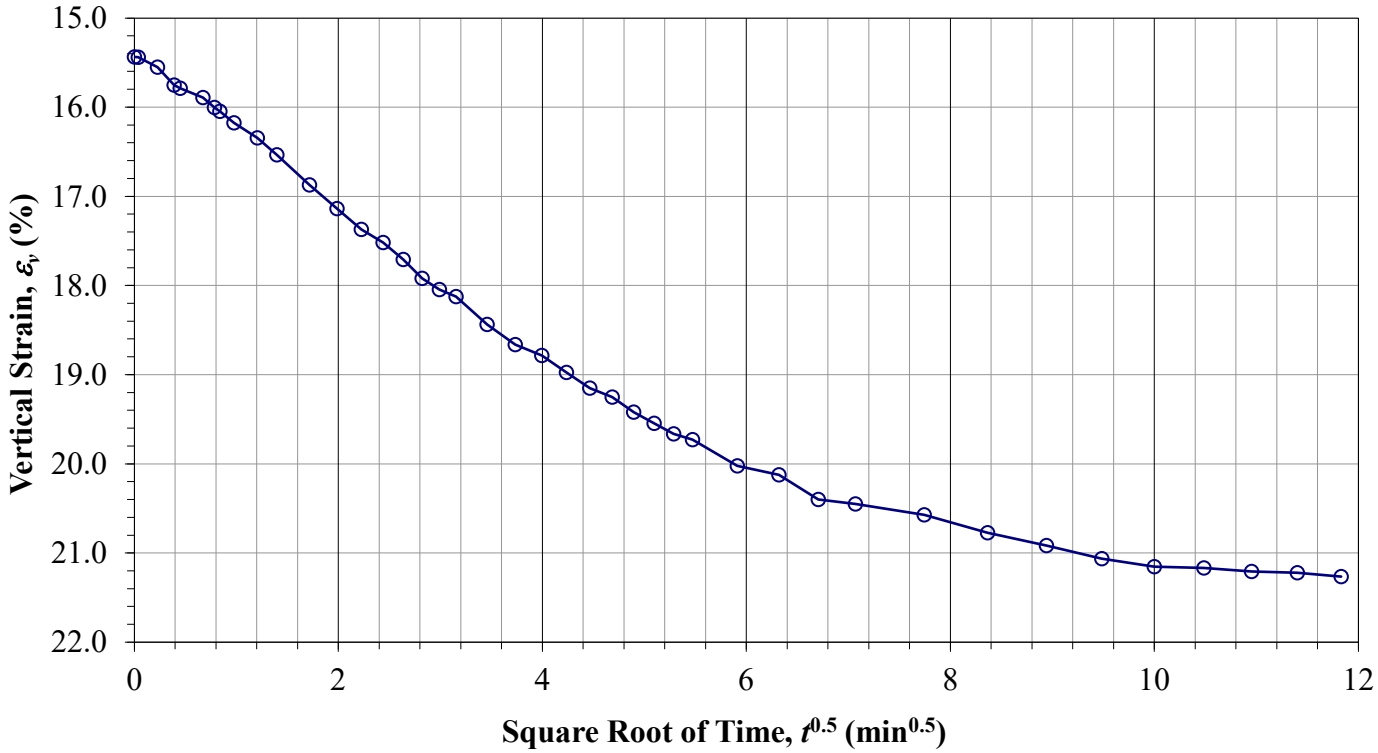
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 8 of 14
Stress: 12800 psf





One-Dimensional Consolidation Properties of Soils

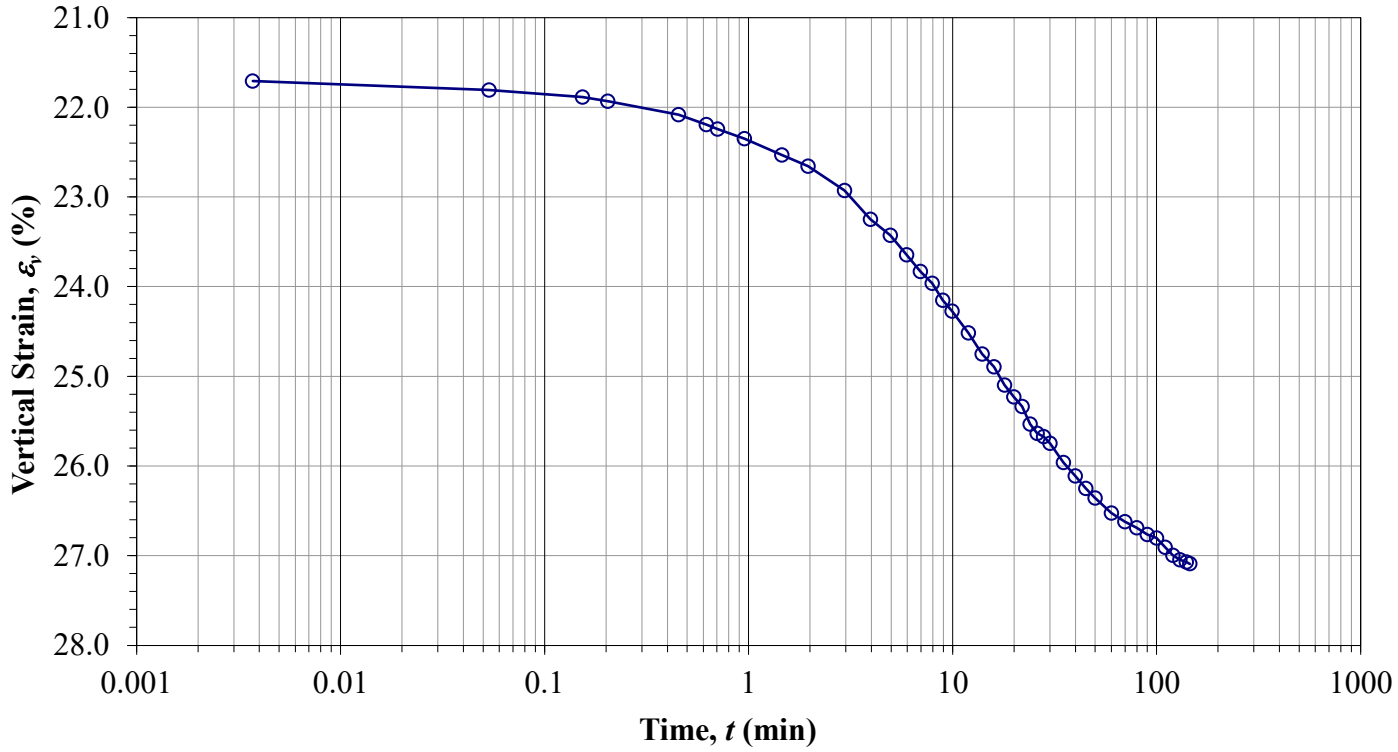
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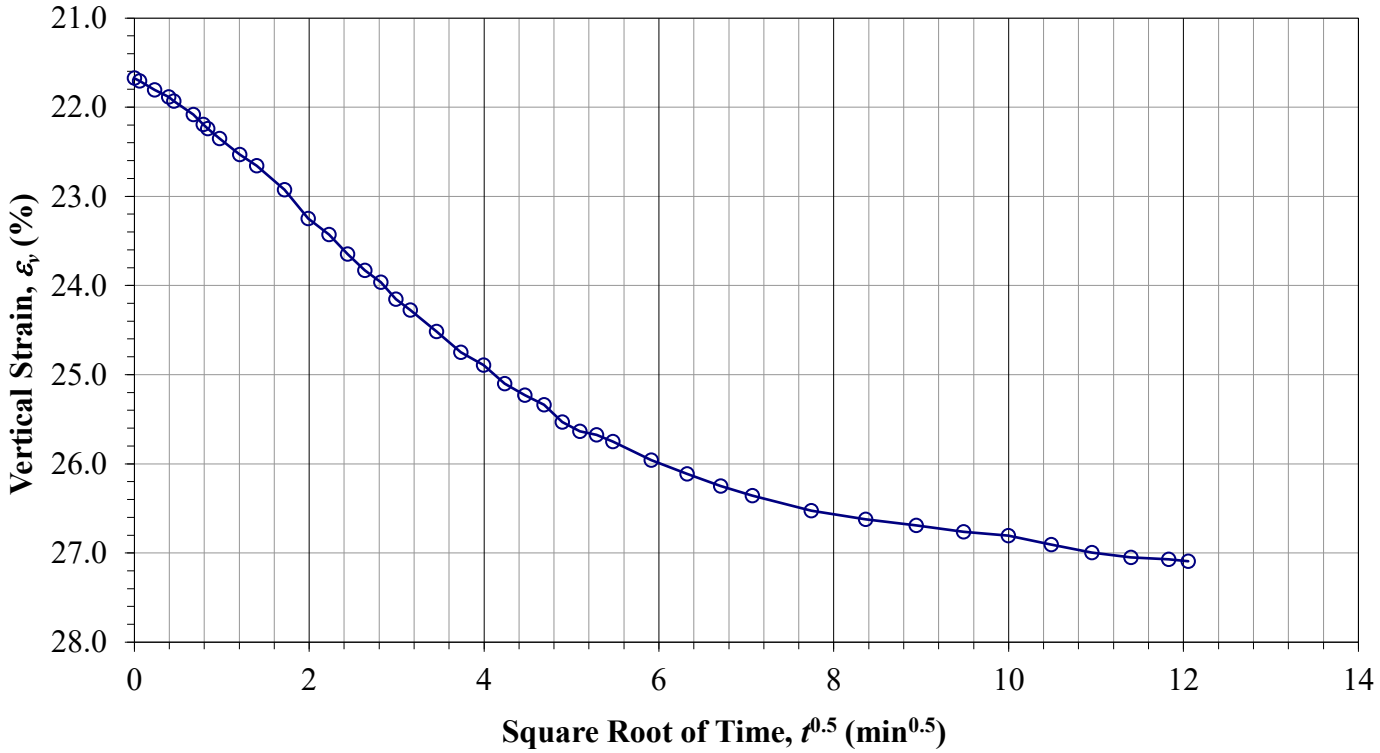
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 9 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

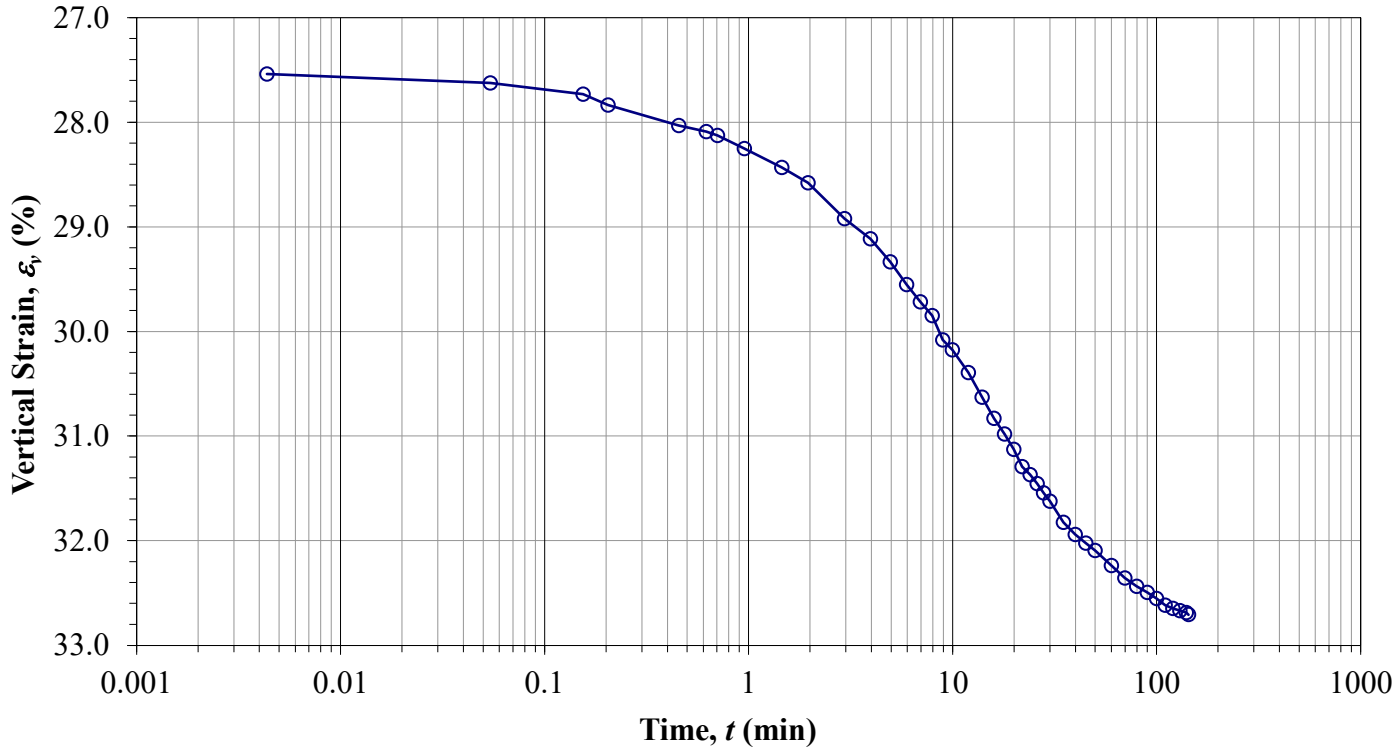
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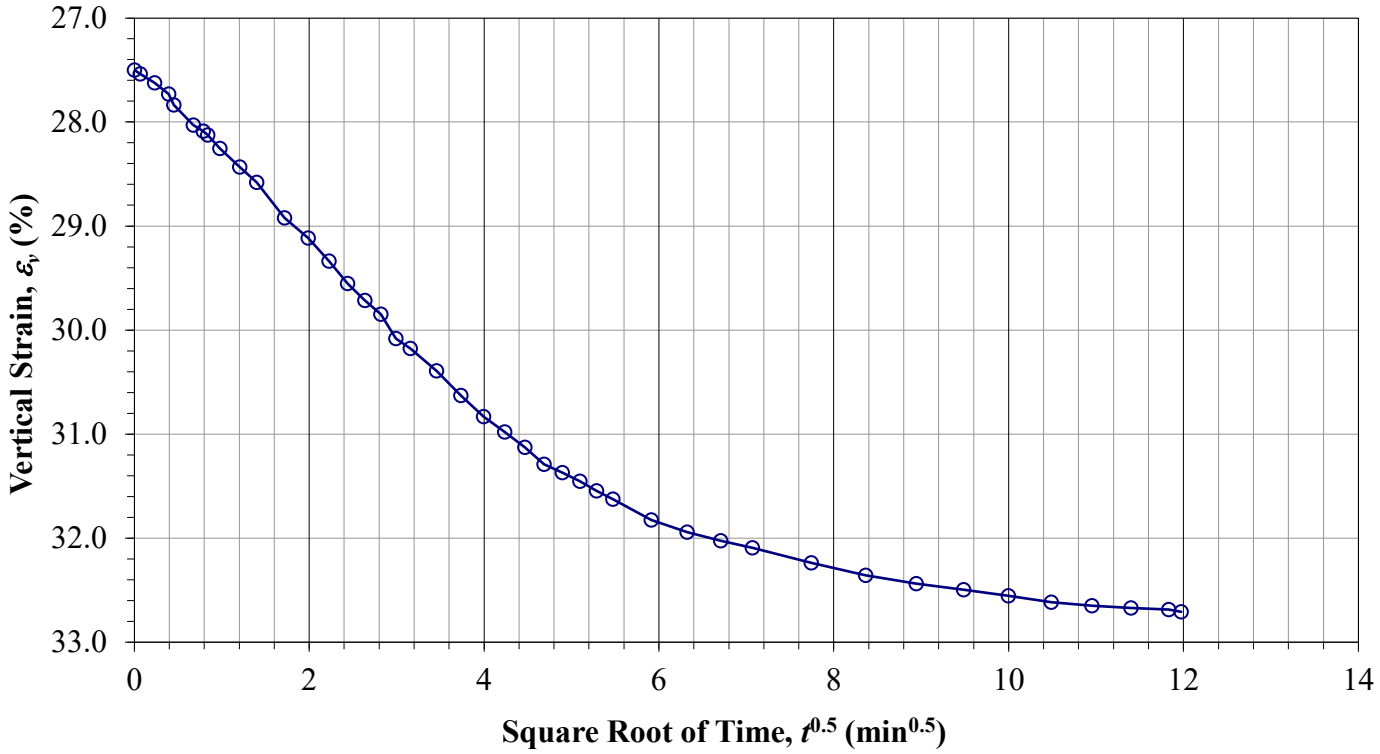
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 10 of 14
Stress: 51200 psf





One-Dimensional Consolidation Properties of Soils

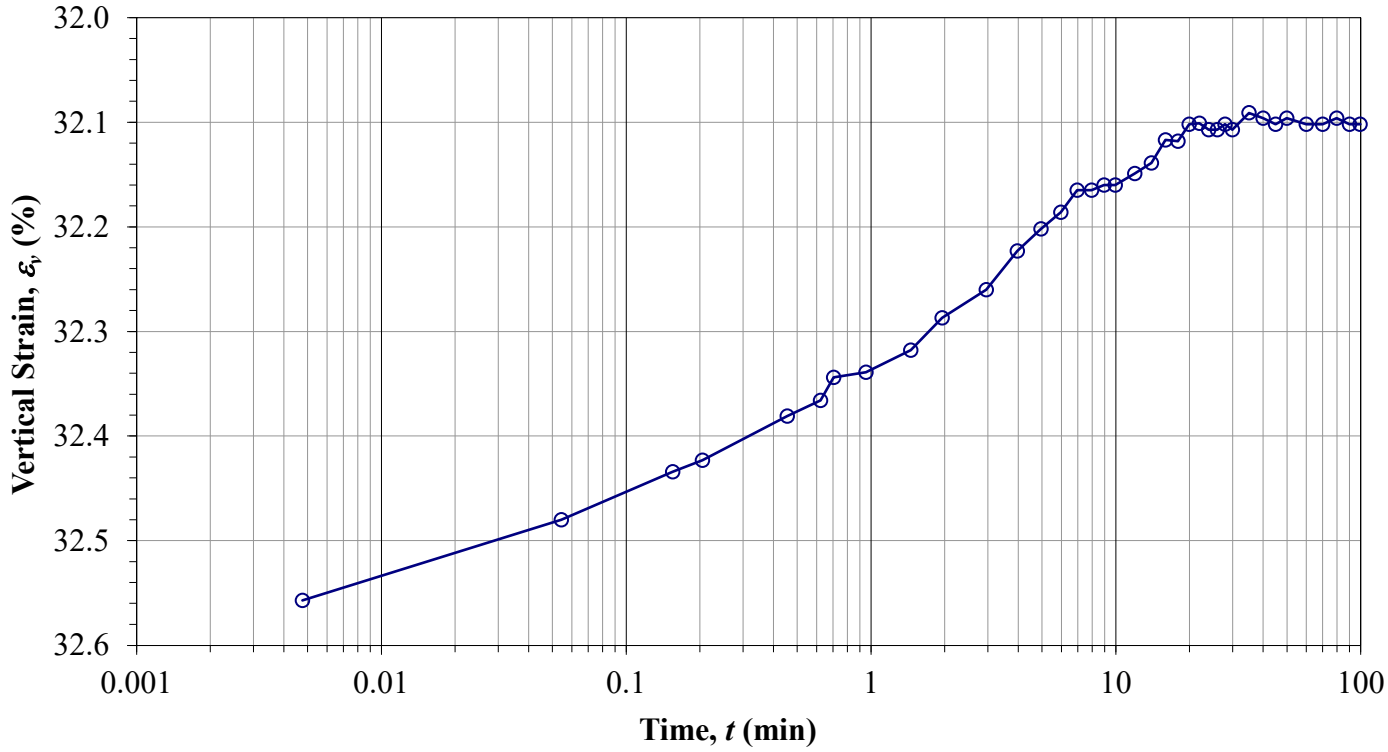
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 11 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

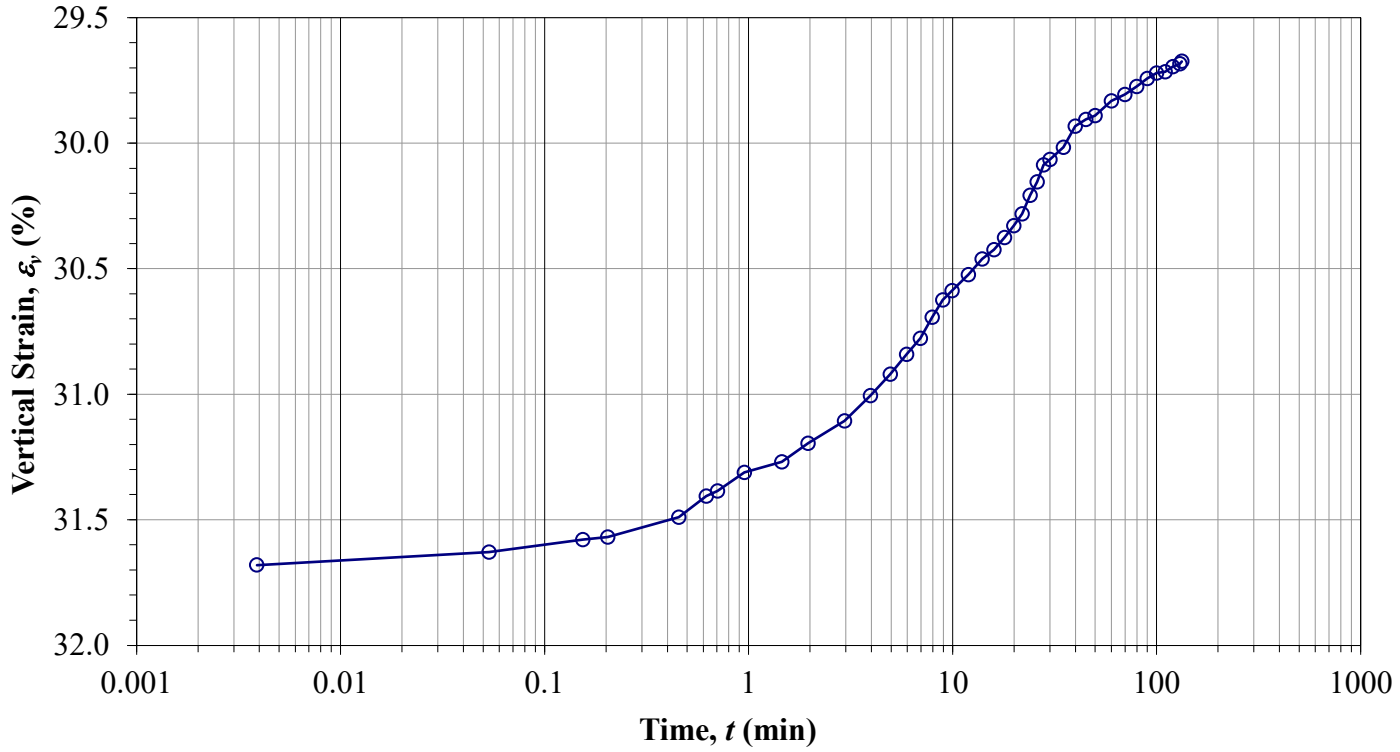
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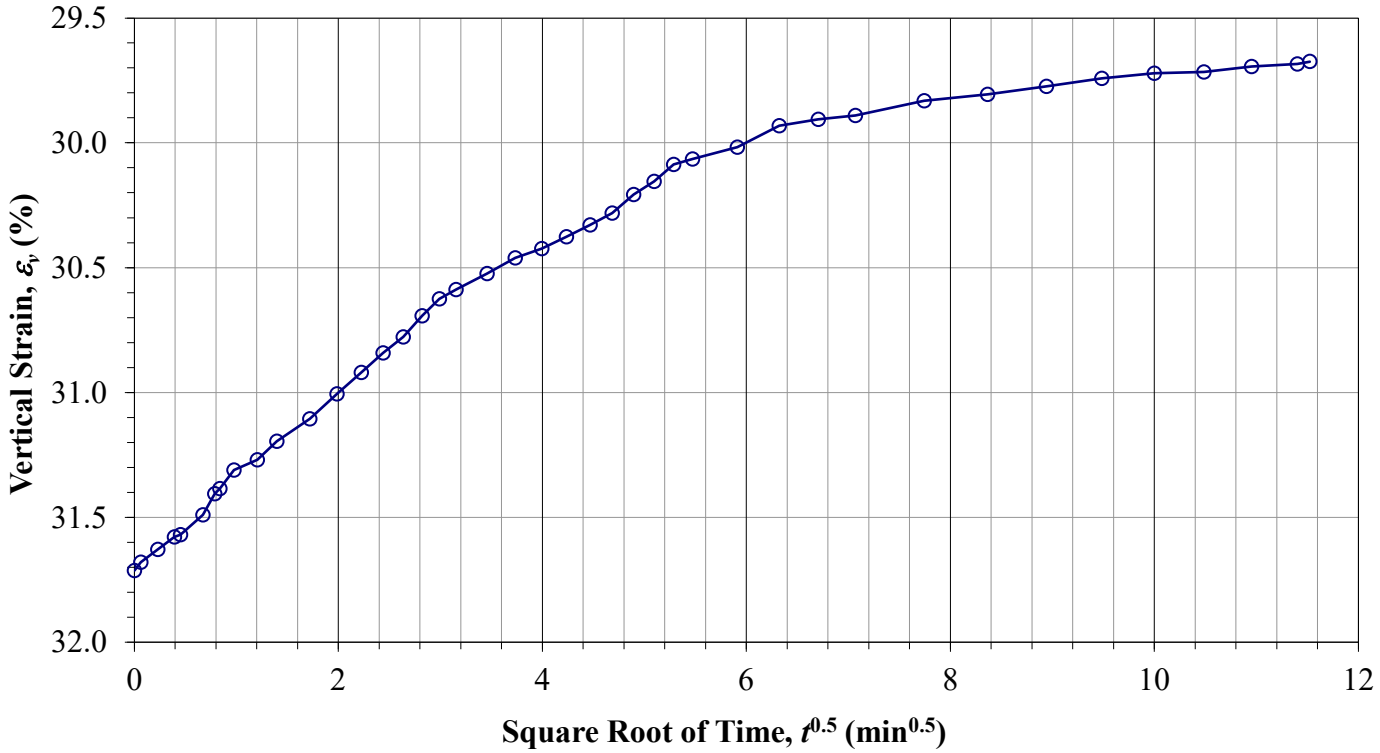
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 12 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

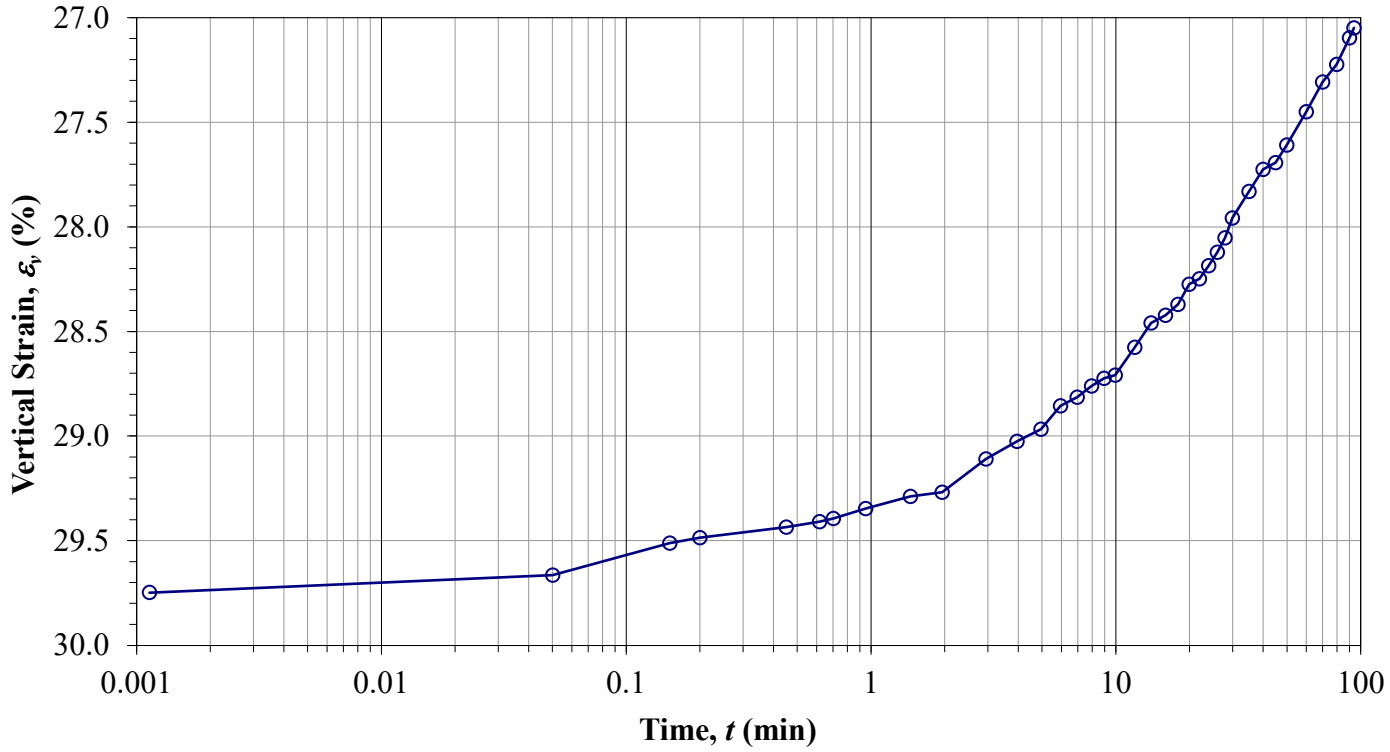
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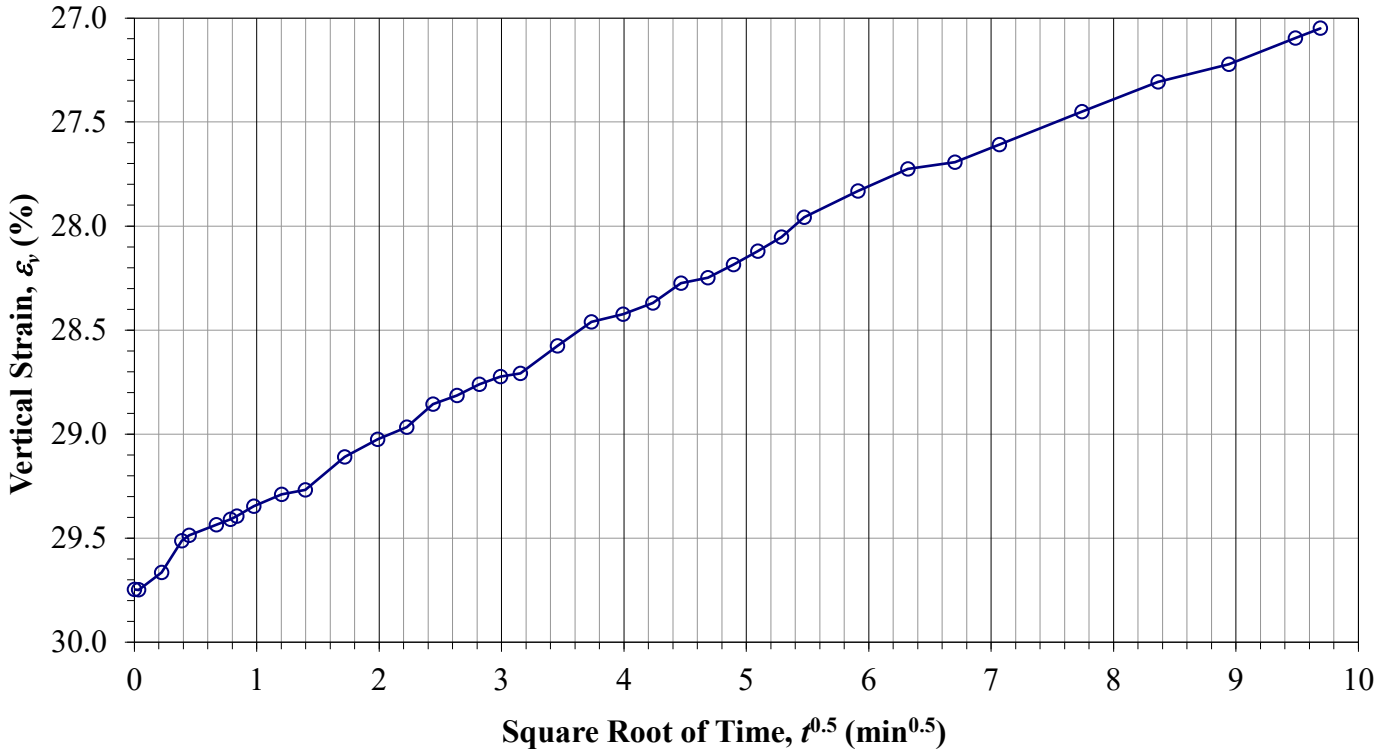
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 13 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

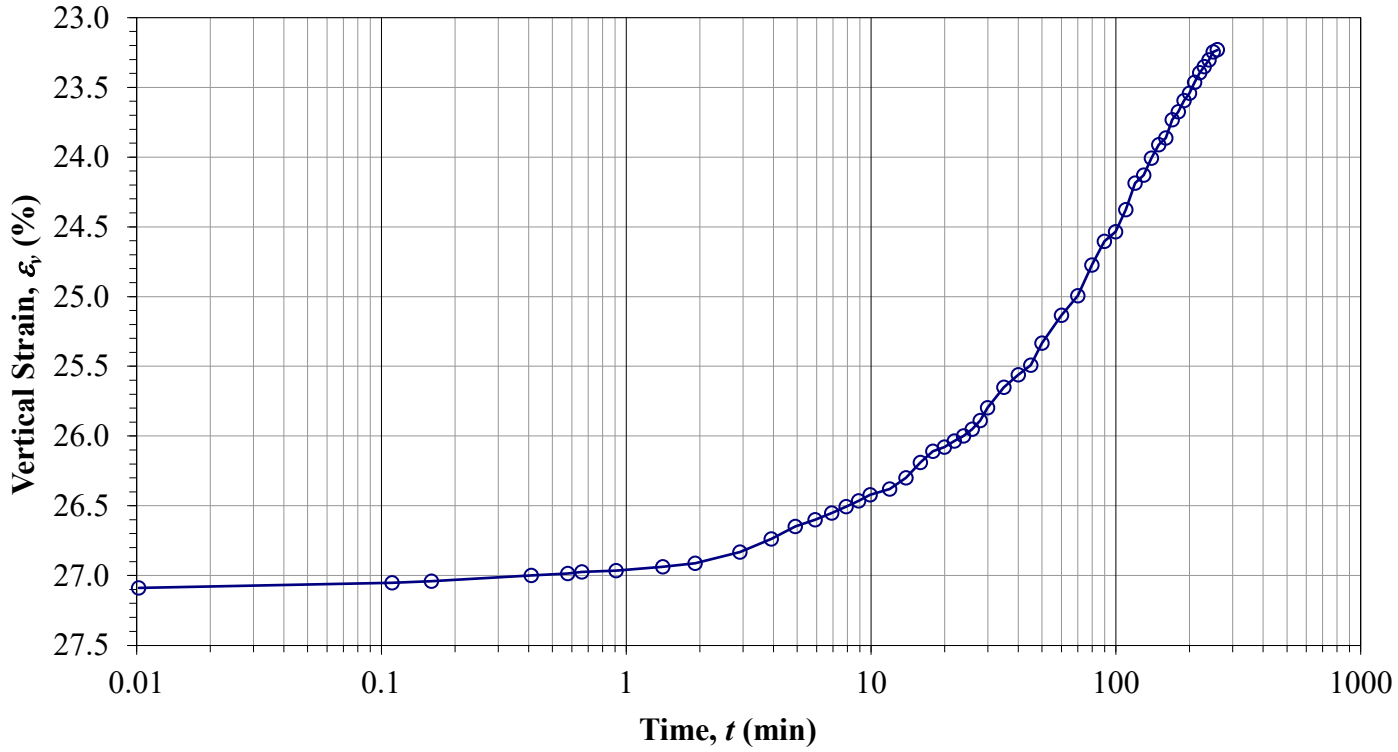
(ASTM D2435)

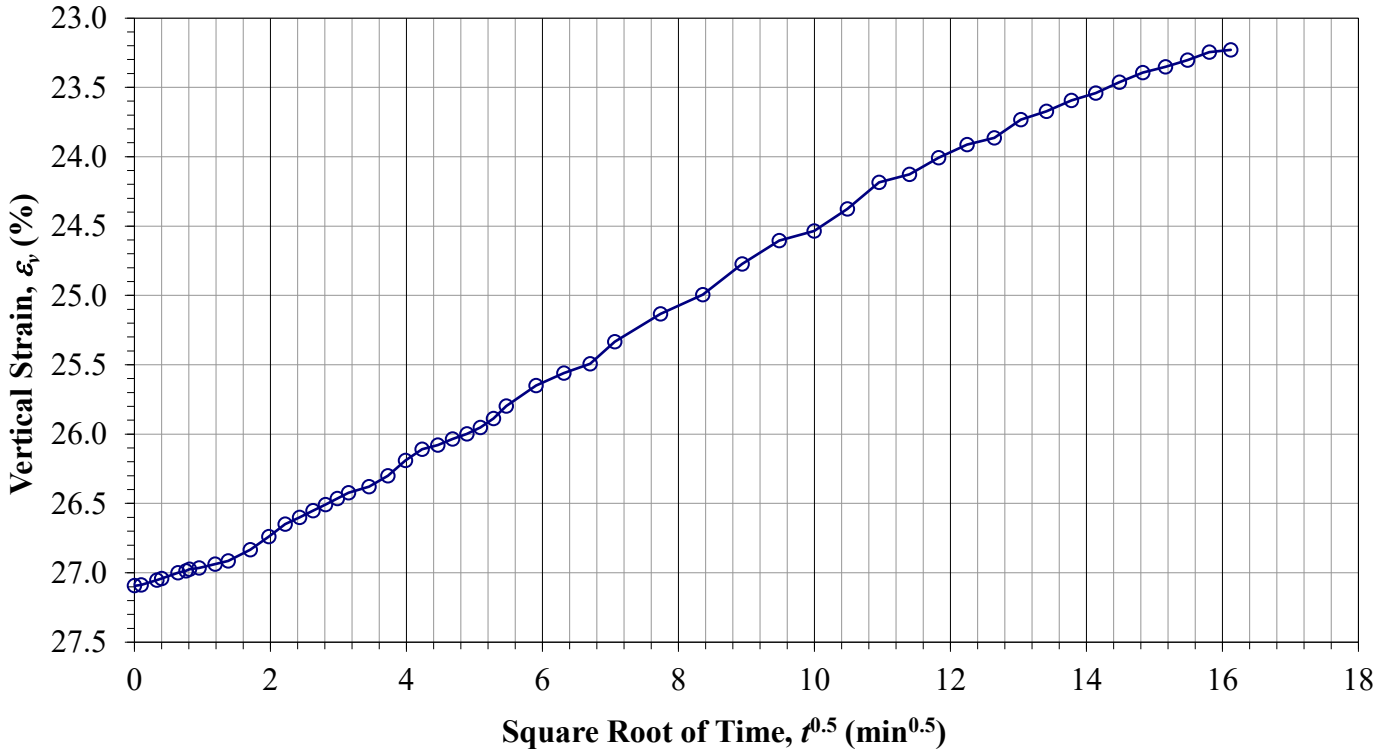
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 2
Depth: 10'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/13/2021
By: EH

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'
Sample Description: Dark grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

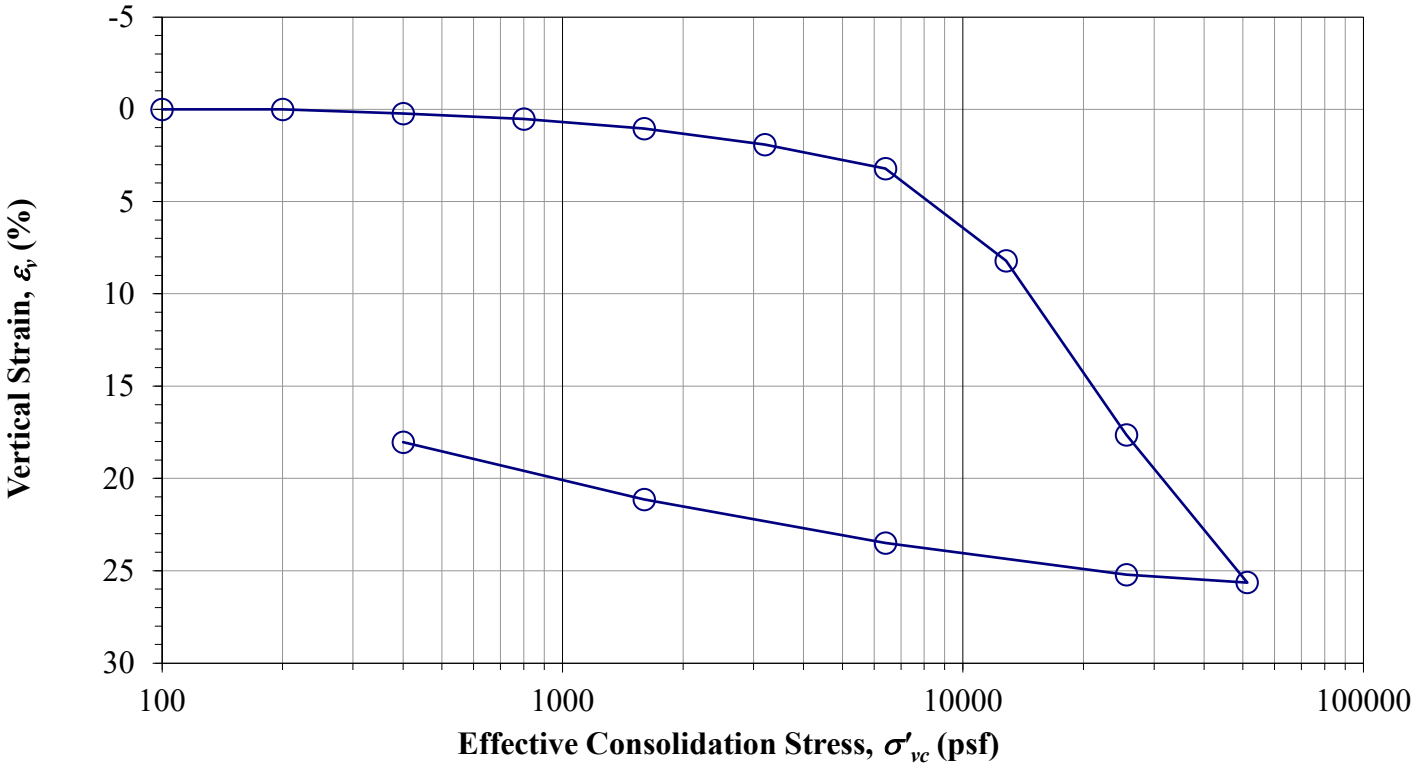
Test method:	B	
Inundation stress (psf), timing:	100	Beginning
Specific gravity, G_s	2.75	Assumed

Water type used for inundation Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.917	0.752
Sample diameter, D (in.)	2.414	2.414
Wt. rings + wet soil (g)	167.49	158.49
Wt. rings/tare (g)	43.38	43.38
Total unit wt., γ (pcf)	112.7	127.48
Wet soil + tare (g)	329.05	231.10
Dry soil + tare (g)	267.91	204.27
Tare (g)	124.68	121.31
Water content, ω (%)	42.7	32.3
Dry unit wt., γ_d (pcf)	79.0	96.3
Saturation, S	1.00	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9170	1.1744
100	0.0000	0.00	0.9170	1.1744
200	0.0000	0.01	0.9170	1.1743
400	0.0022	0.24	0.9148	1.1692
800	0.0048	0.52	0.9122	1.1631
1600	0.0096	1.04	0.9074	1.1517
3200	0.0175	1.91	0.8995	1.1329
6400	0.0295	3.22	0.8875	1.1044
12800	0.0752	8.21	0.8418	0.9960
25600	0.1618	17.64	0.7552	0.7908
51200	0.2351	25.64	0.6819	0.6169
25600	0.2312	25.21	0.6858	0.6262
6400	0.2155	23.50	0.7015	0.6634
1600	0.1938	21.13	0.7232	0.7149
400	0.1654	18.04	0.7516	0.7822



Comments: Test specimen contains trace sand seams. Test specimen swelled upon inundation and at 100 and 200 psf load steps.

Entered: _____
Reviewed: _____

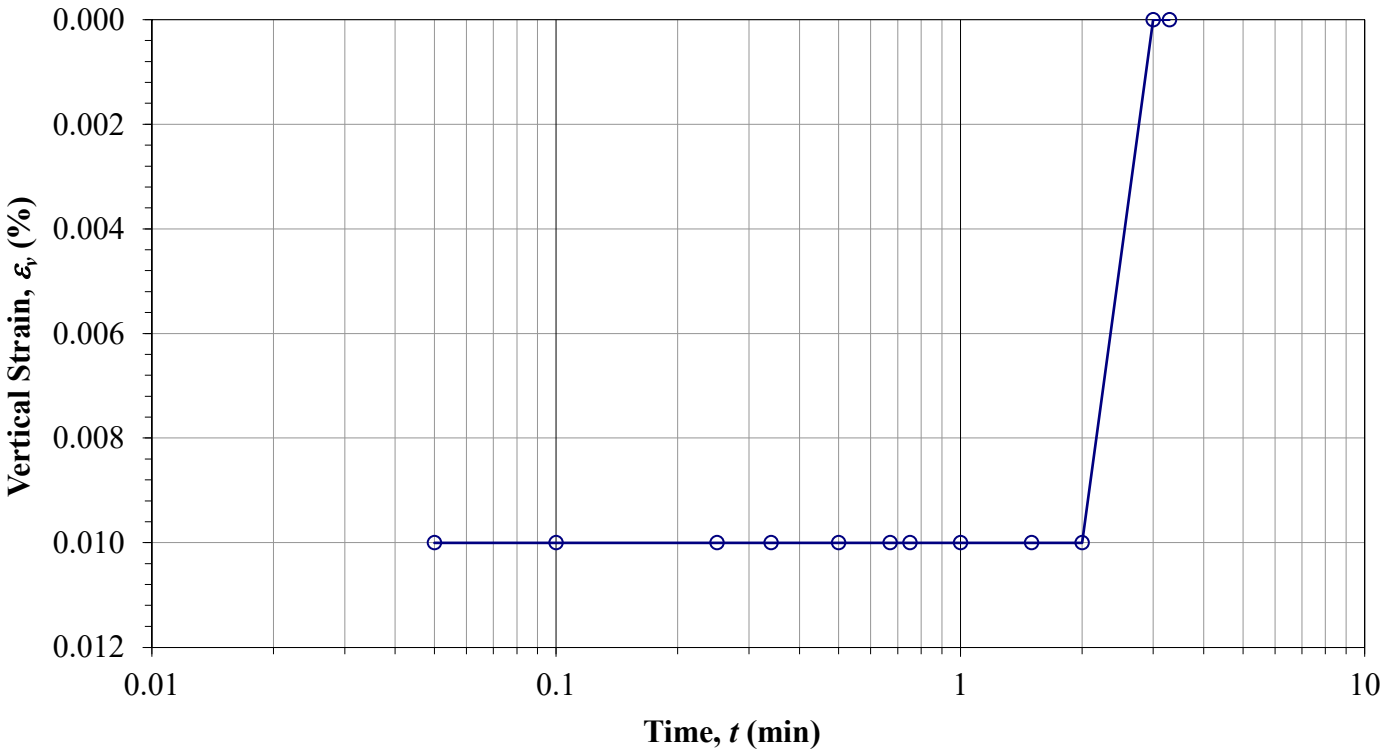
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

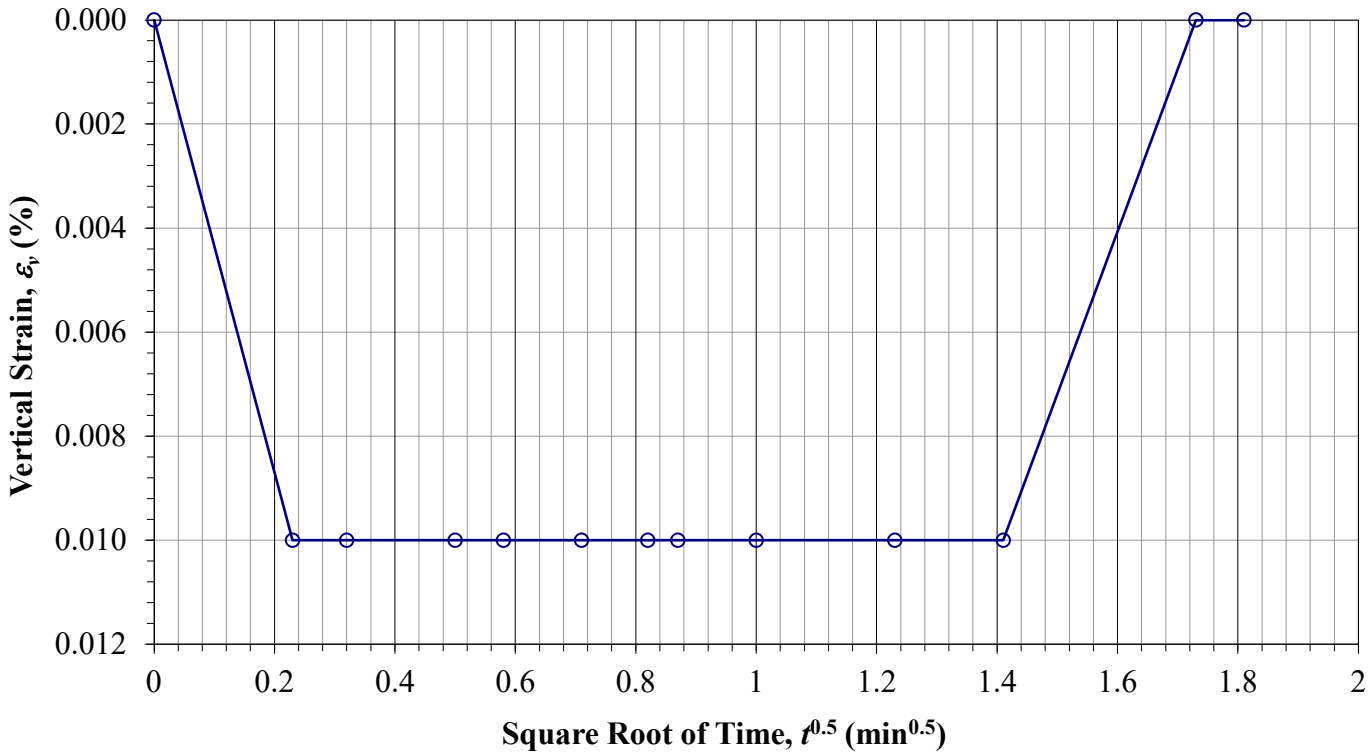
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 1 of 14
Stress: 100 psf





One-Dimensional Consolidation Properties of Soils

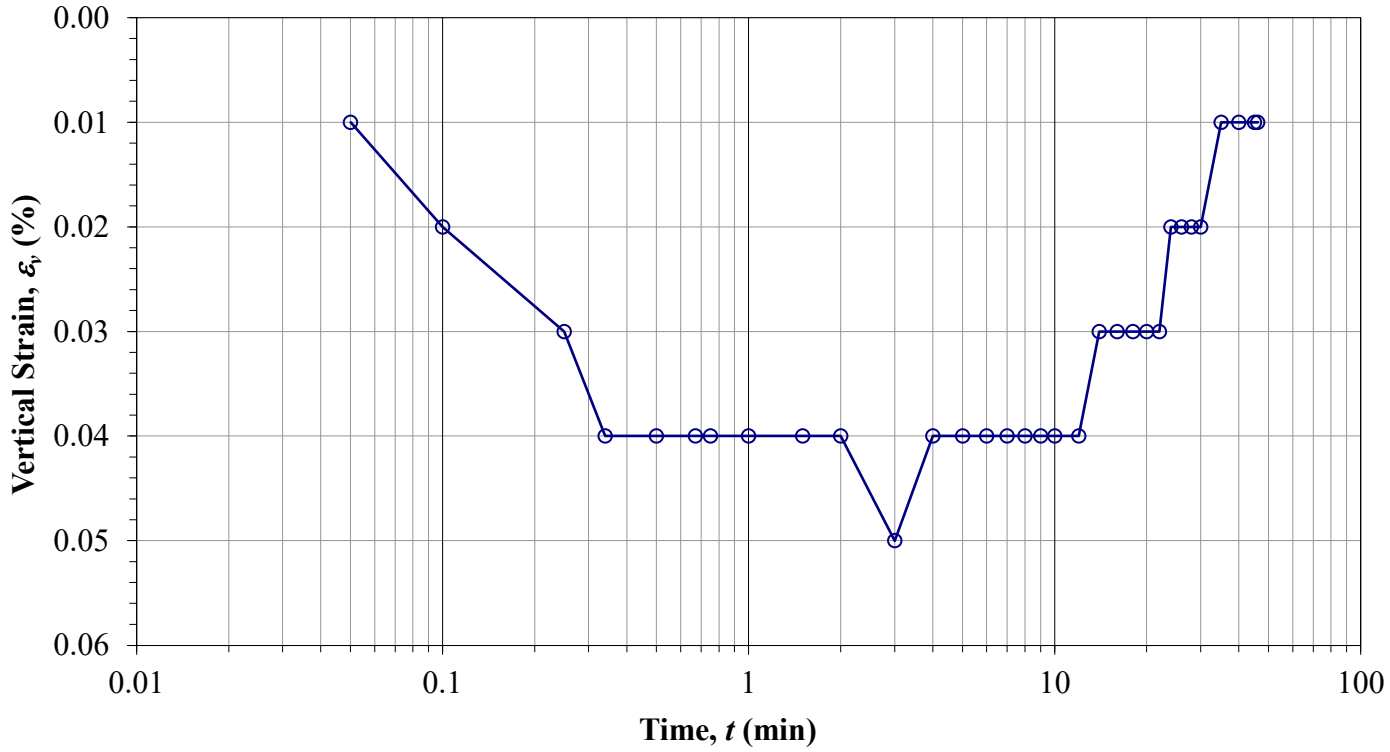
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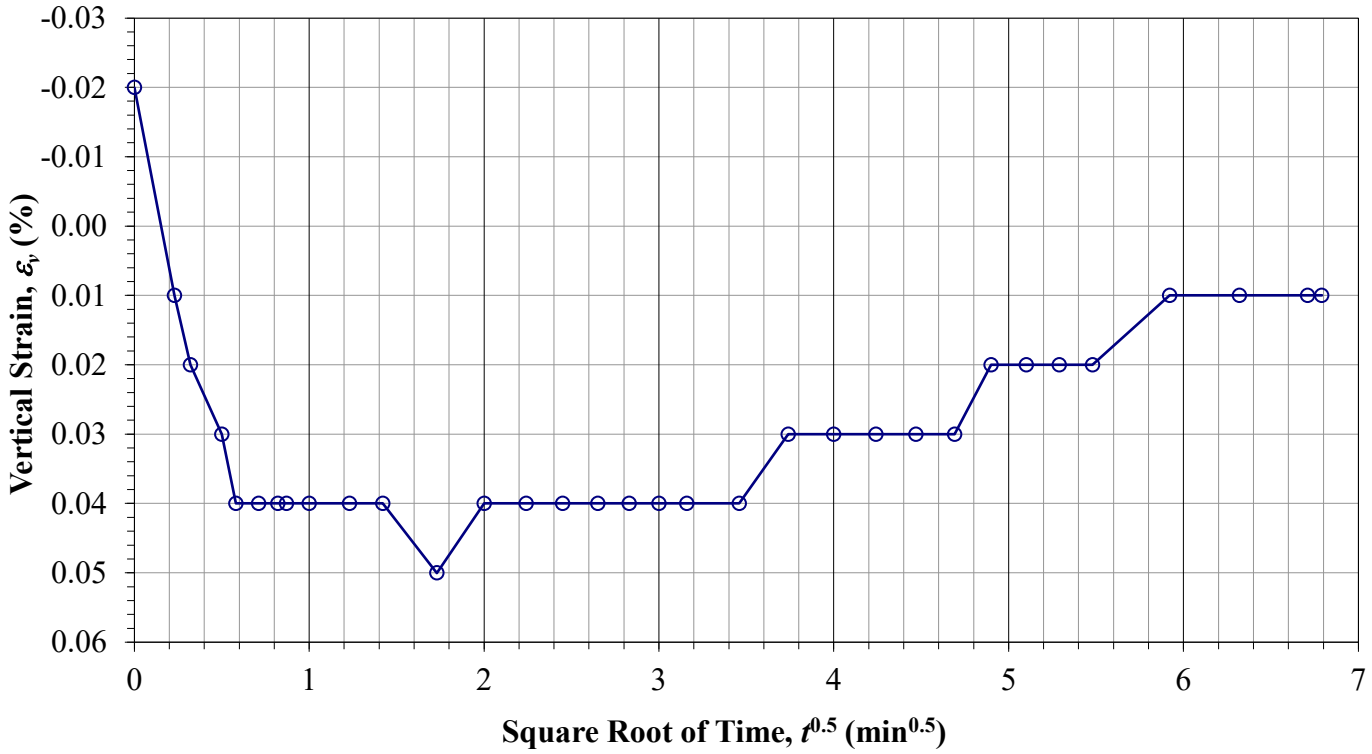
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

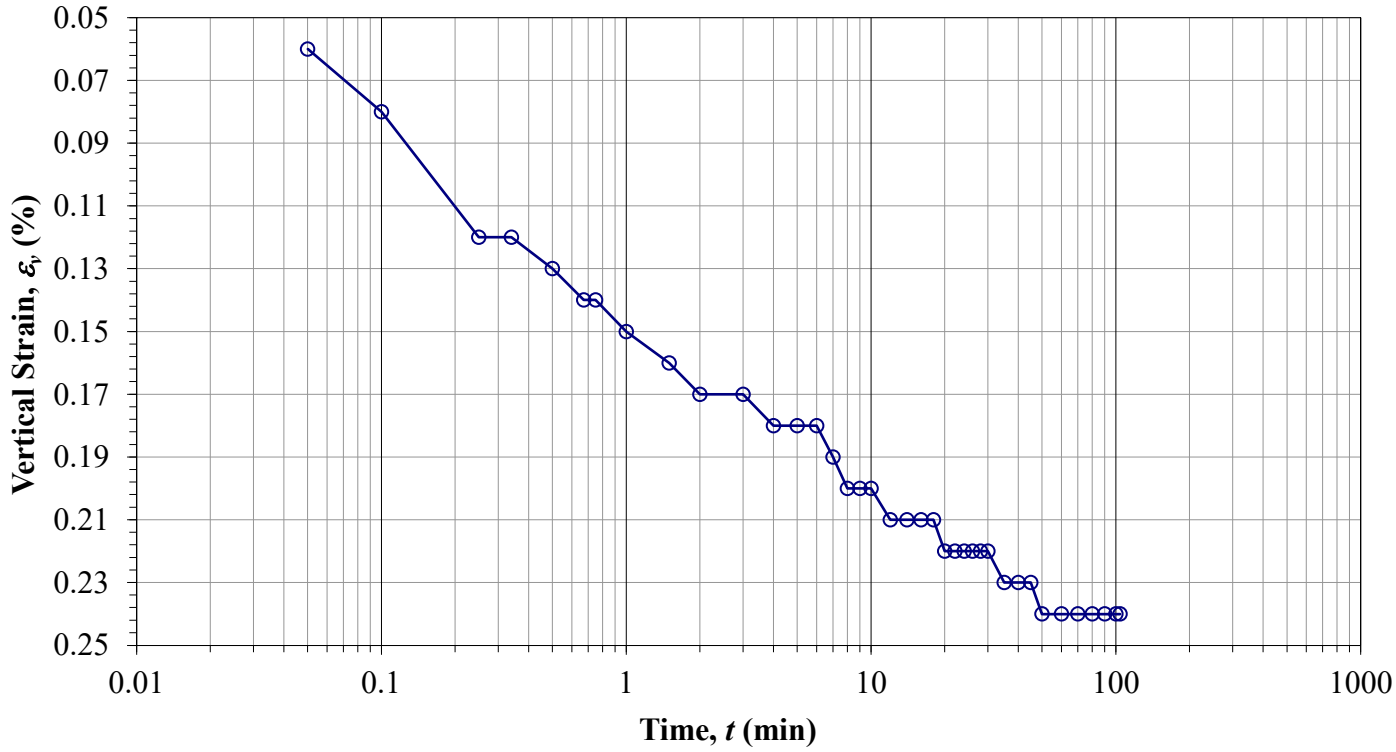
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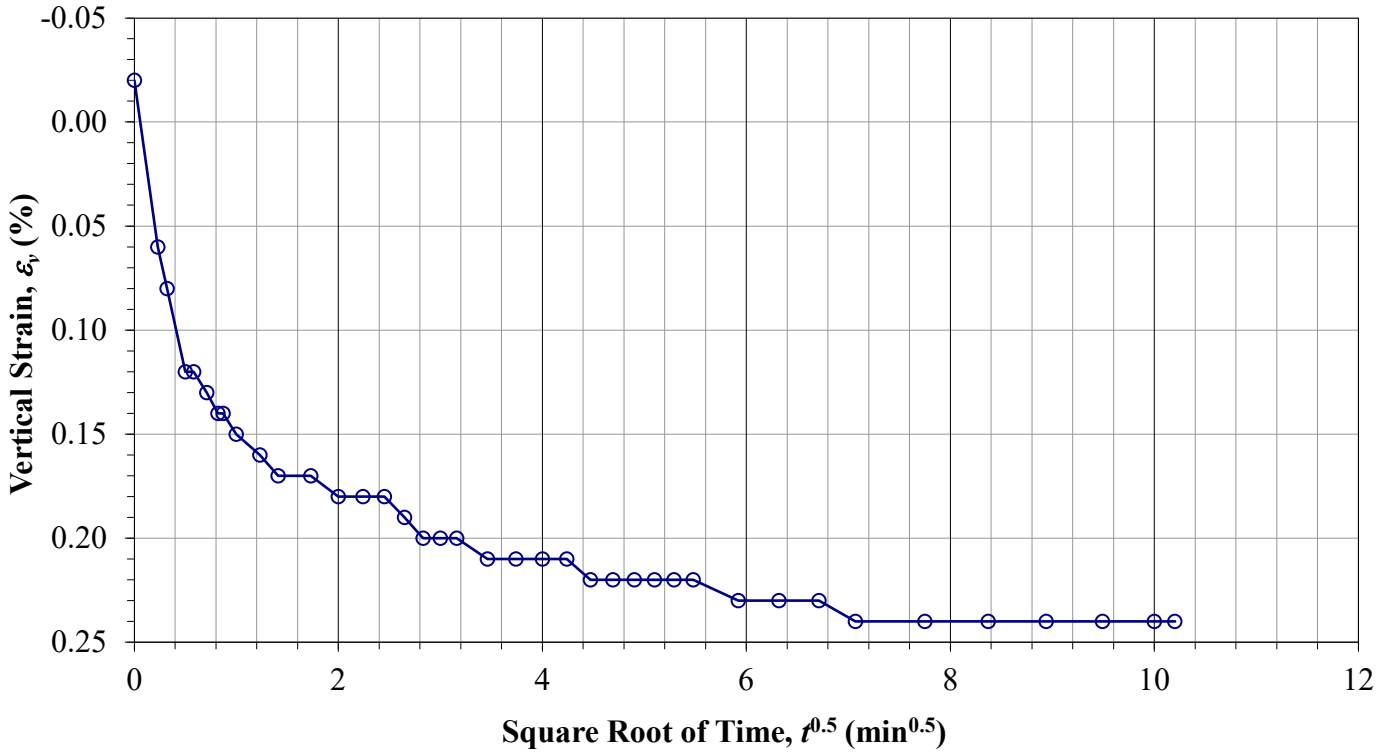
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 3 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

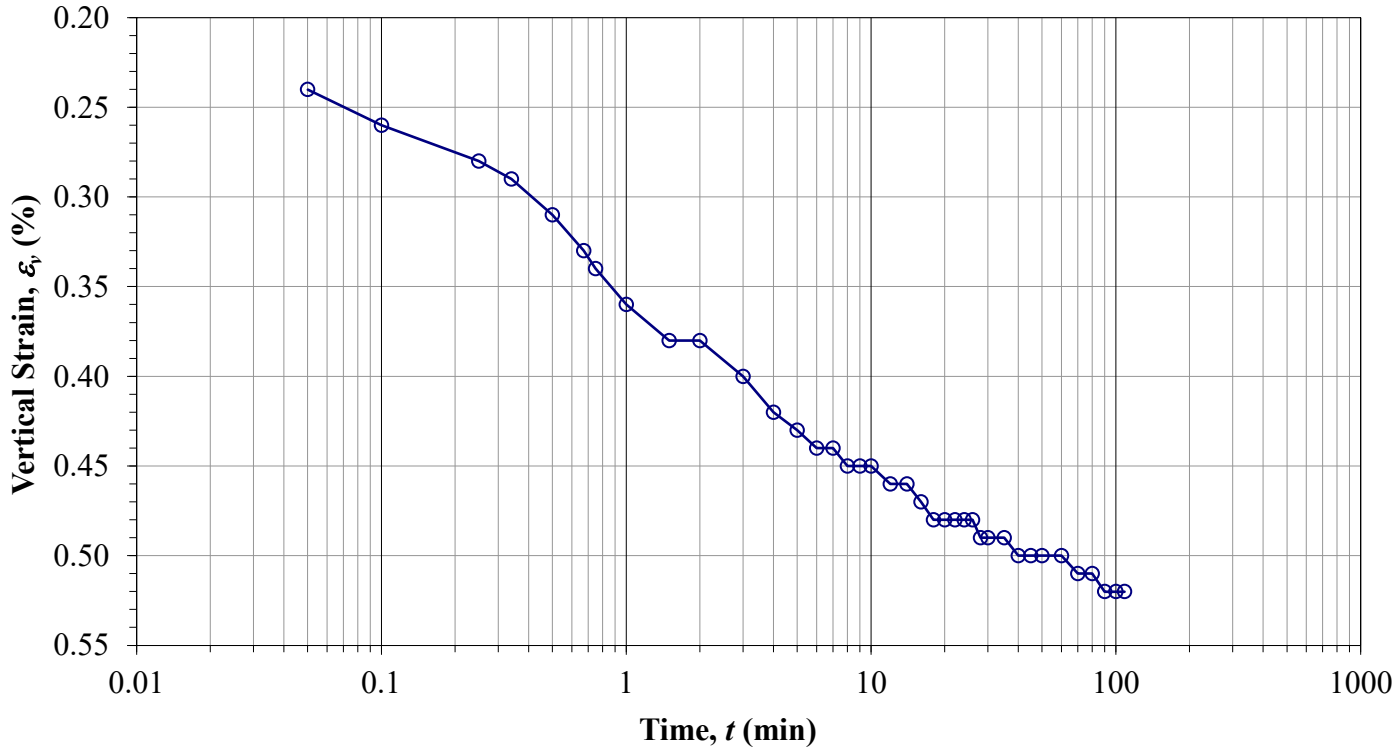
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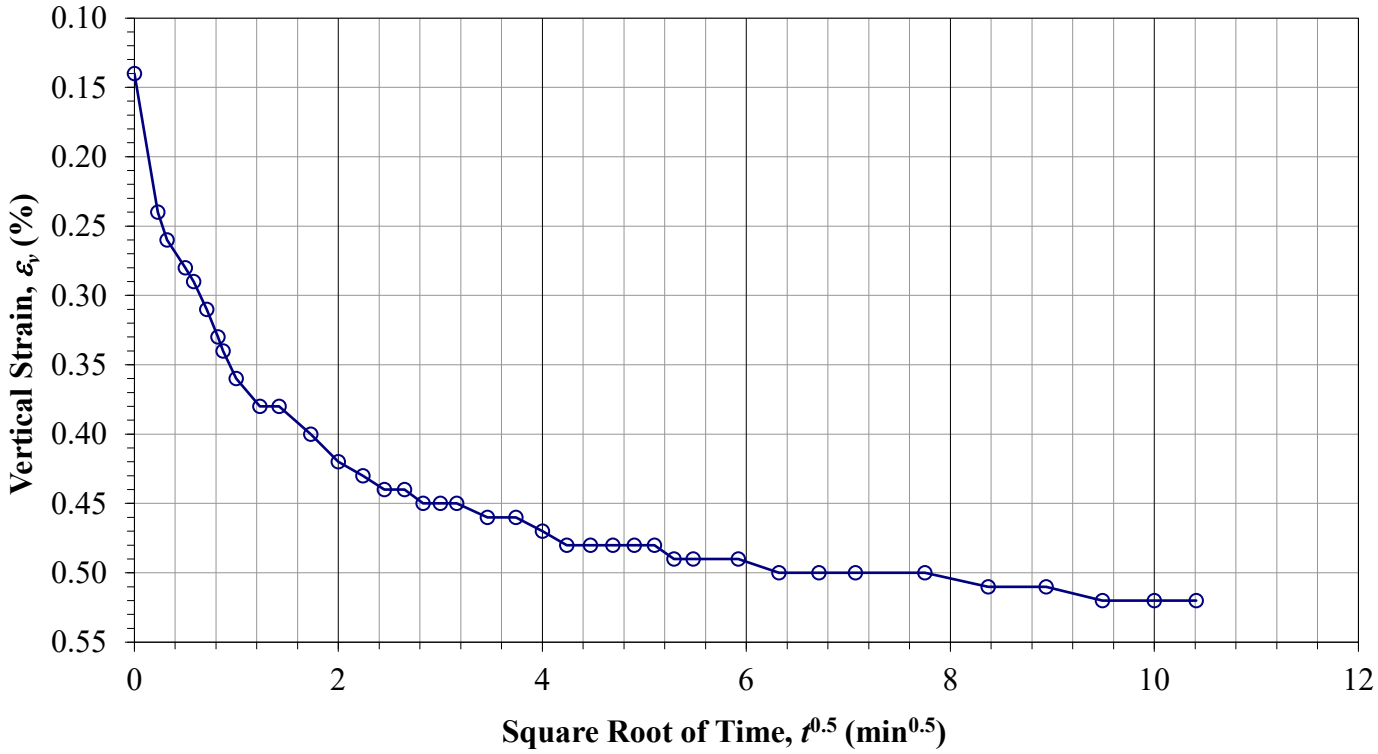
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

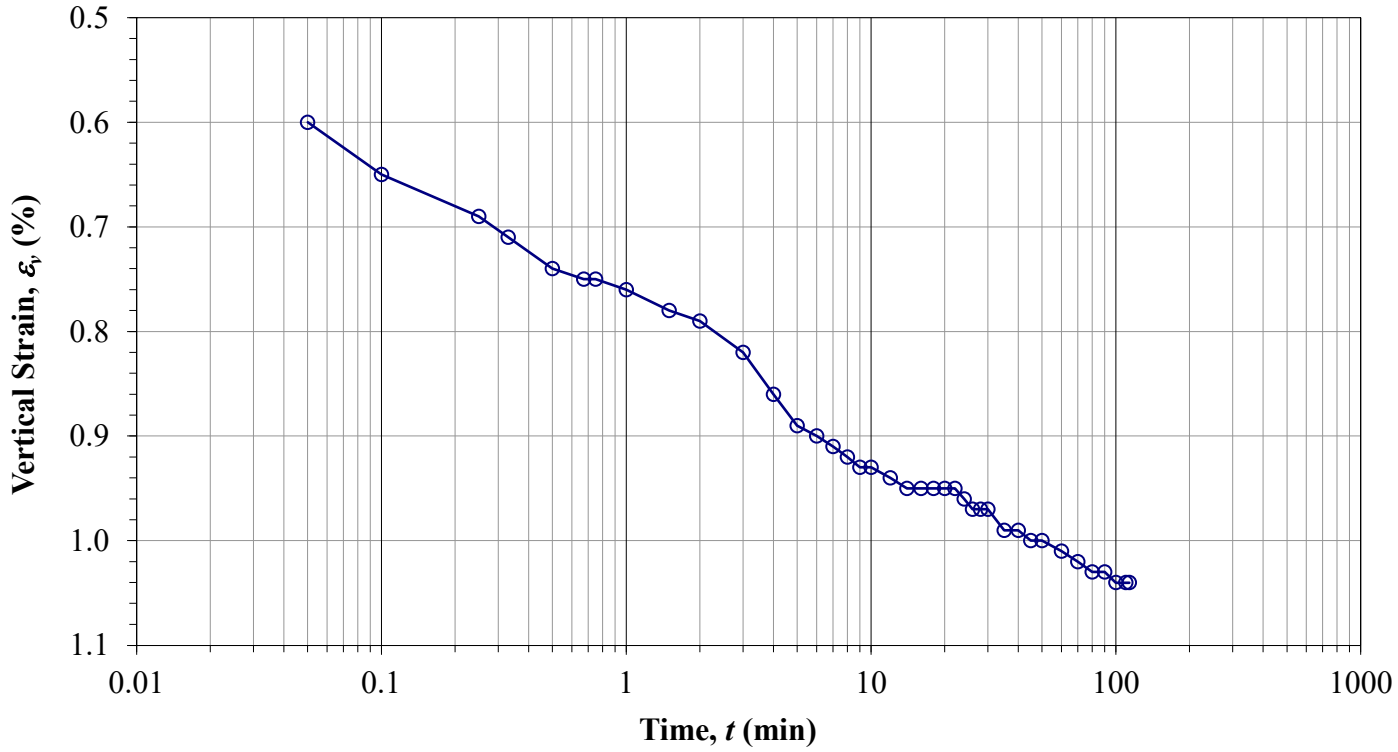
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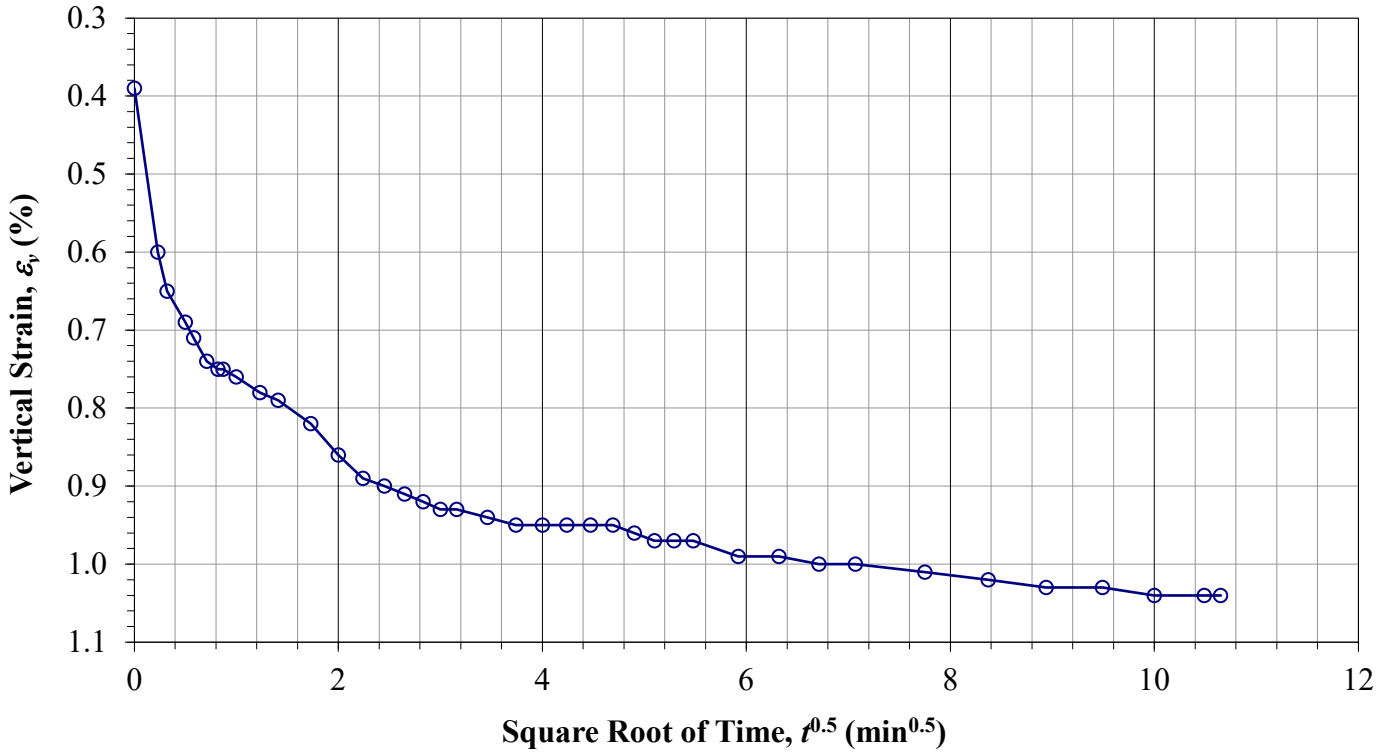
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 5 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

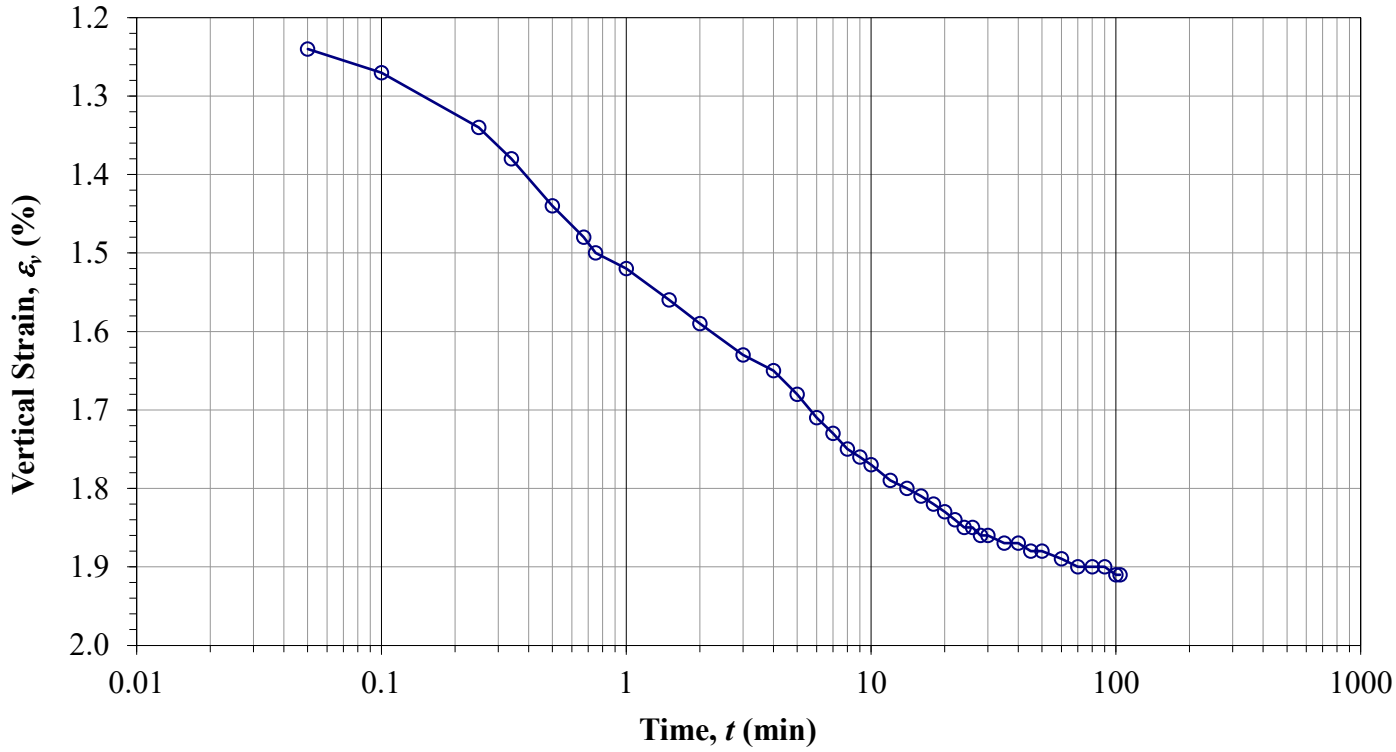
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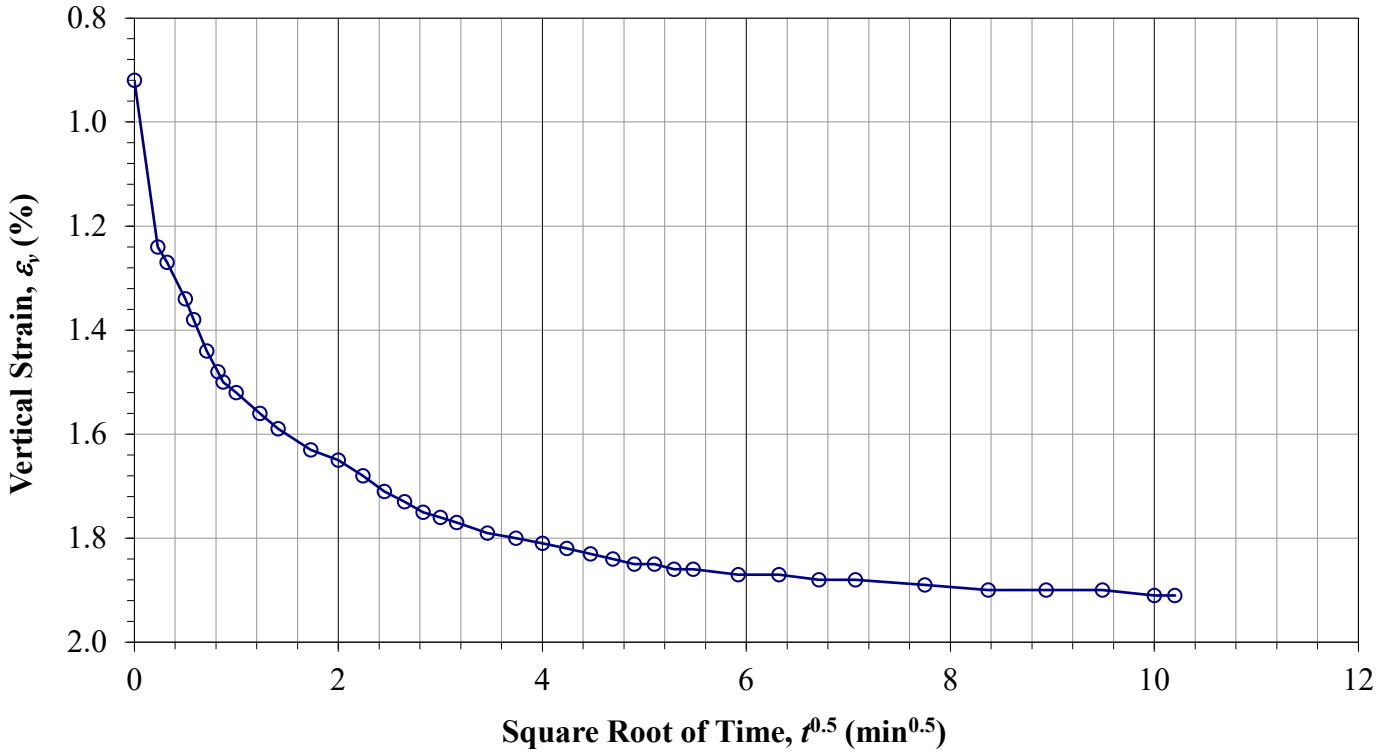
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 6 of 14
Stress: 3200 psf





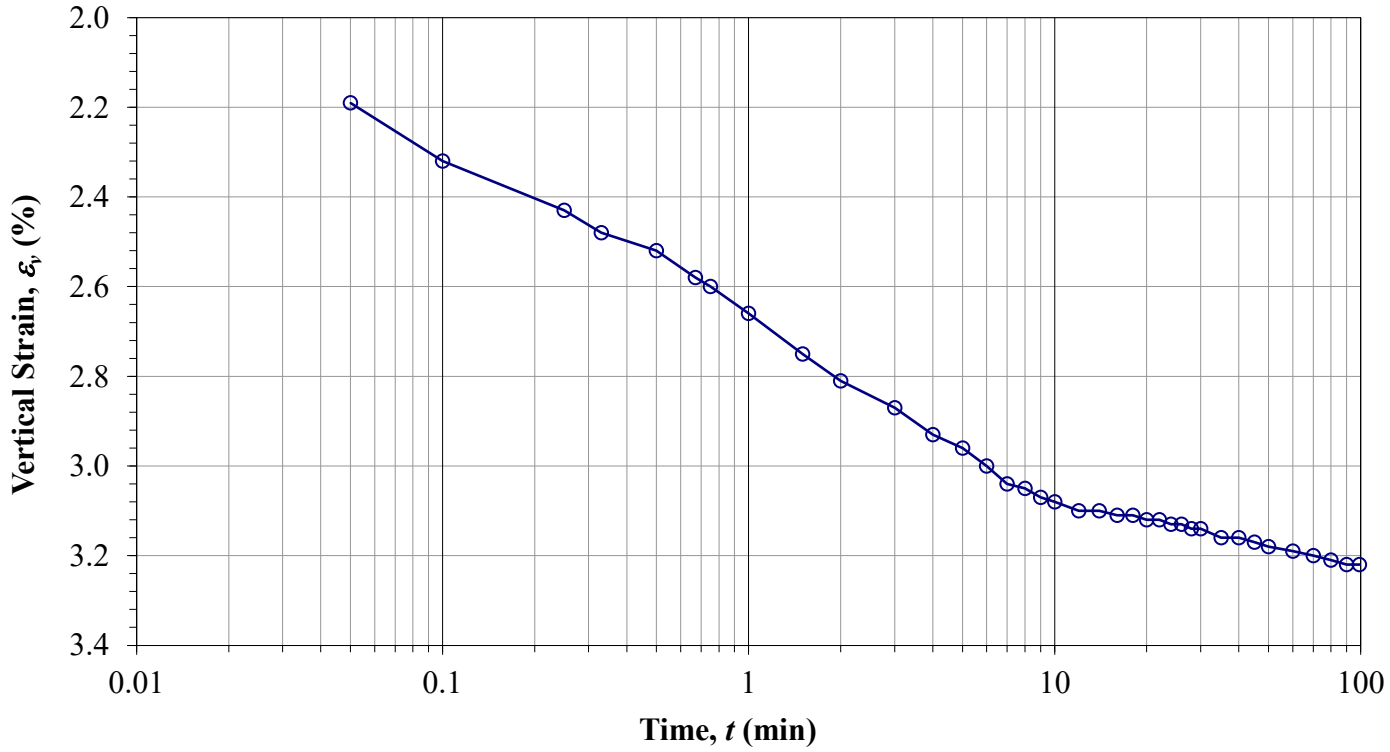
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

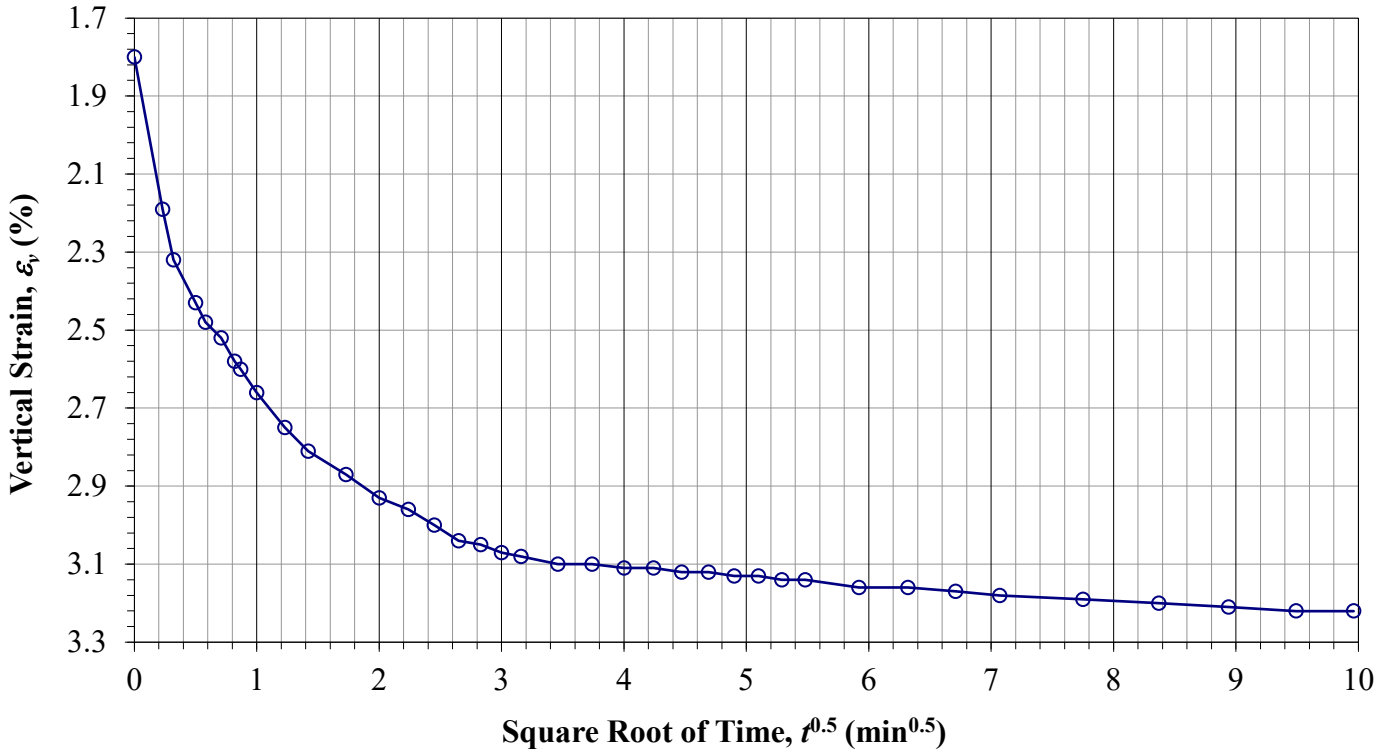
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 7 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

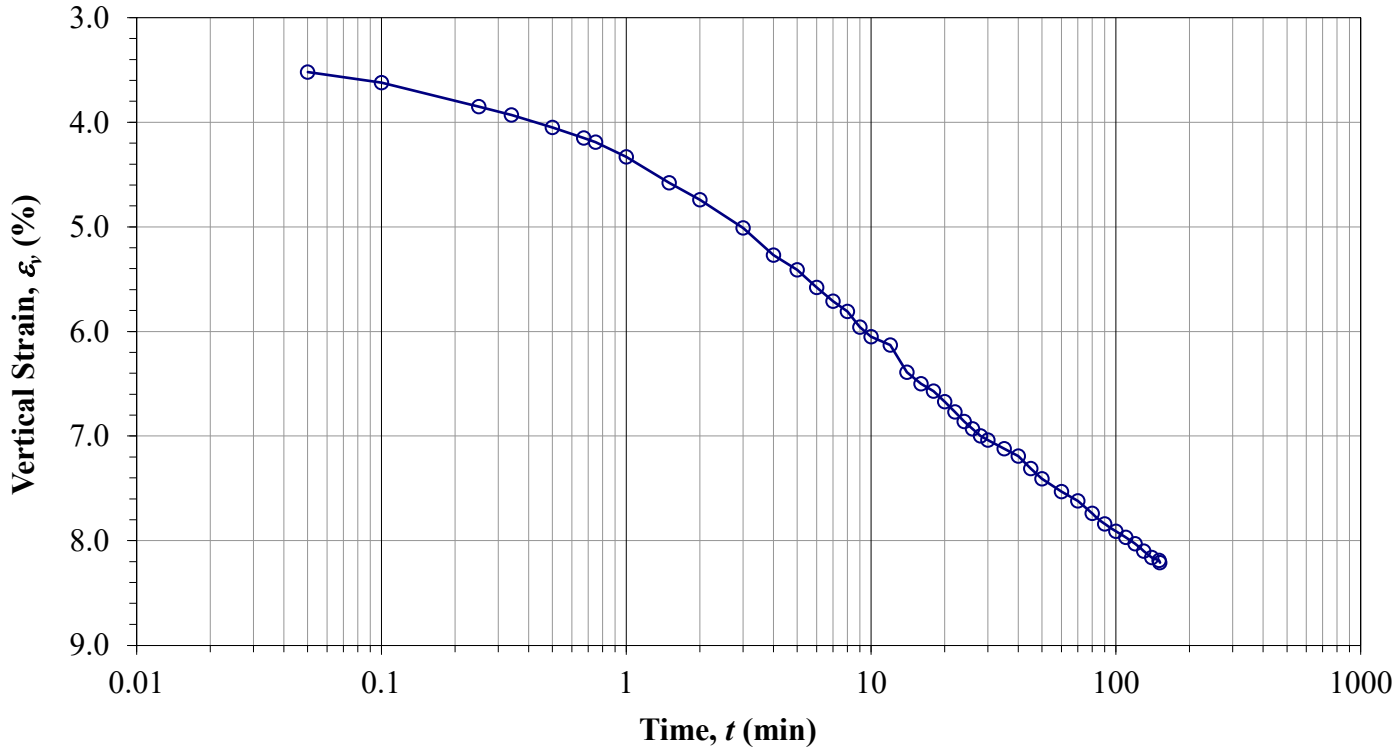
(ASTM D2435)

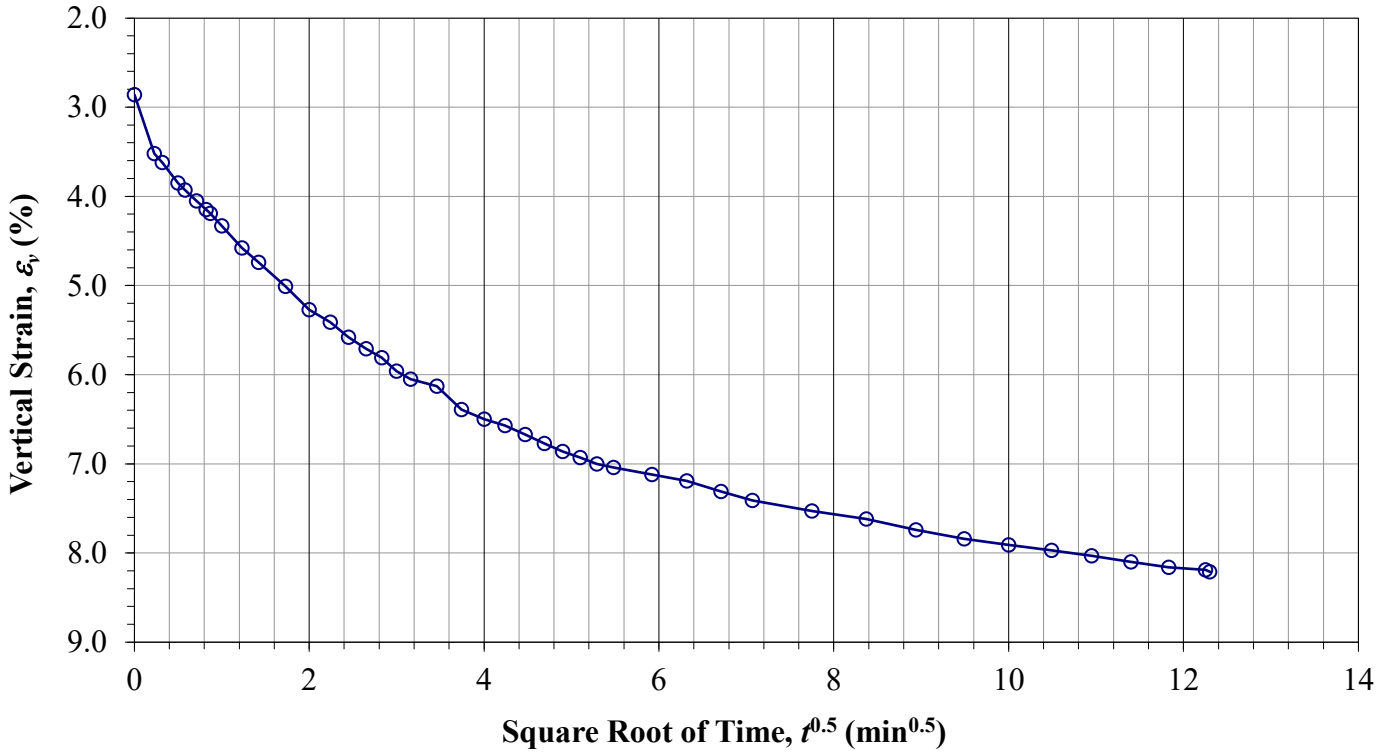
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 8 of 14
Stress: 12800 psf





One-Dimensional Consolidation Properties of Soils

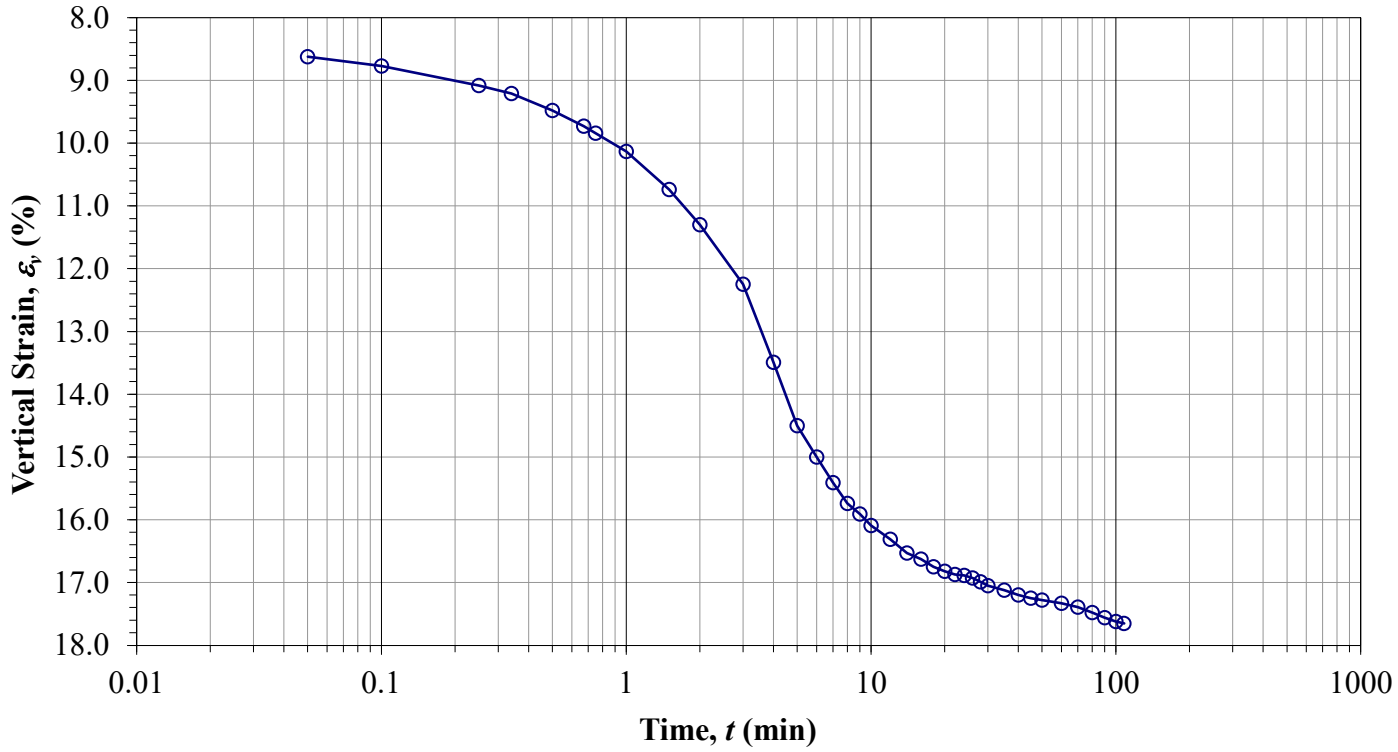
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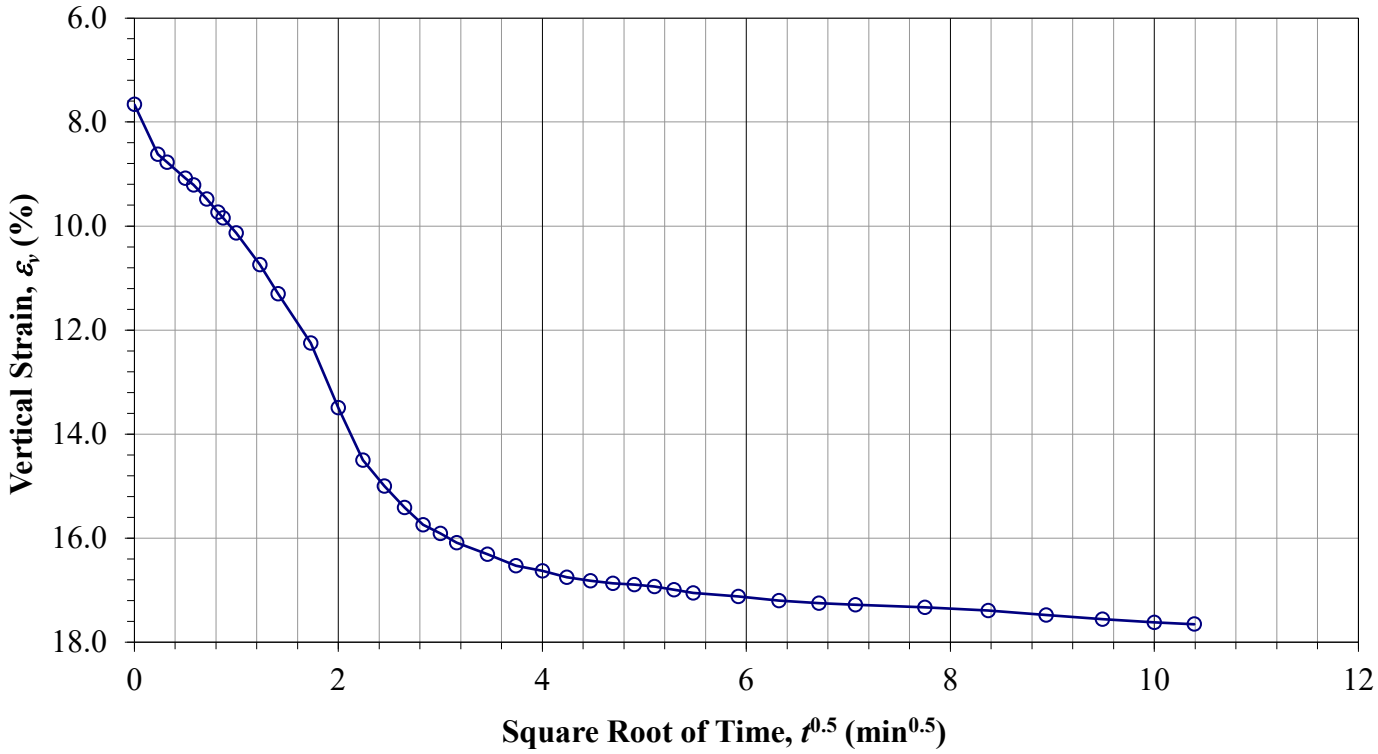
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 9 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

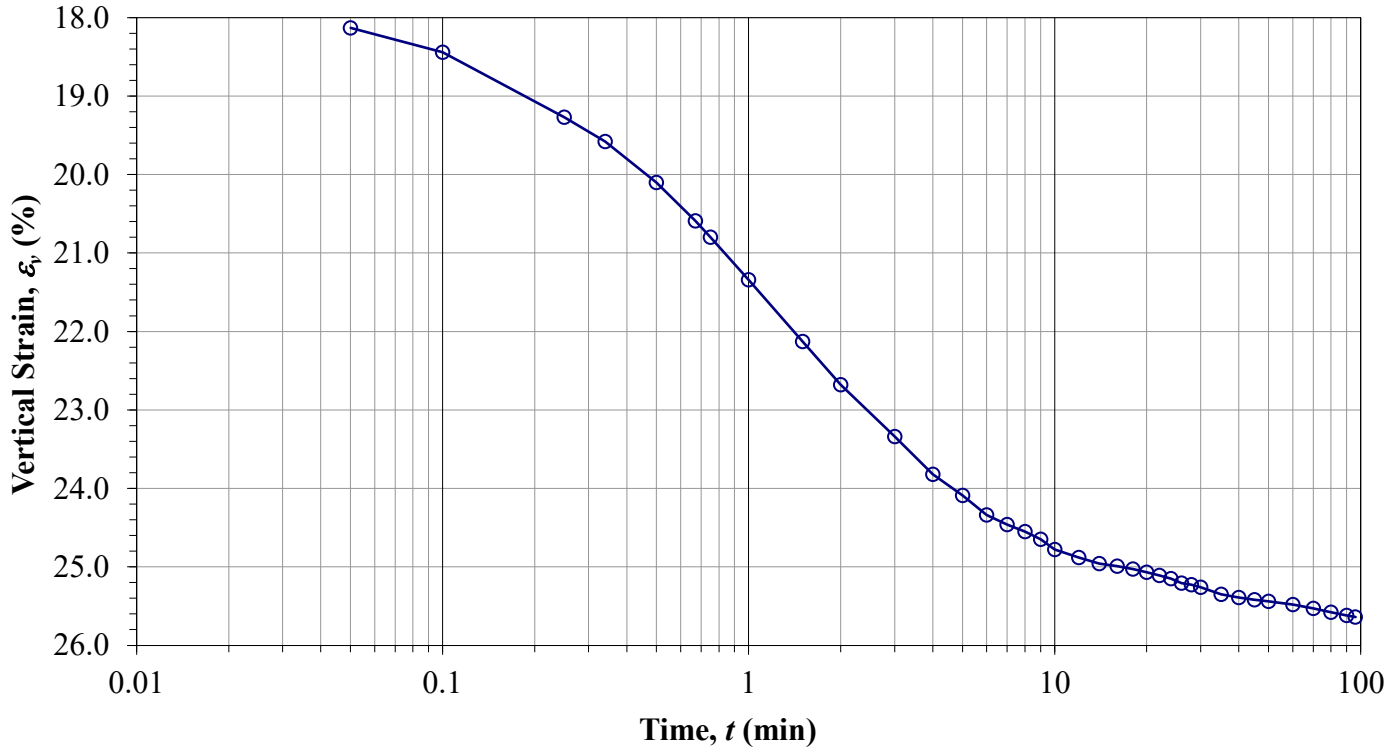
(ASTM D2435)

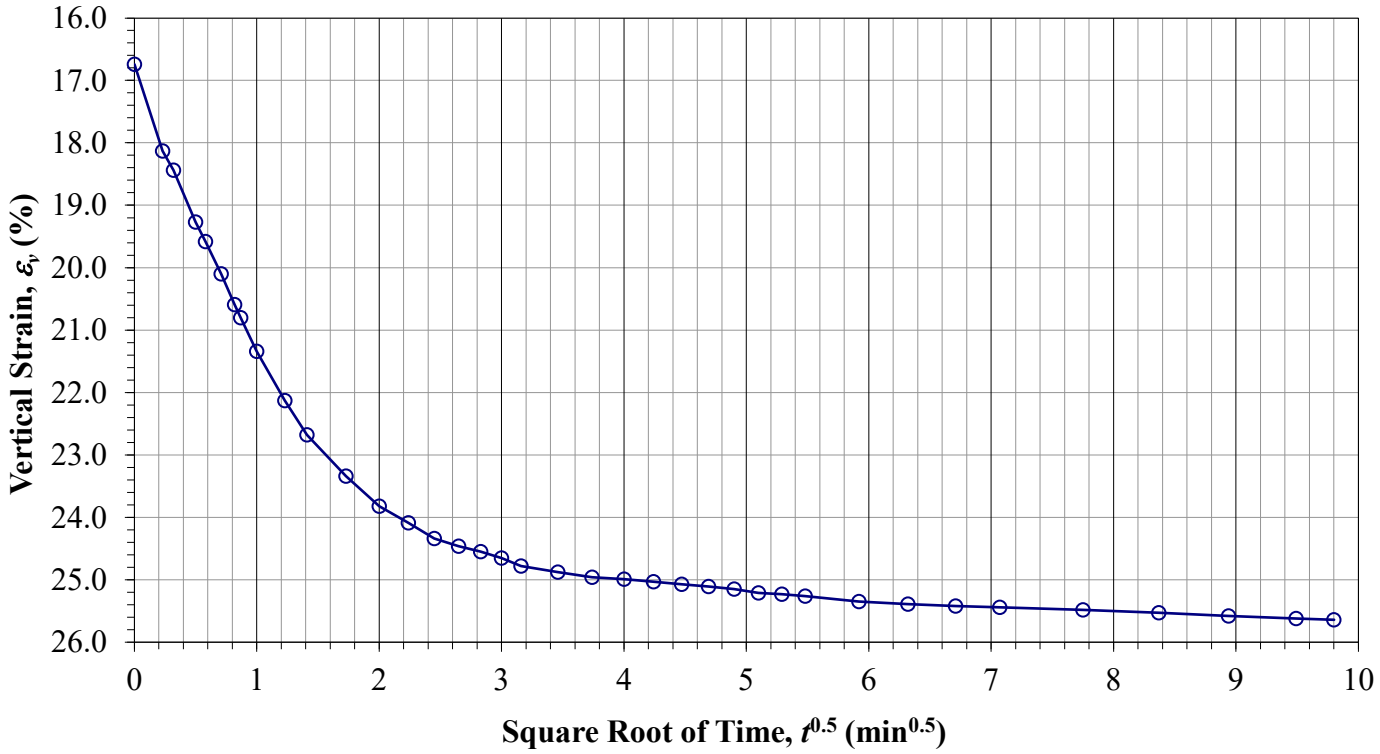
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 10 of 14
Stress: 51200 psf





One-Dimensional Consolidation Properties of Soils

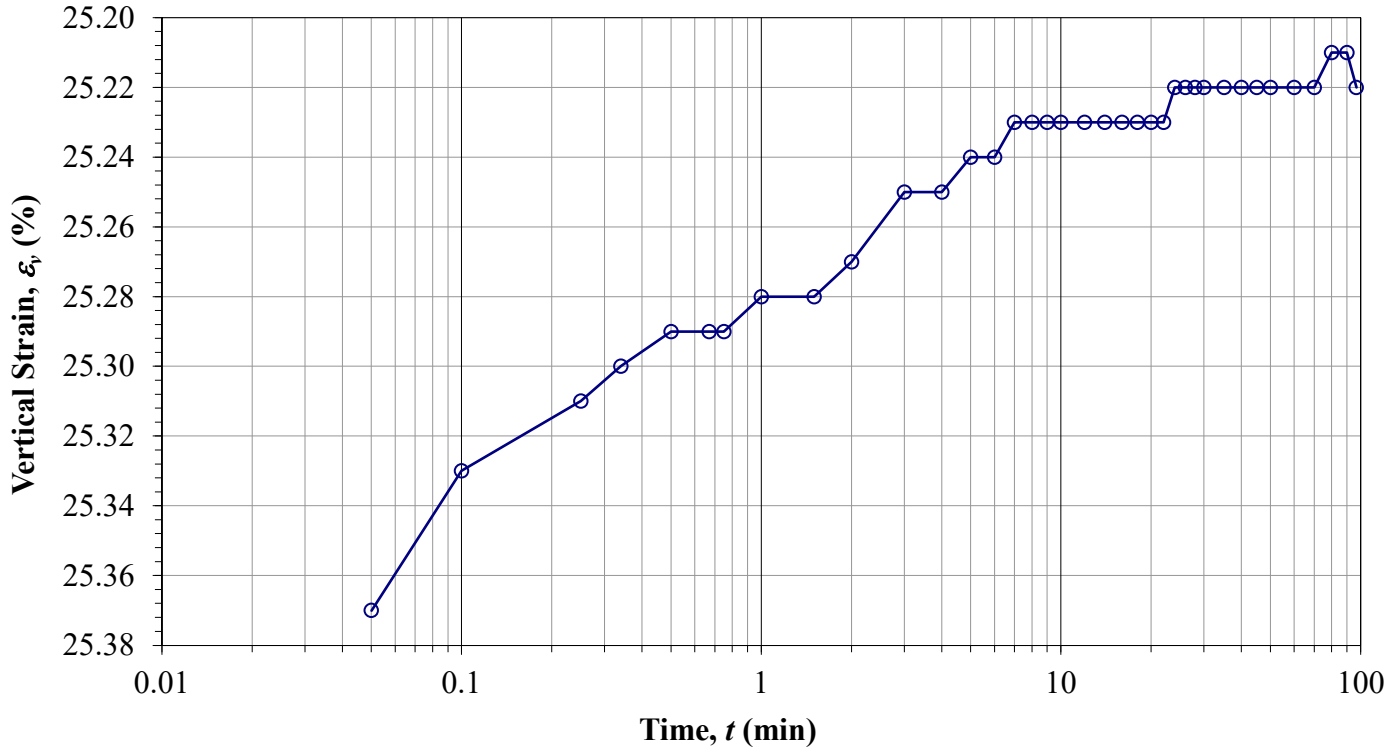
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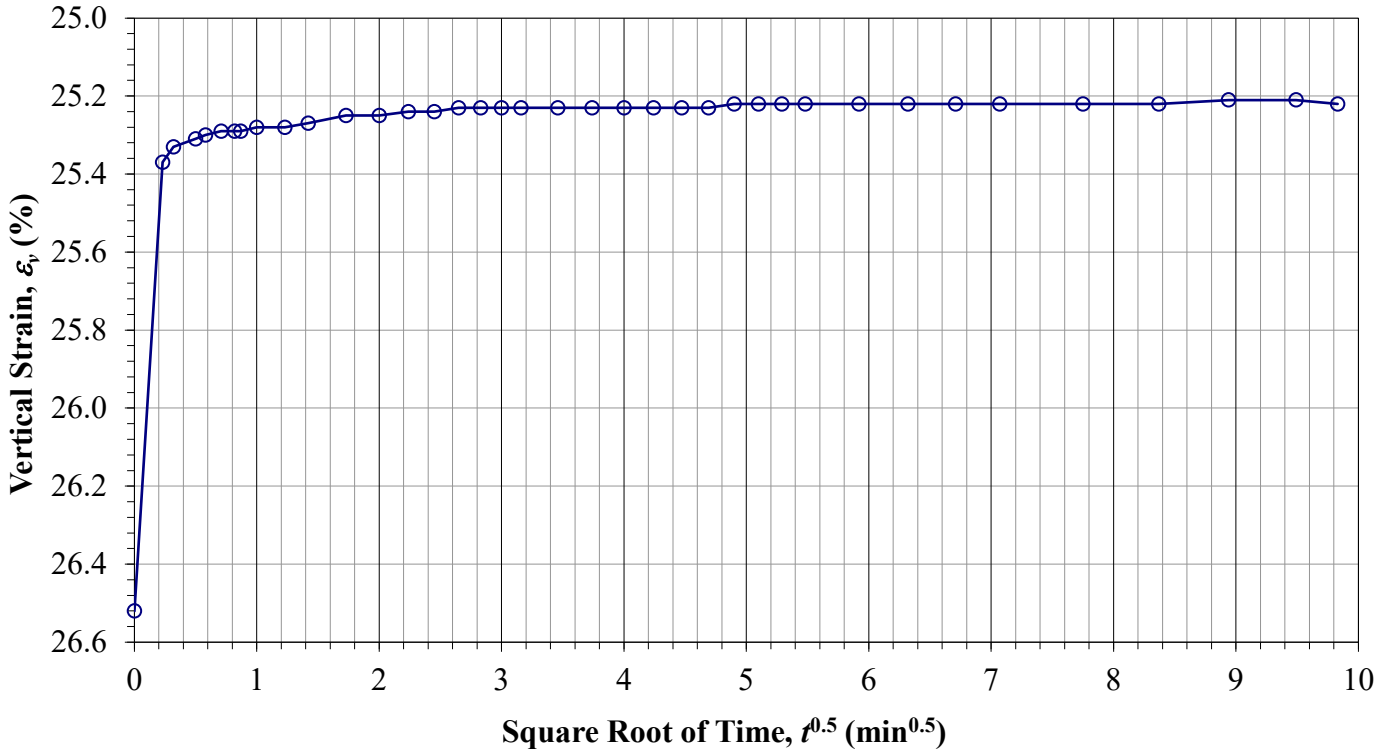
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 11 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

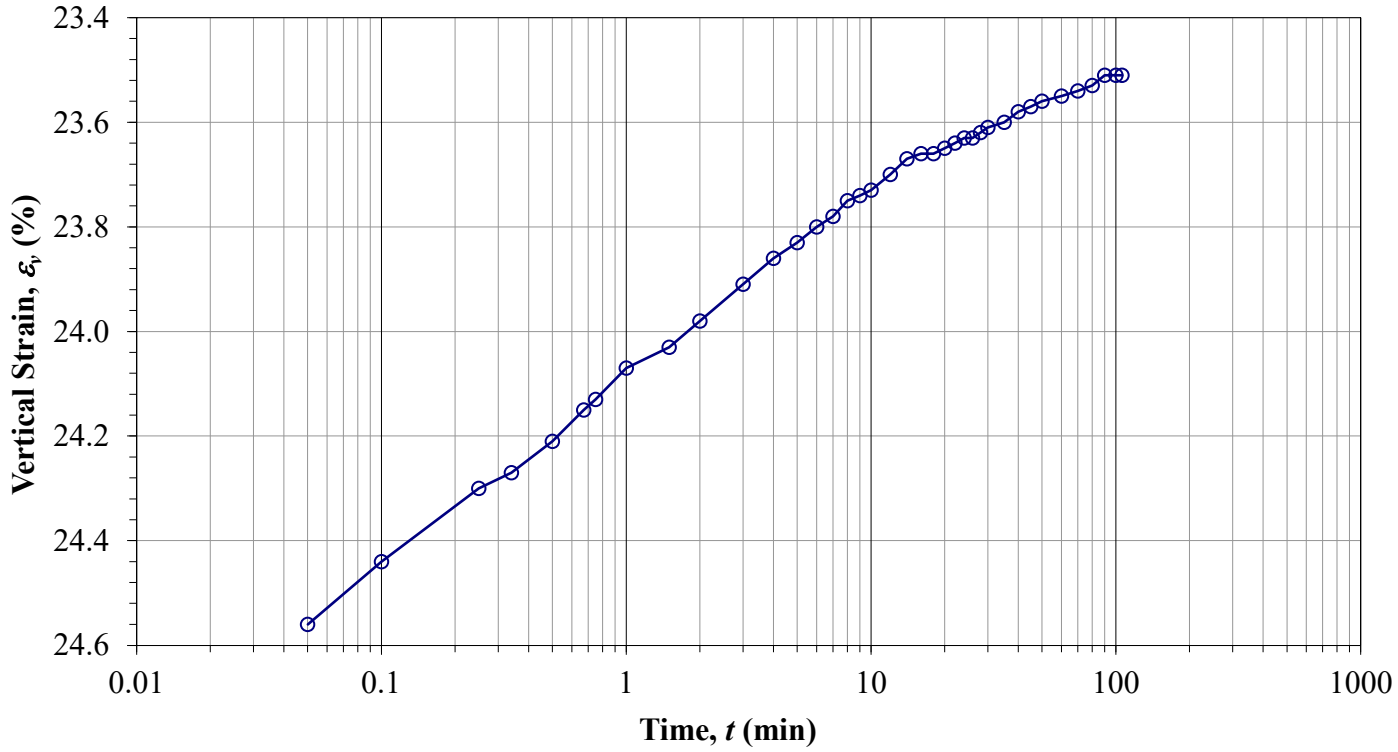
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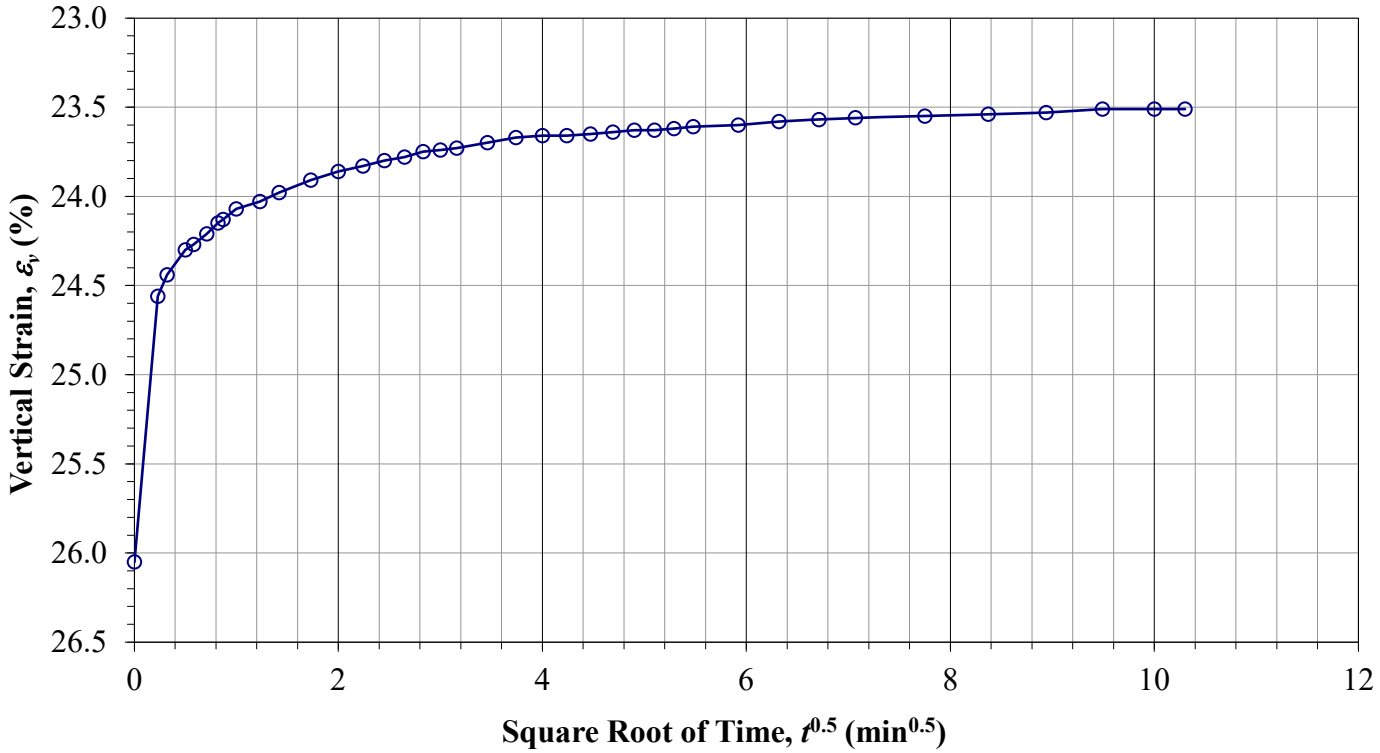
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 12 of 14
Stress: 6400 psf





Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[CONSOL_GC+TRv1_B21-OIPS-07_19_96ft.xlsm]12

One-Dimensional Consolidation Properties of Soils

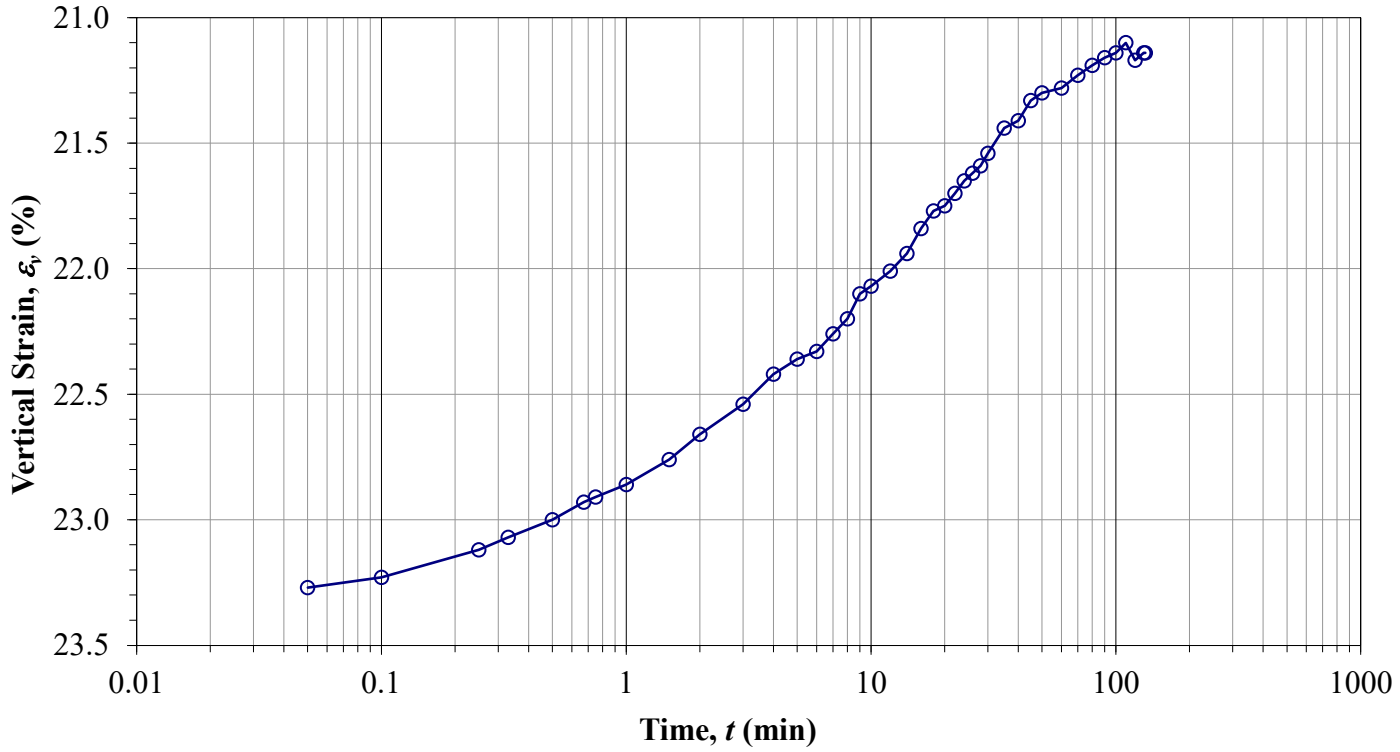
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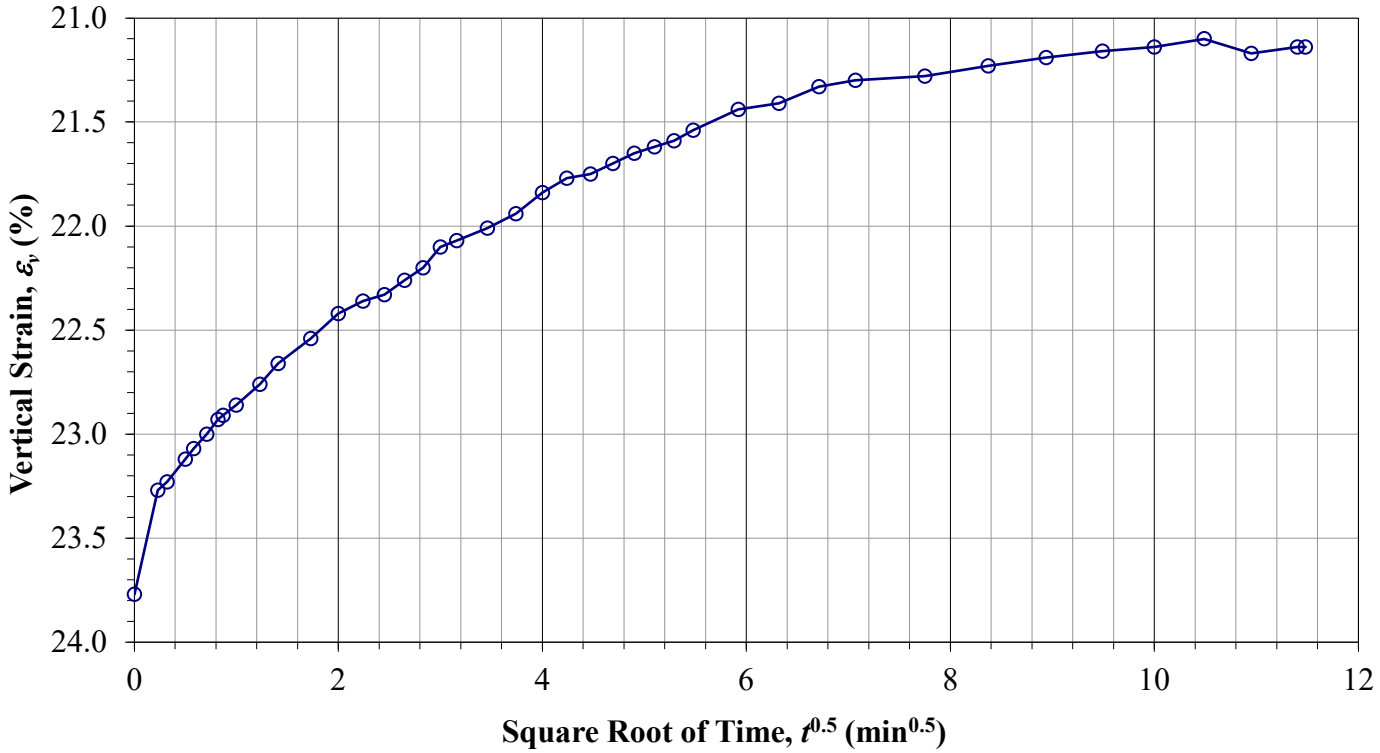
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 13 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

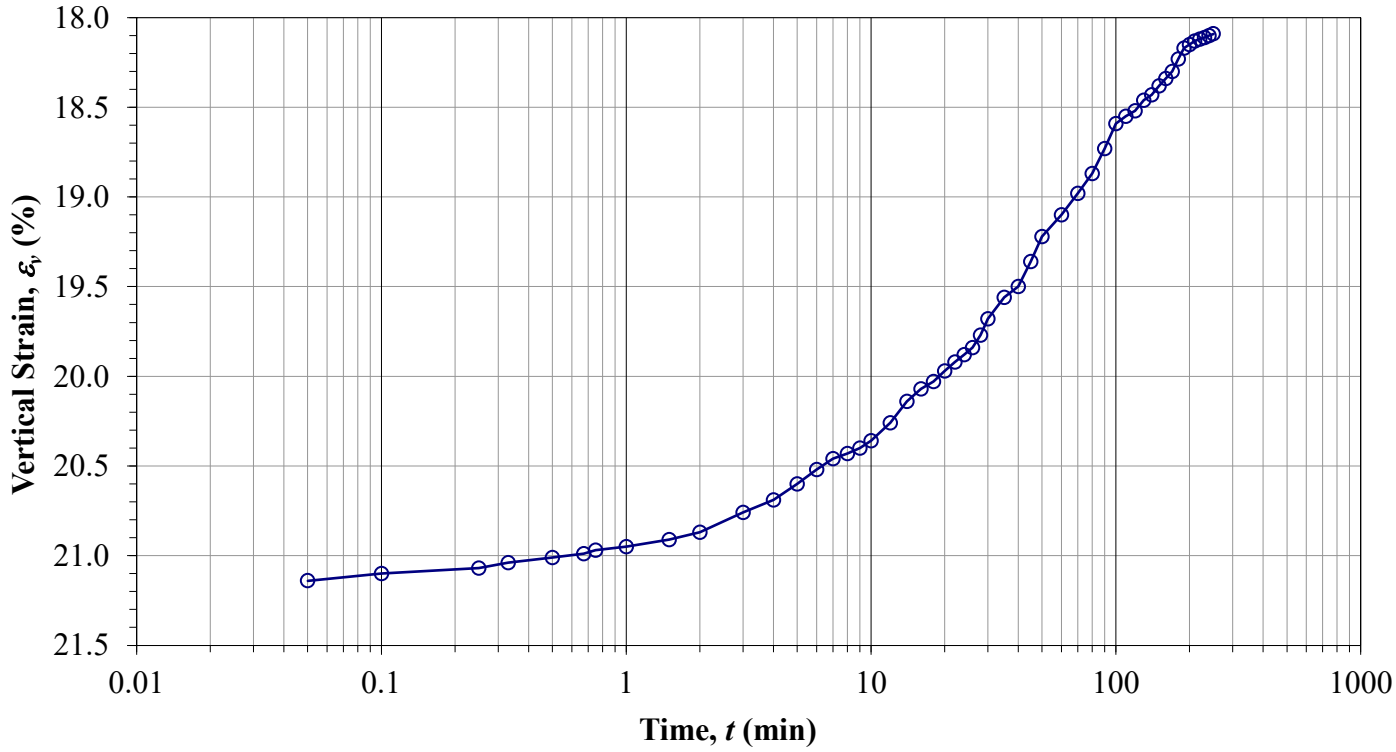
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-07
Sample: 19
Depth: 96'

Constant Load Step: 14 of 14
Stress: 400 psf





Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[CONSOL_GC+TRv1_B21-OIPS-07_19_96ft.xlsm]14

One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/14/2021
By: EH

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

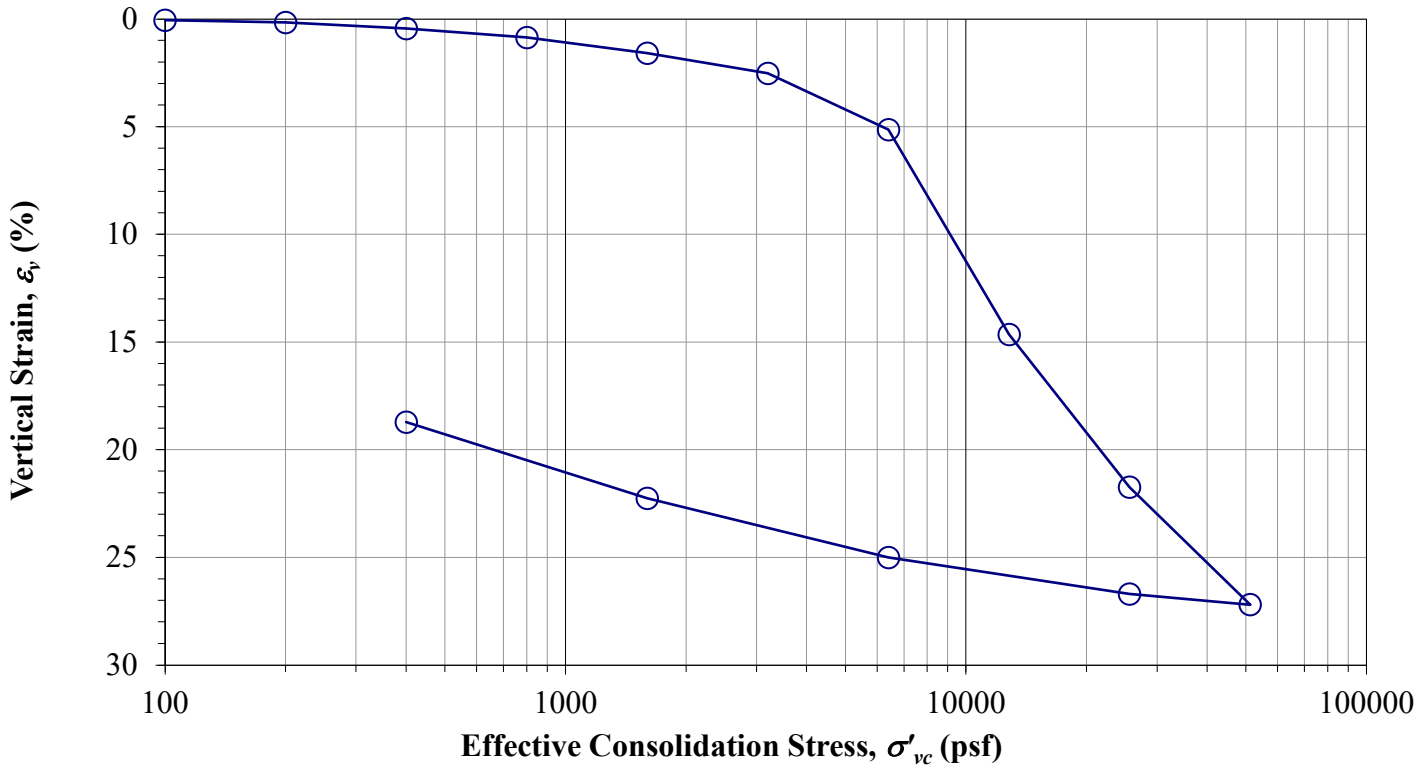
Test method:	B	
Inundation stress (psf), timing:	100	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.920	0.748
Sample diameter, D (in.)	2.417	2.417
Wt. rings + wet soil (g)	166.11	156.82
Wt. rings/tare (g)	44.84	44.84
Total unit wt., γ (pcf)	109.4	124.34
Wet soil + tare (g)	337.78	230.06
Dry soil + tare (g)	271.59	202.83
Tare (g)	122.43	121.11
Water content, ω (%)	44.4	33.3
Dry unit wt., γ_d (pcf)	75.8	93.3
Saturation, S	0.98	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9200	1.2235
100	0.0005	0.05	0.9195	1.2223
200	0.0015	0.16	0.9185	1.2200
400	0.0041	0.45	0.9159	1.2135
800	0.0079	0.86	0.9121	1.2044
1600	0.0146	1.59	0.9054	1.1882
3200	0.0233	2.53	0.8968	1.1673
6400	0.0473	5.14	0.8727	1.1092
12800	0.1348	14.65	0.7852	0.8977
25600	0.2000	21.74	0.7200	0.7401
51200	0.2502	27.20	0.6698	0.6188
25600	0.2456	26.70	0.6744	0.6299
6400	0.2301	25.01	0.6899	0.6674
1600	0.2048	22.26	0.7152	0.7285
400	0.1722	18.72	0.7478	0.8073



Entered: _____
Reviewed: _____

One-Dimensional Consolidation Properties of Soils

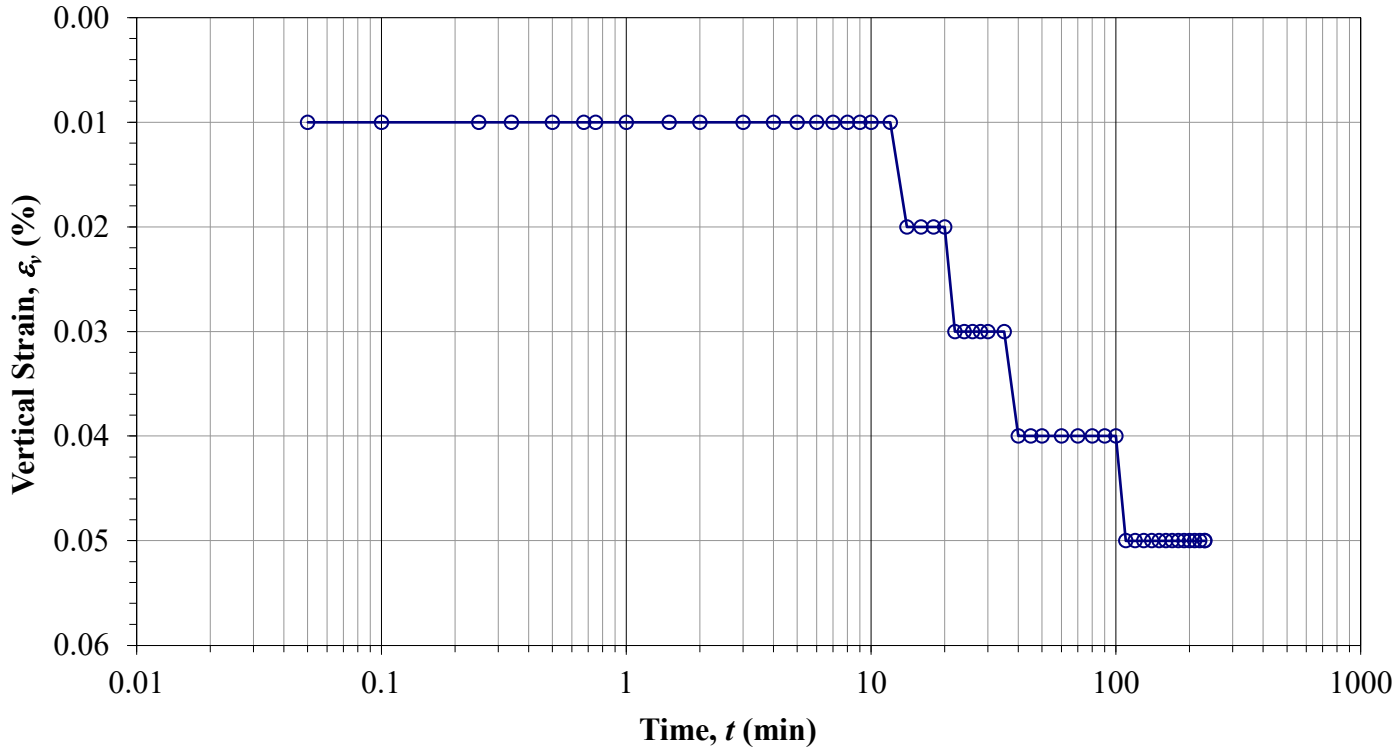
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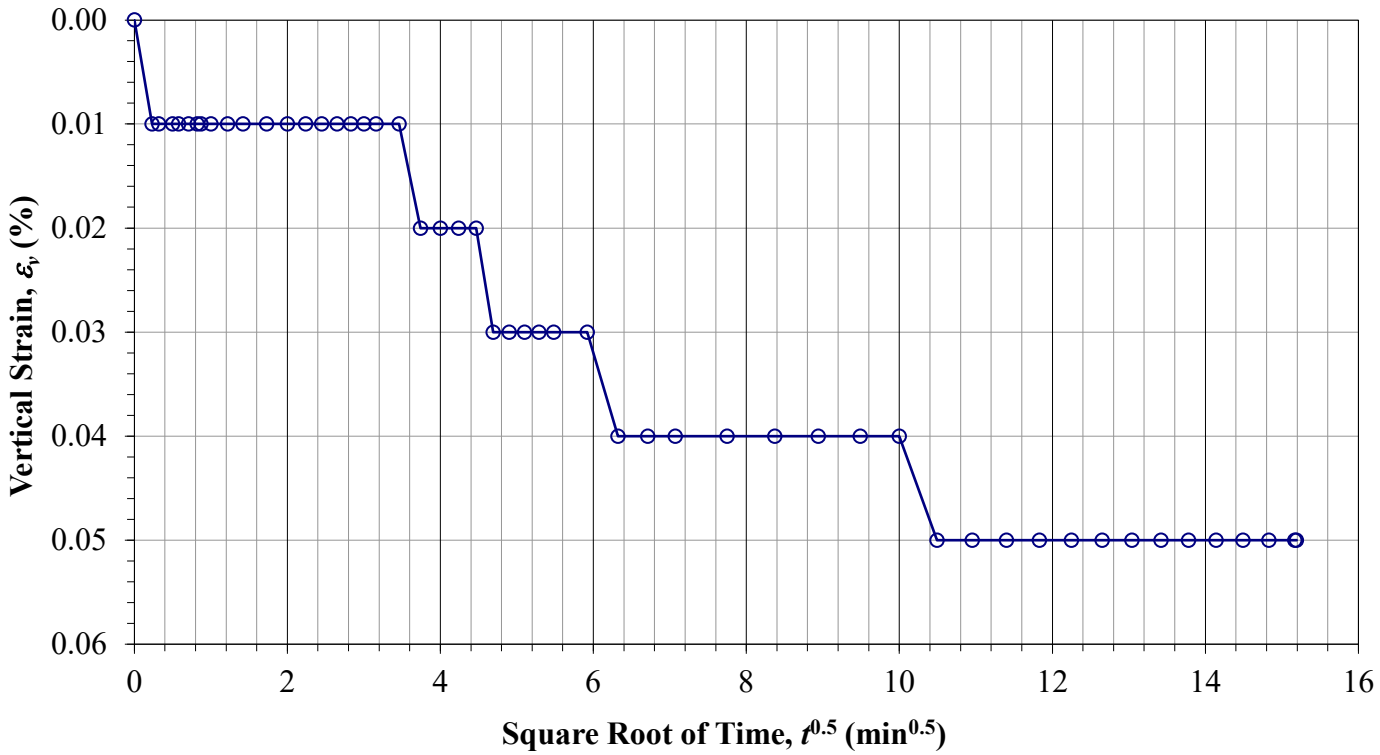
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 1 of 14
Stress: 100 psf





One-Dimensional Consolidation Properties of Soils

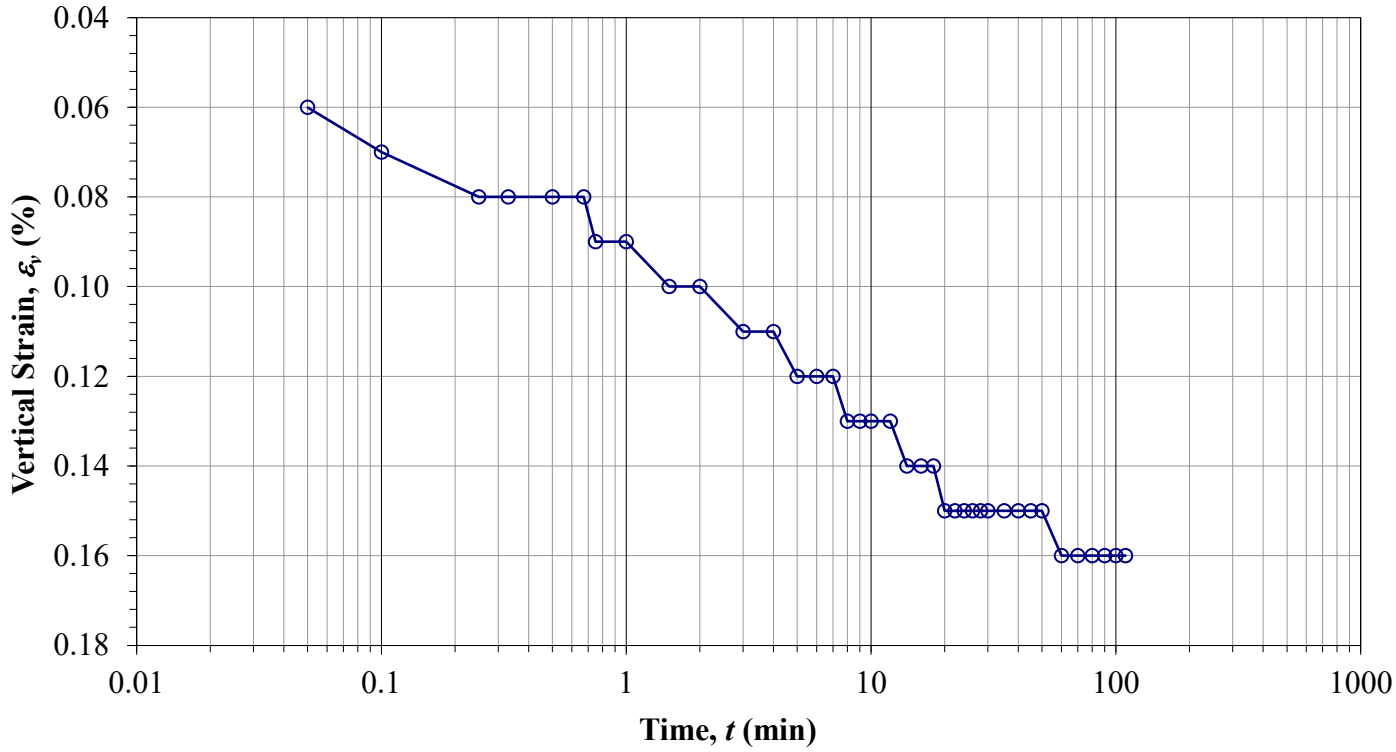
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

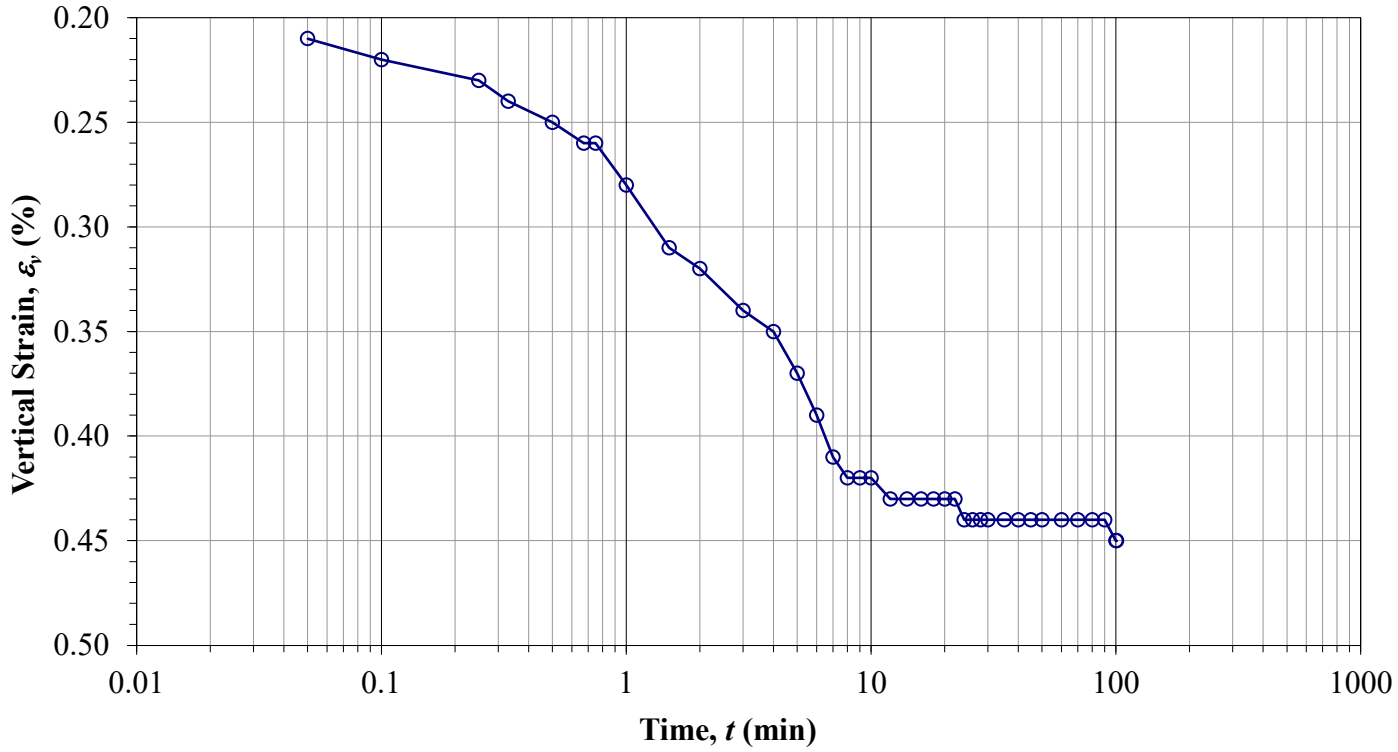
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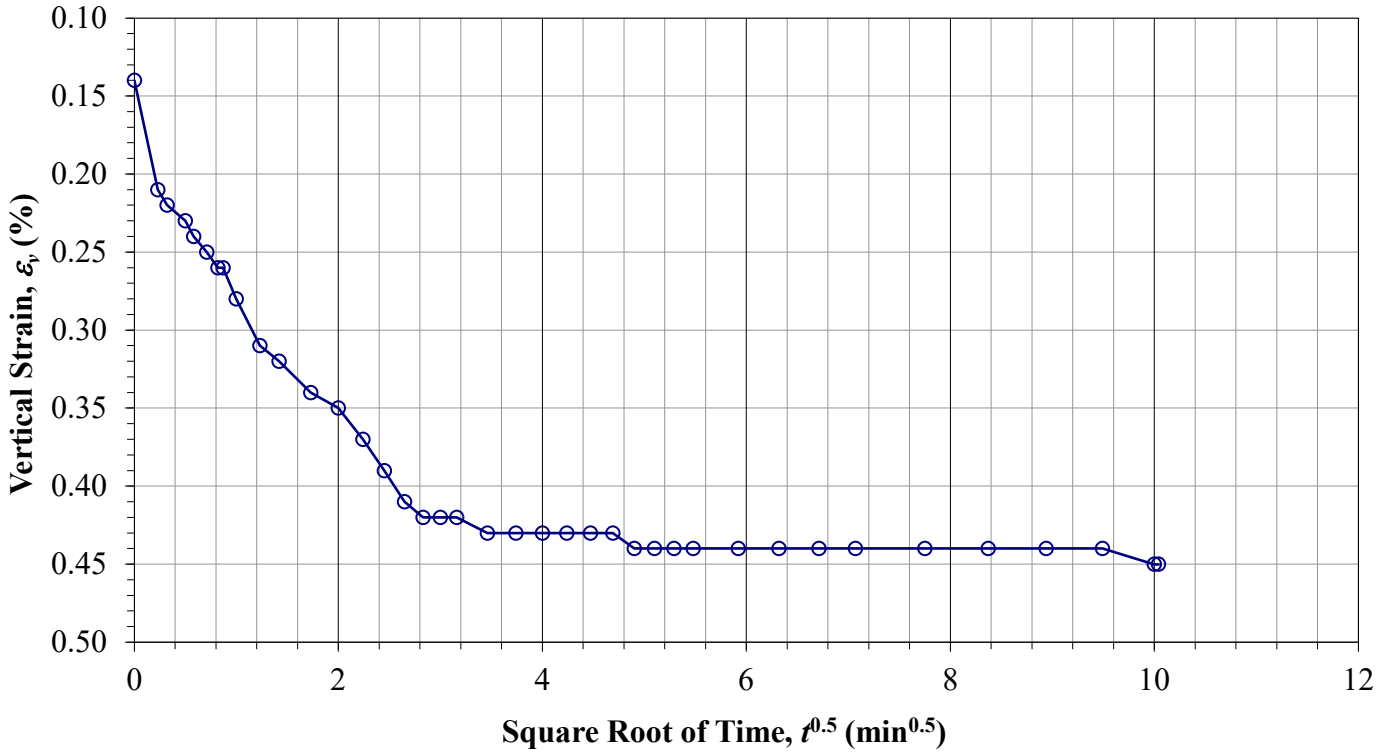
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 3 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

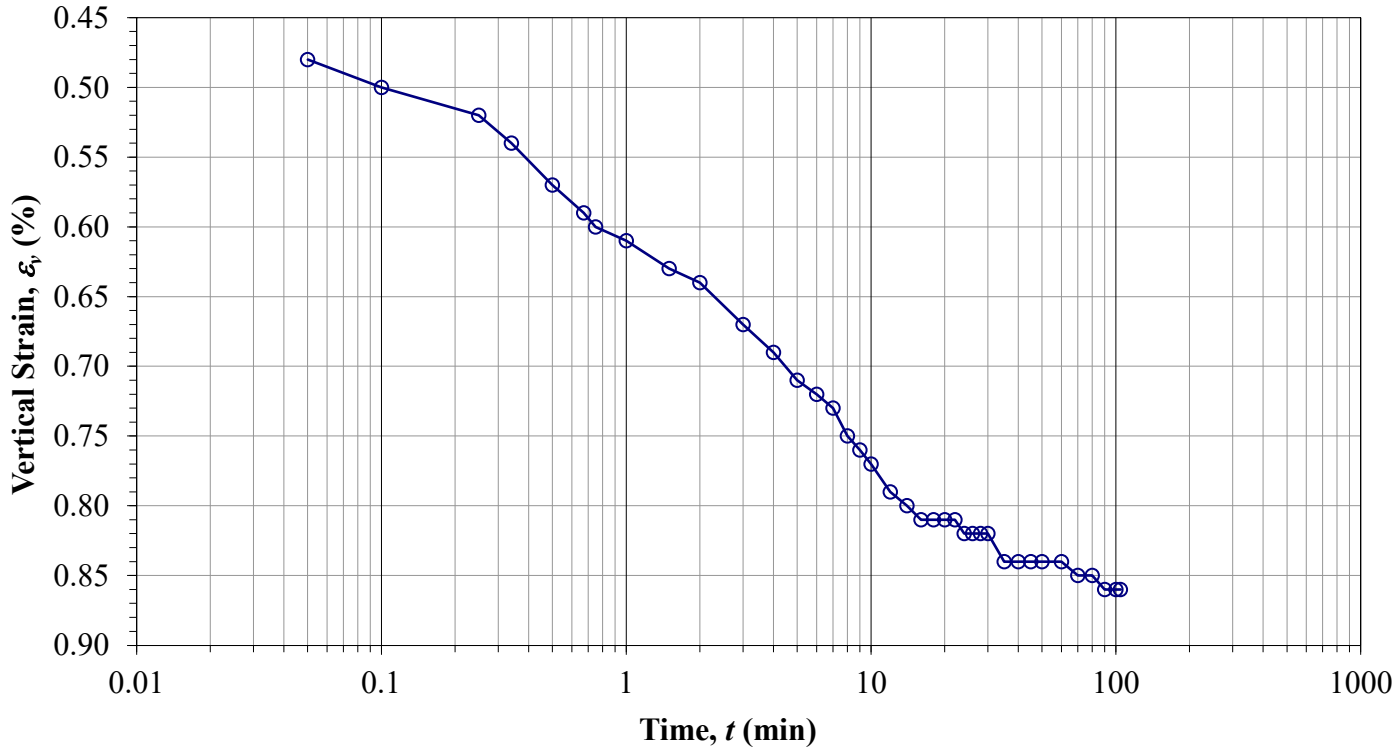
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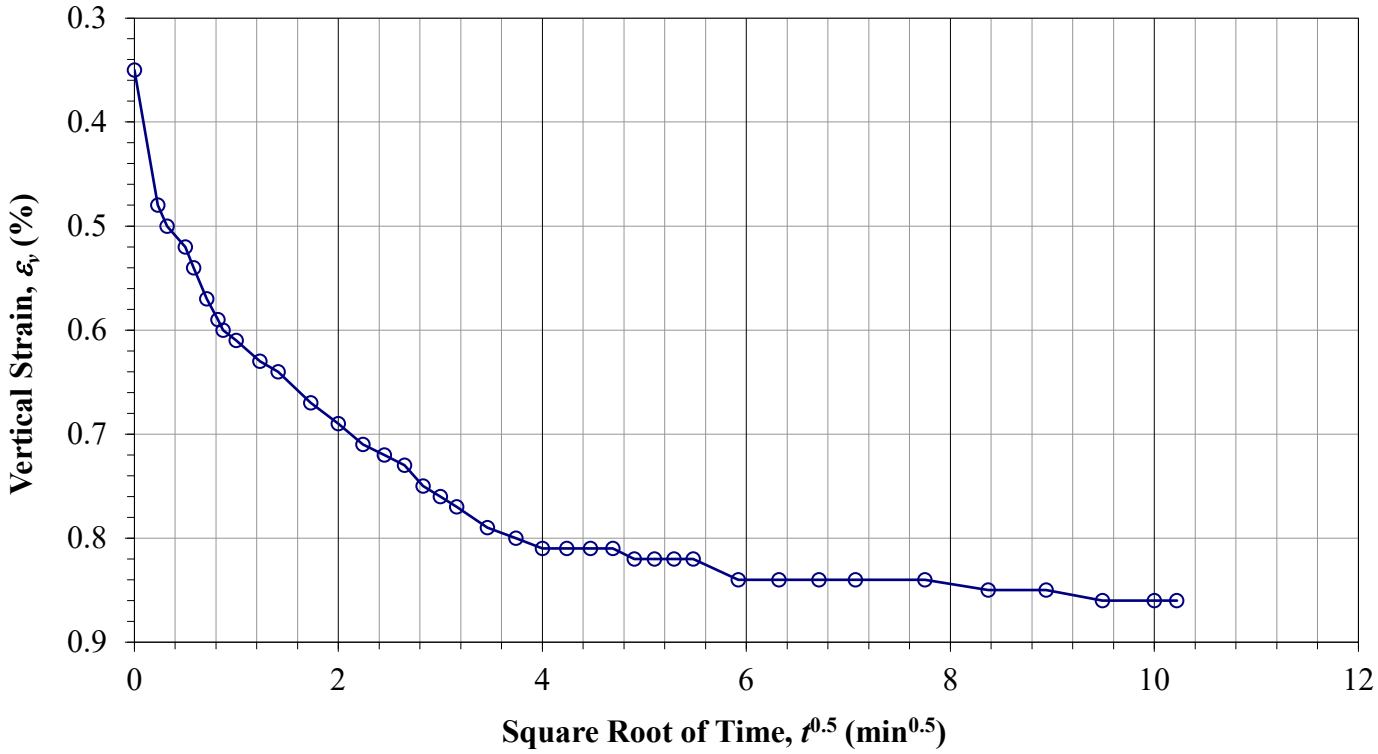
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

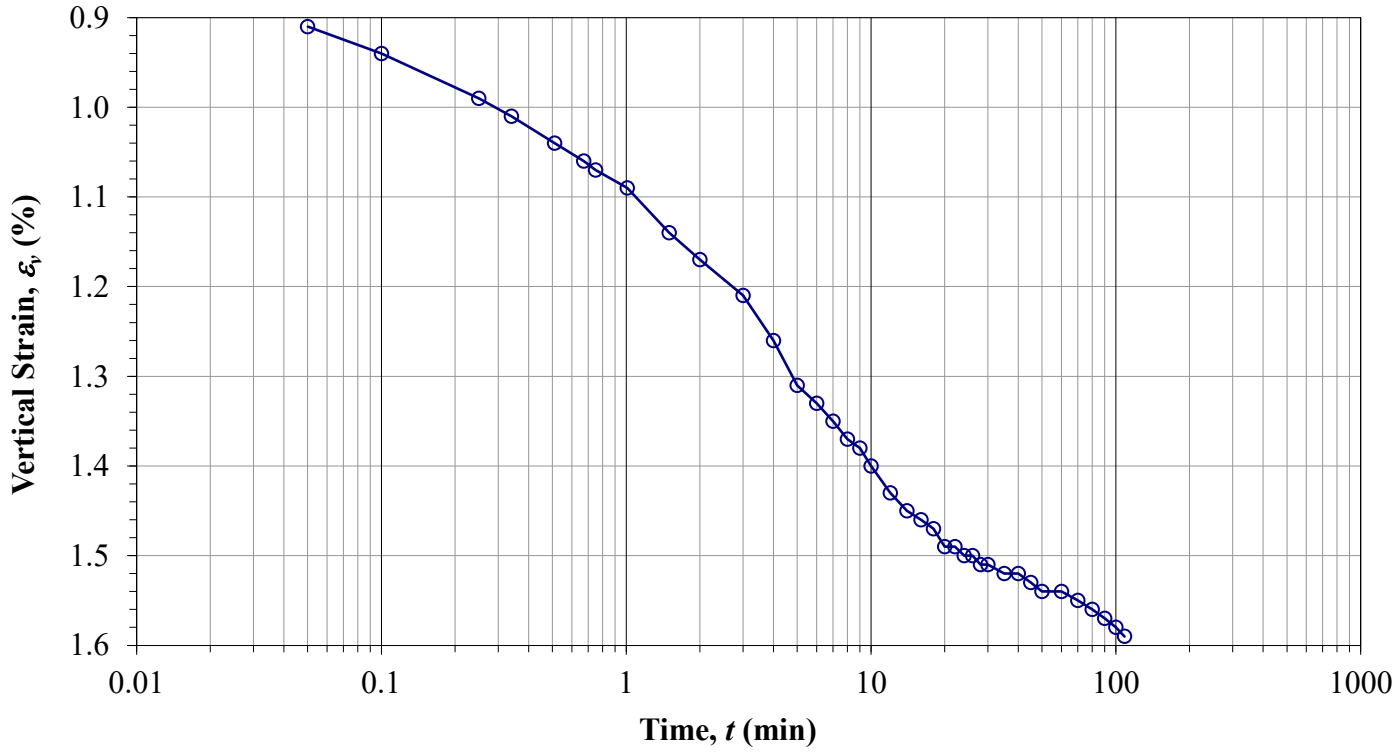
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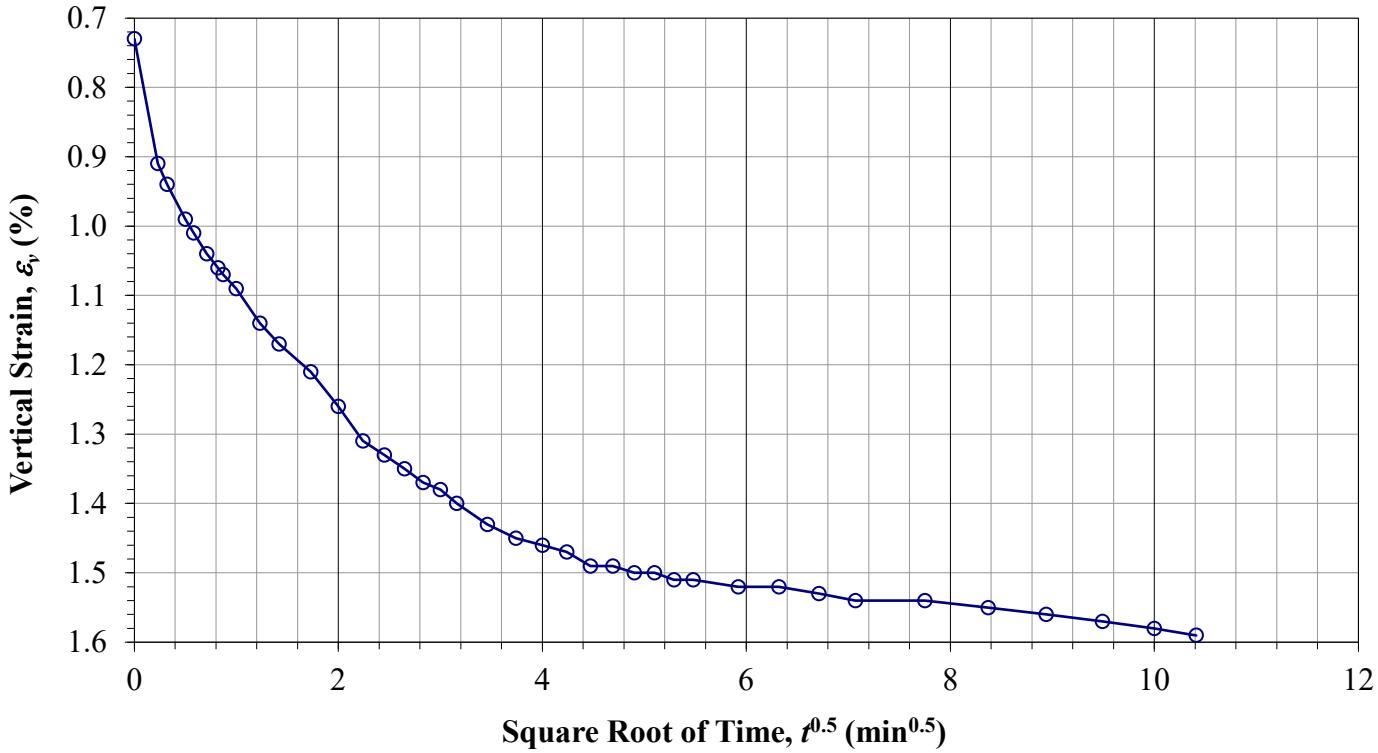
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 5 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

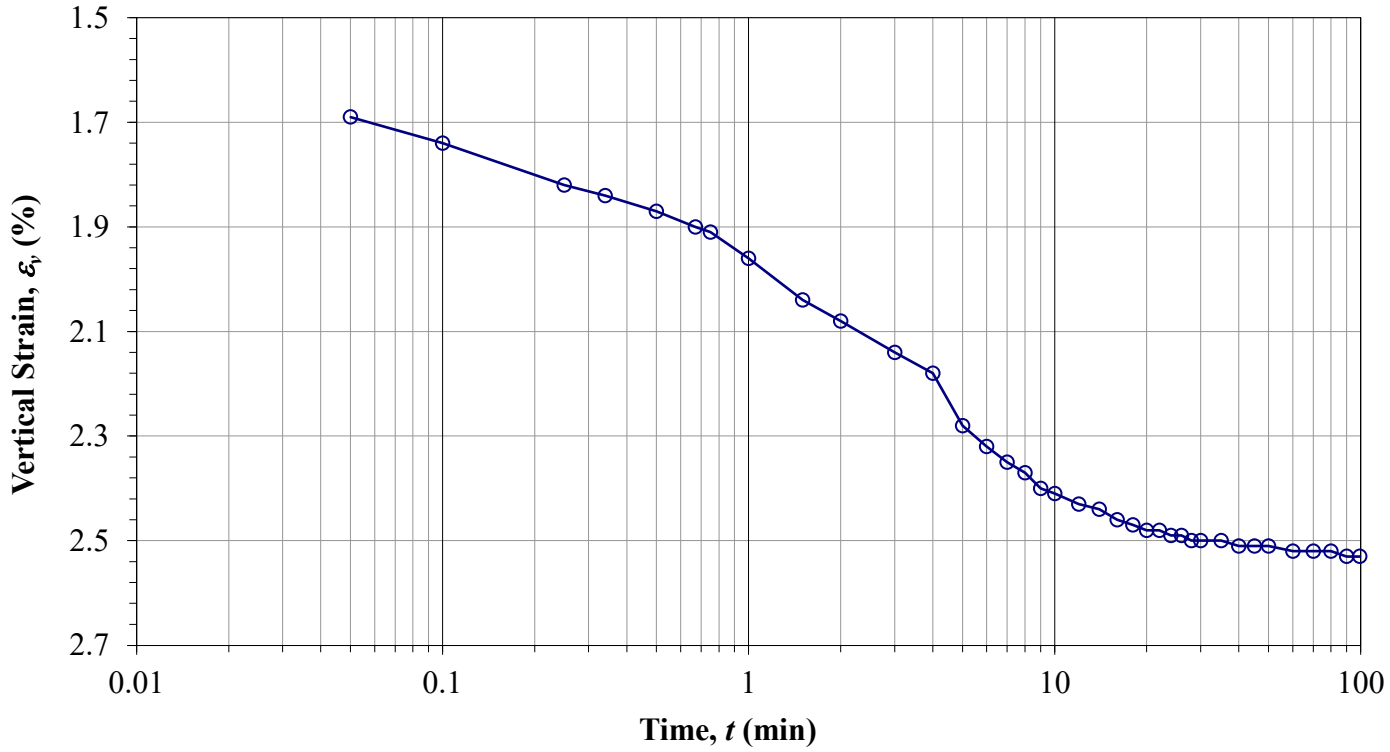
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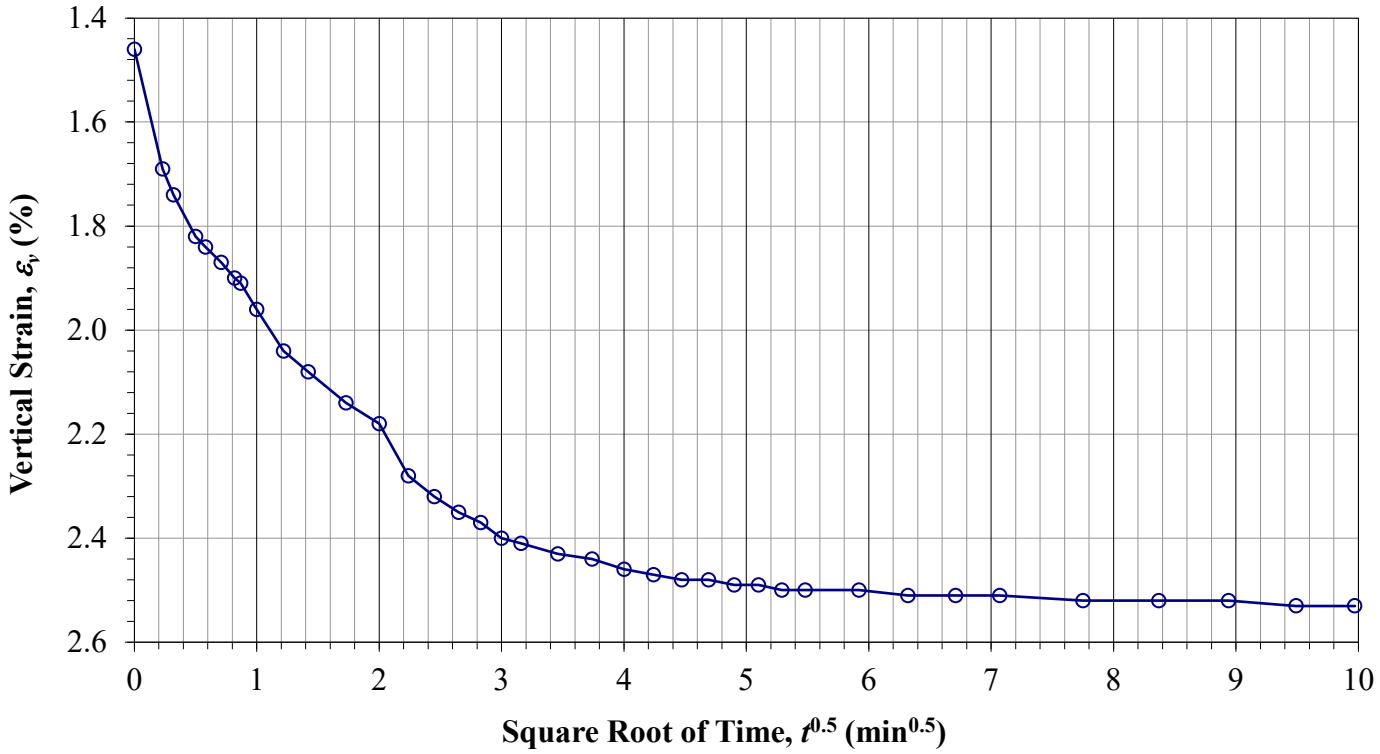
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 6 of 14
Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

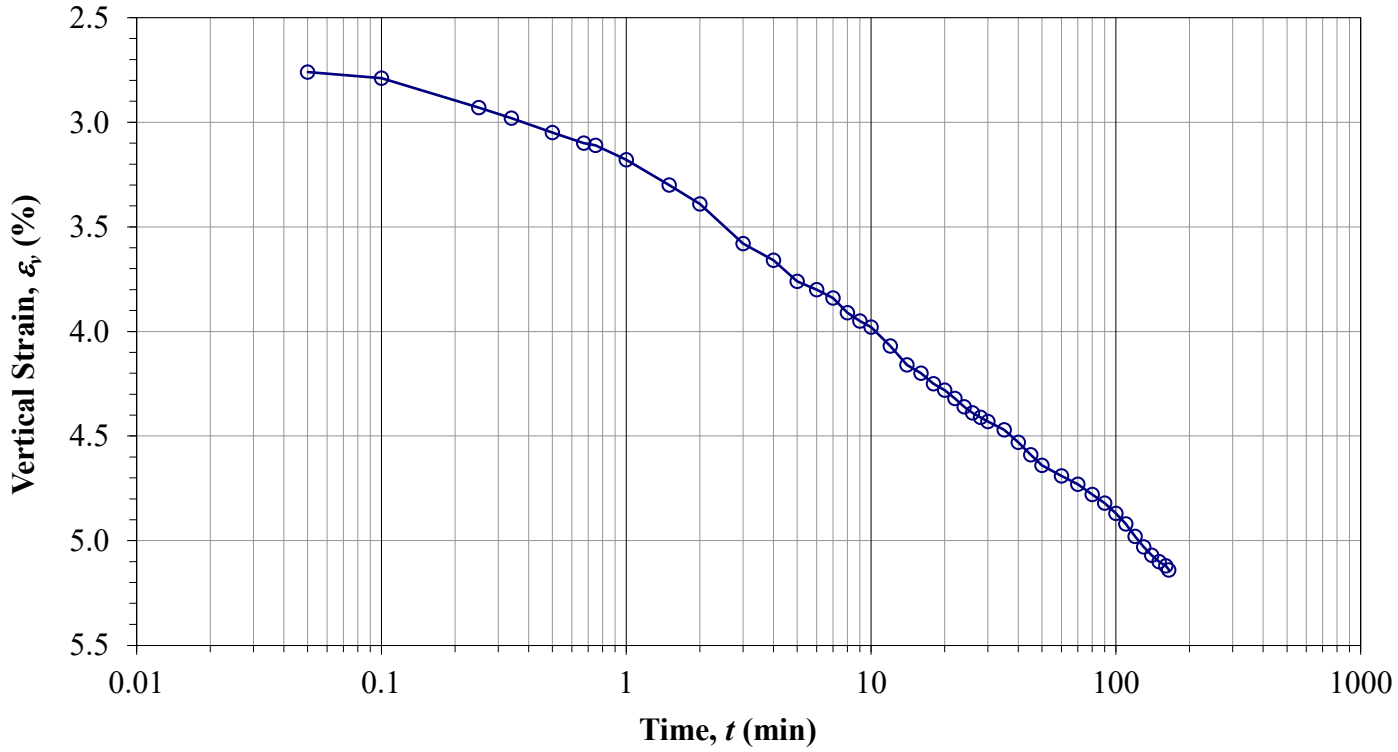
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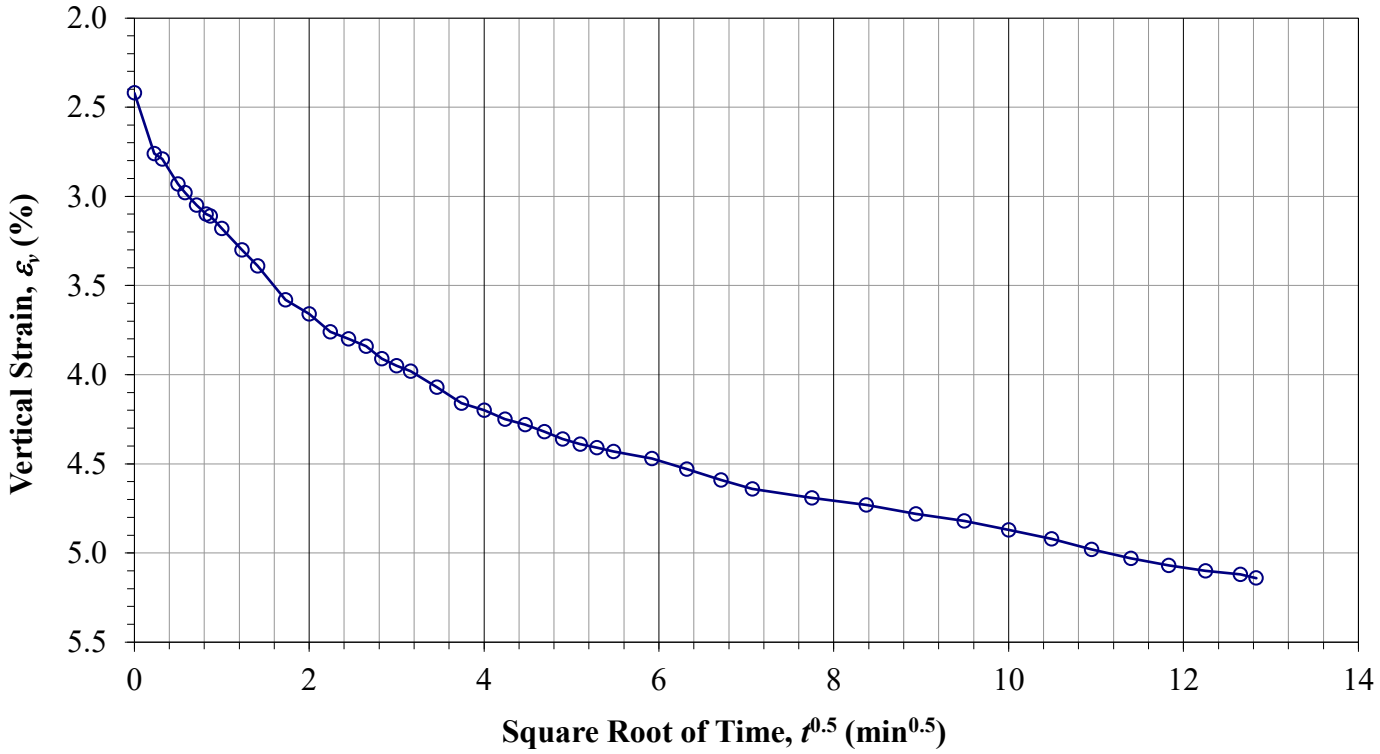
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 7 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

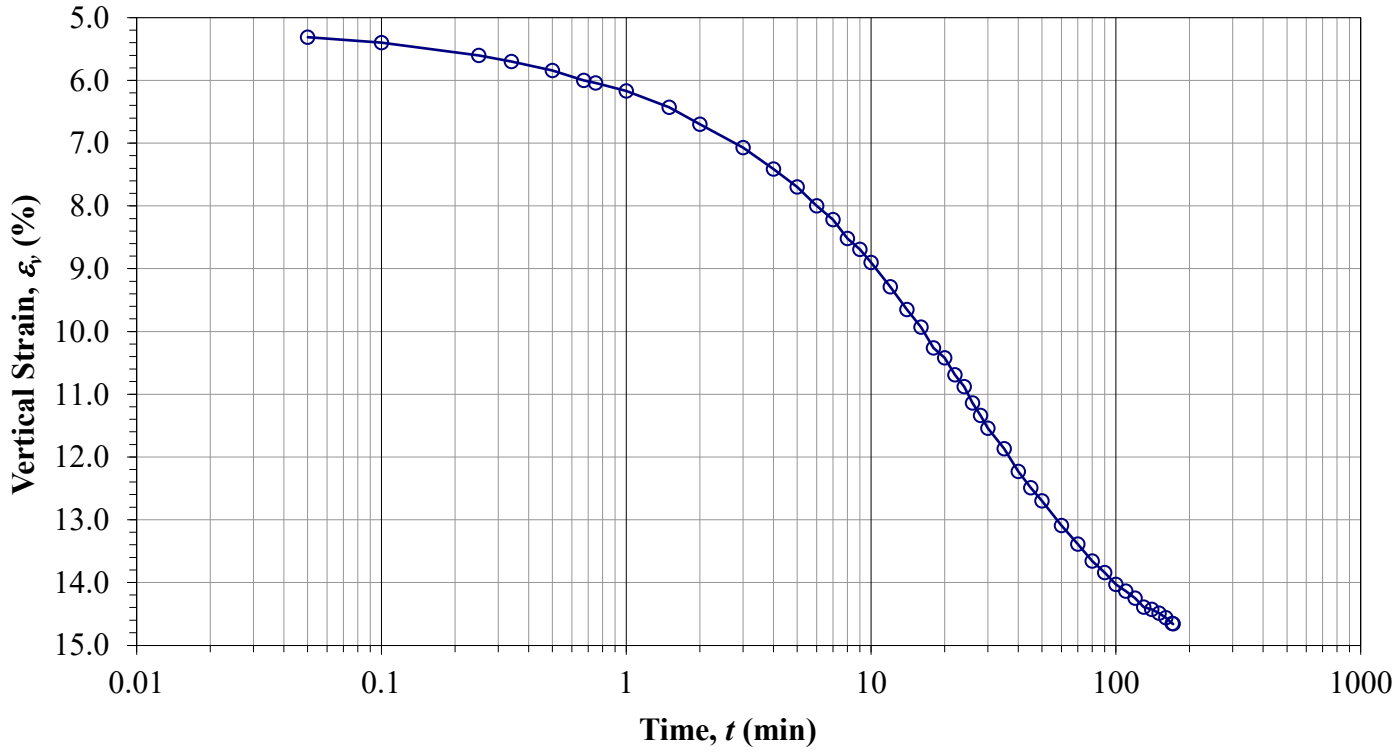
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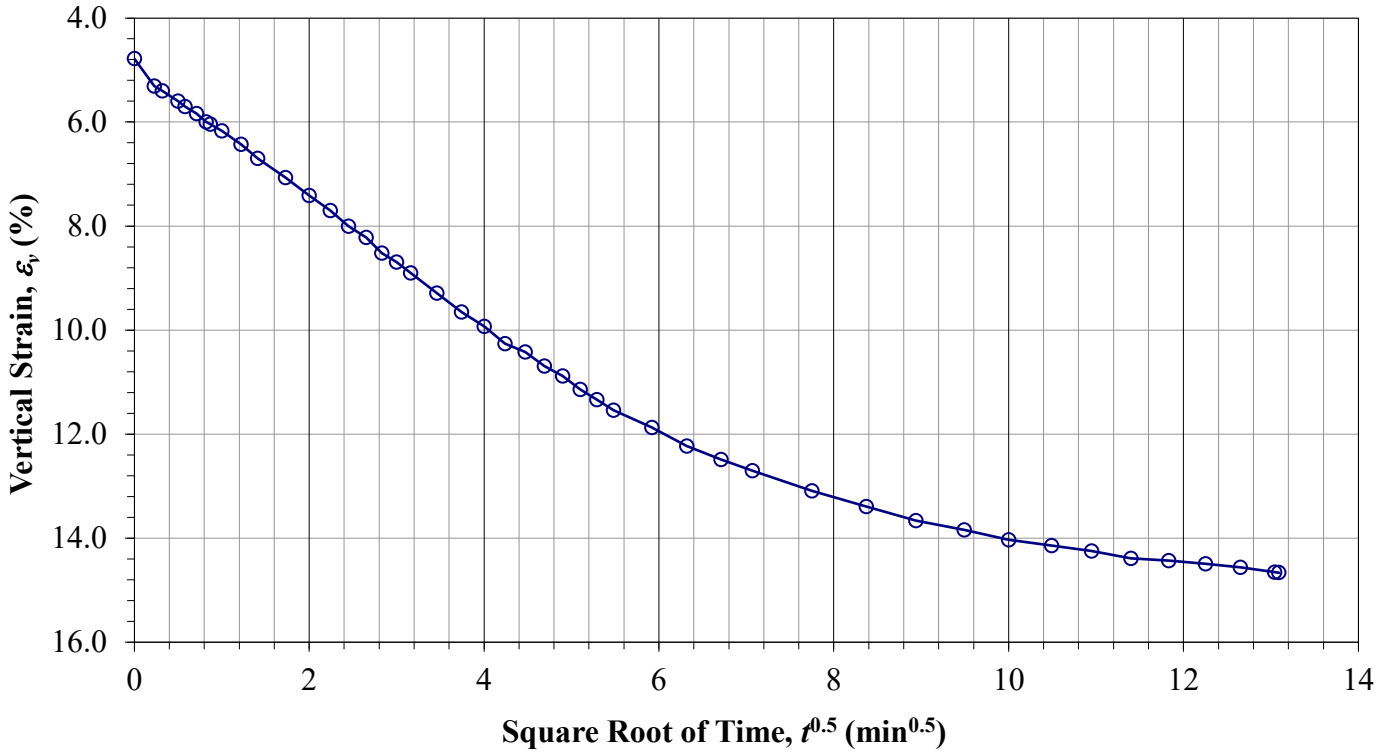
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 8 of 14
Stress: 12800 psf





One-Dimensional Consolidation Properties of Soils

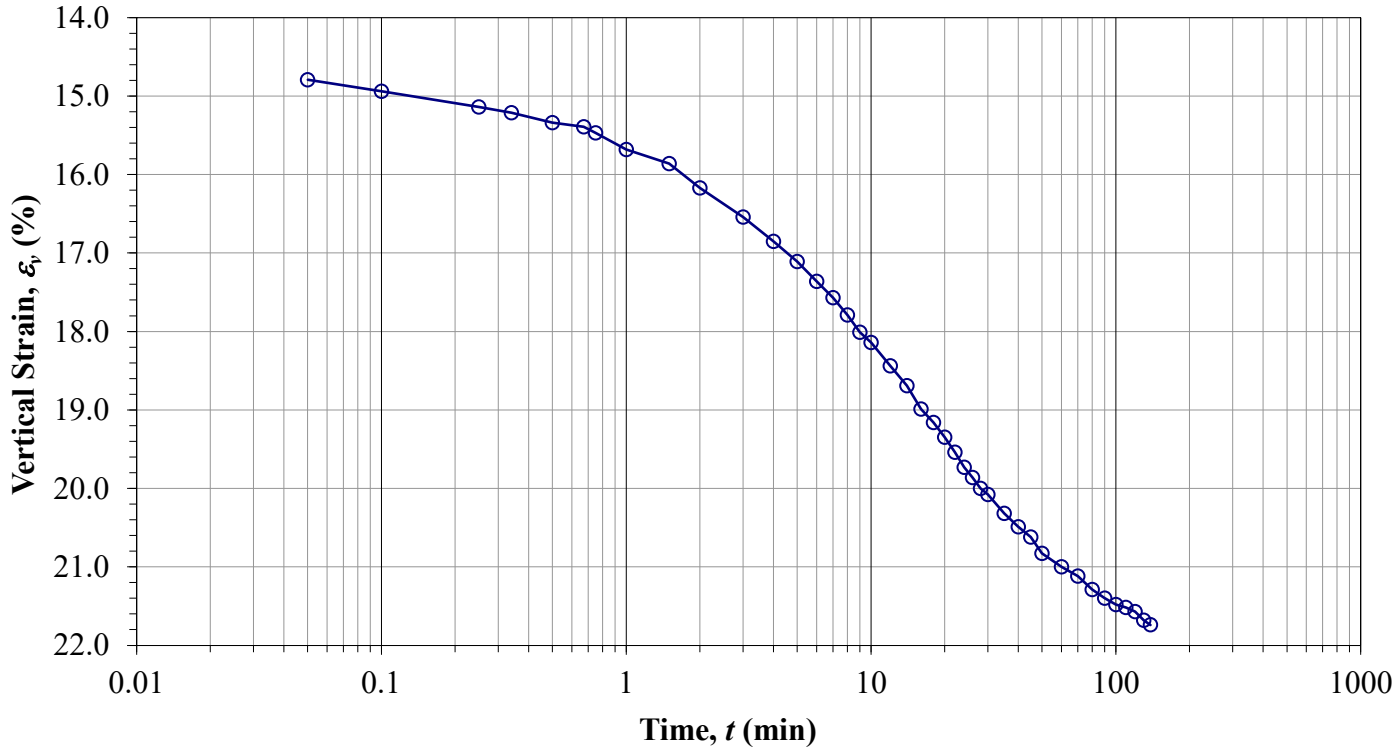
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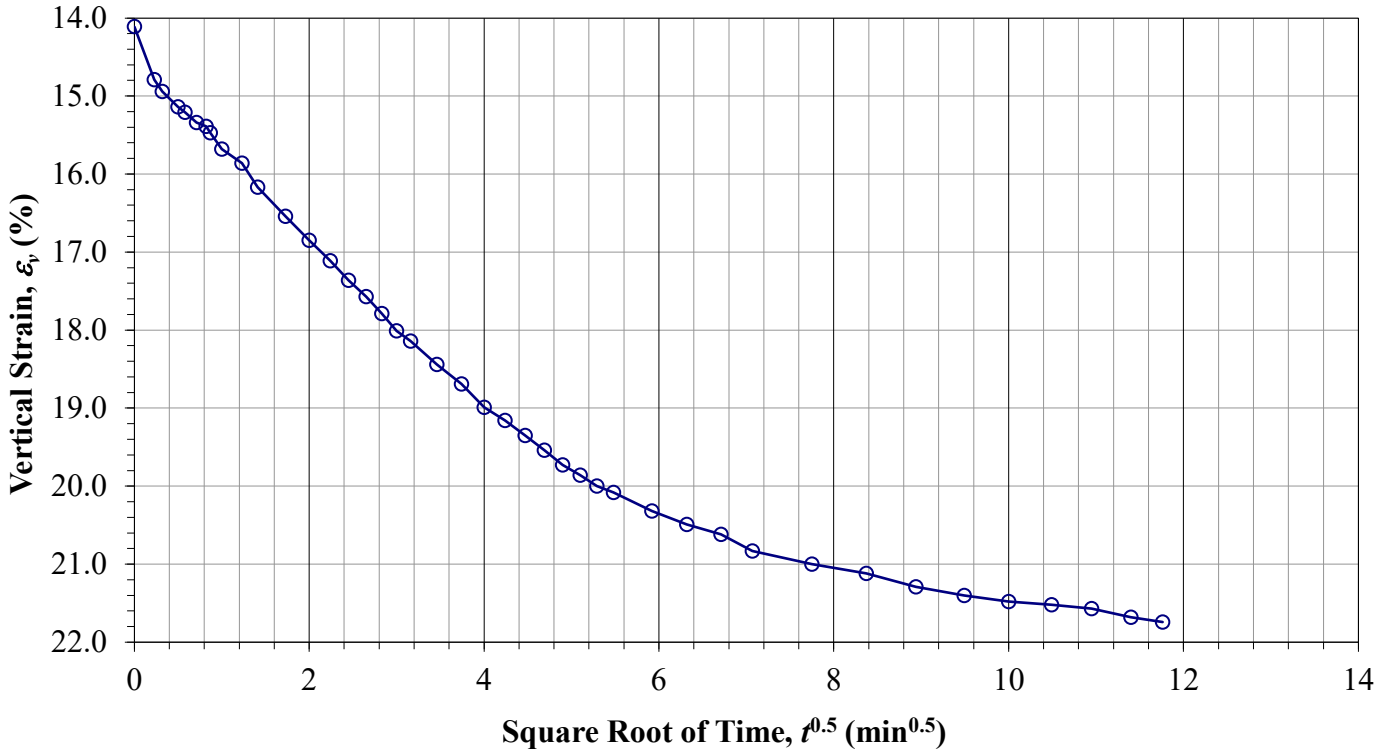
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 9 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

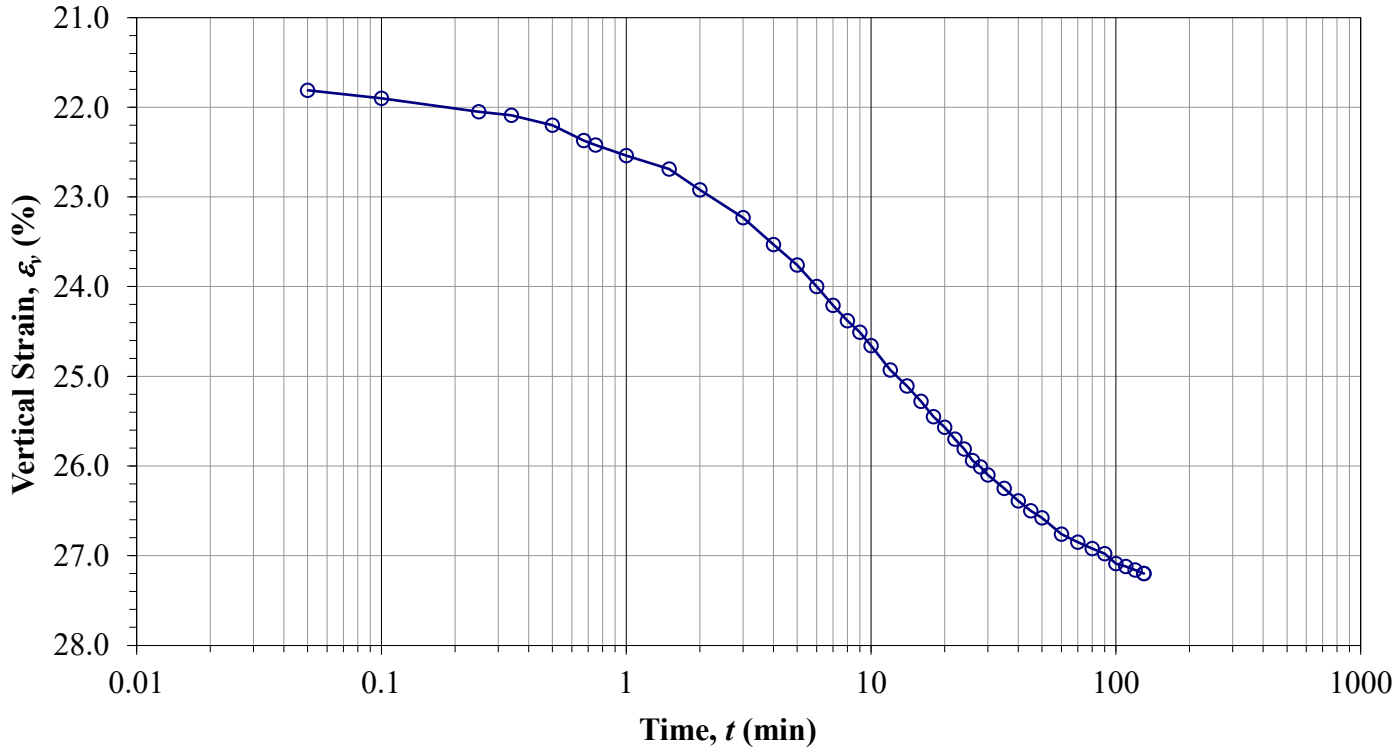
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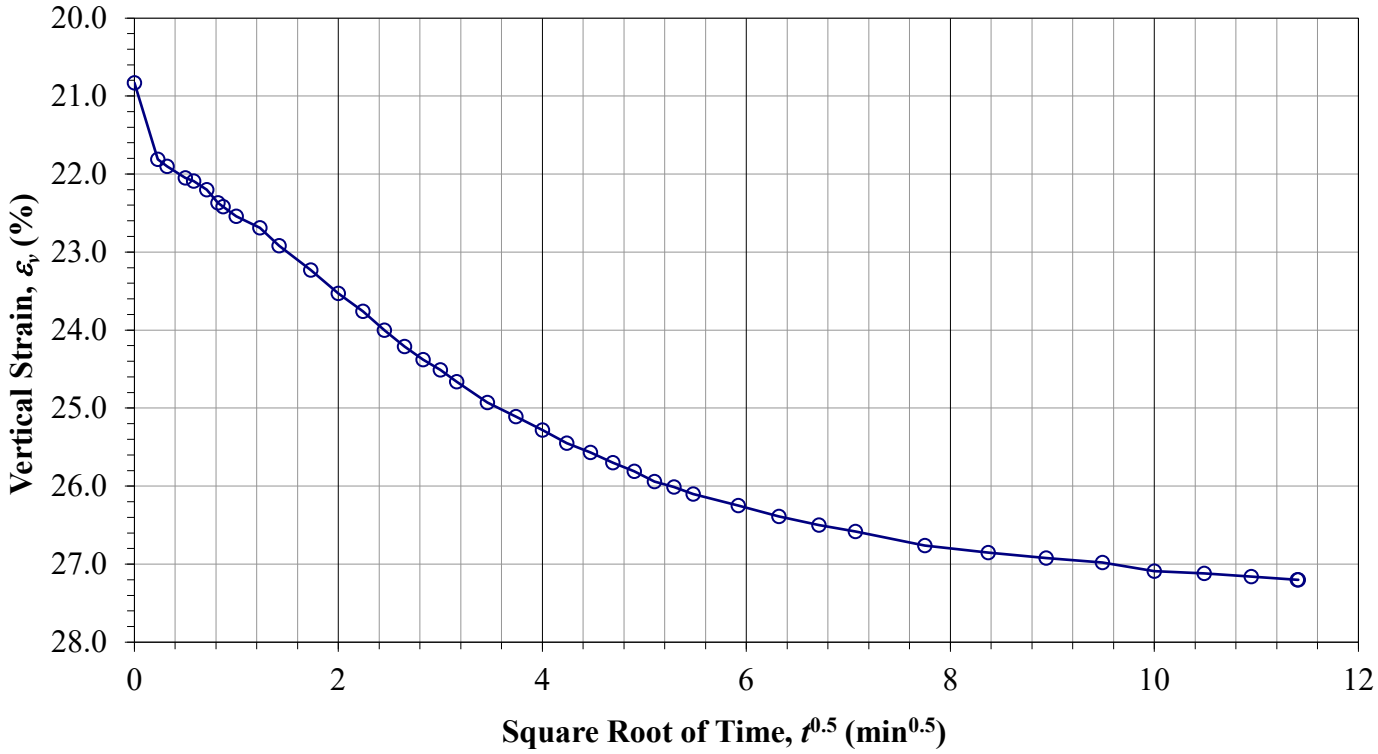
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 10 of 14
Stress: 51200 psf





One-Dimensional Consolidation Properties of Soils

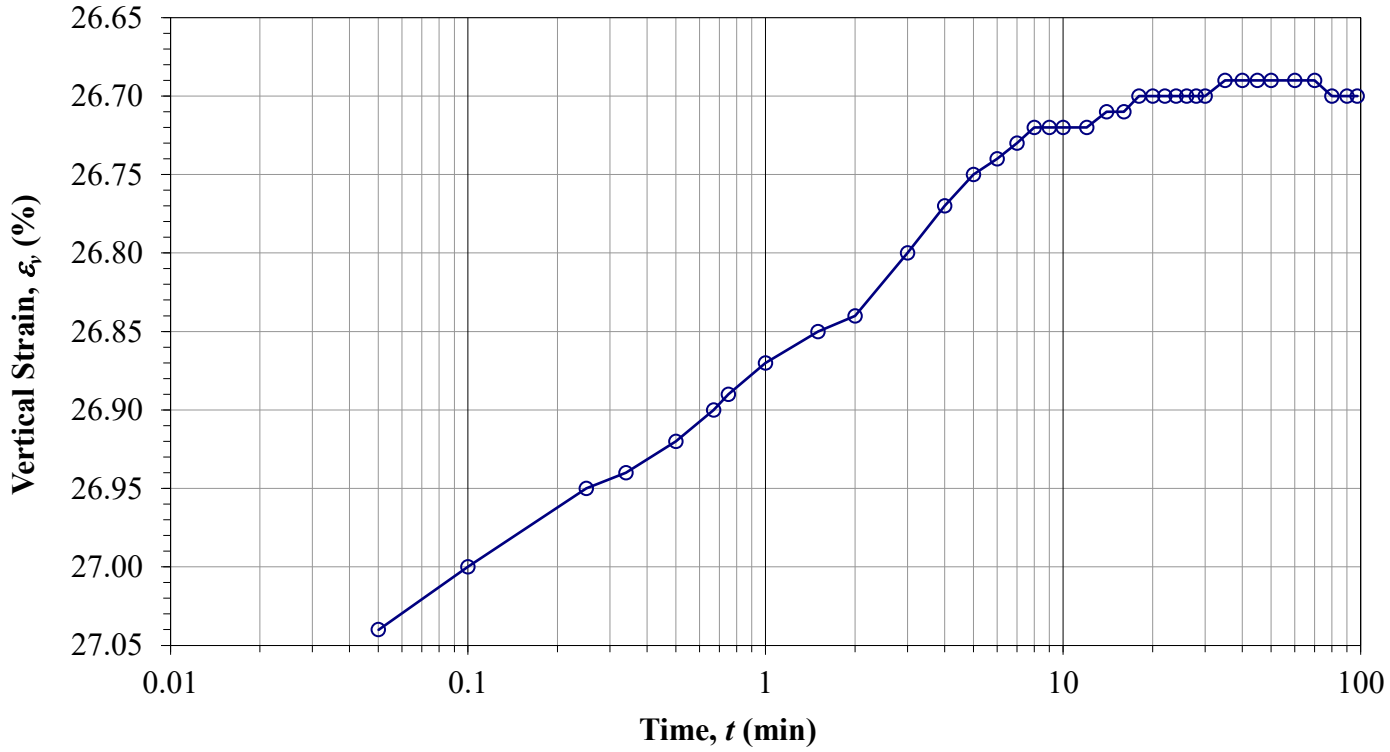
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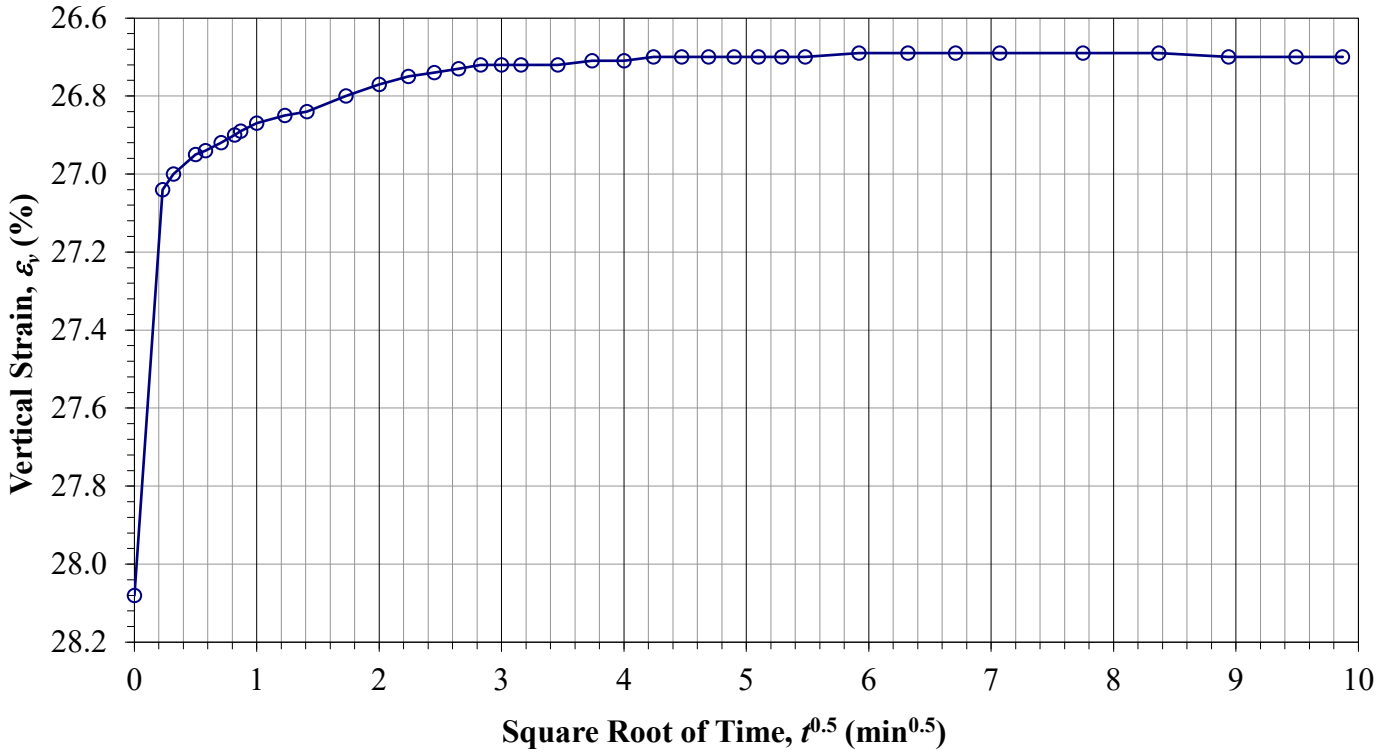
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 11 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

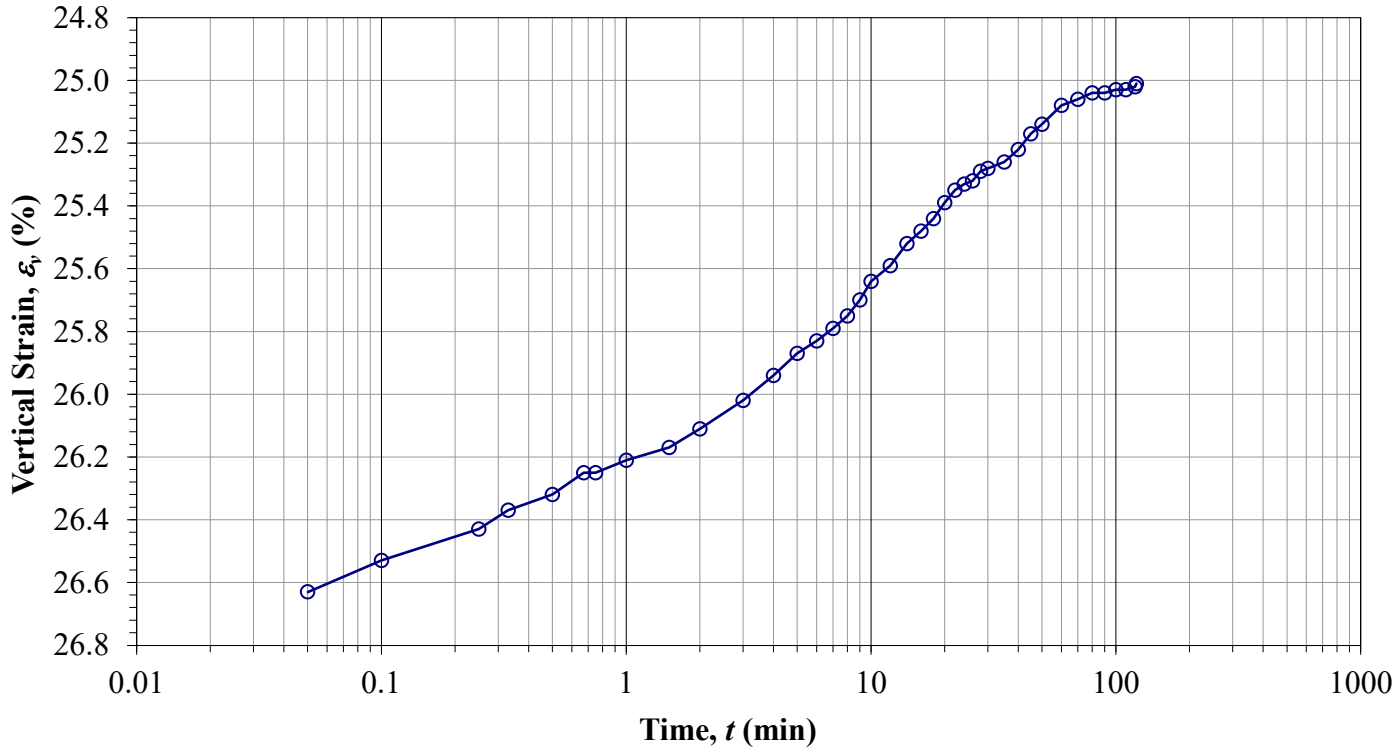
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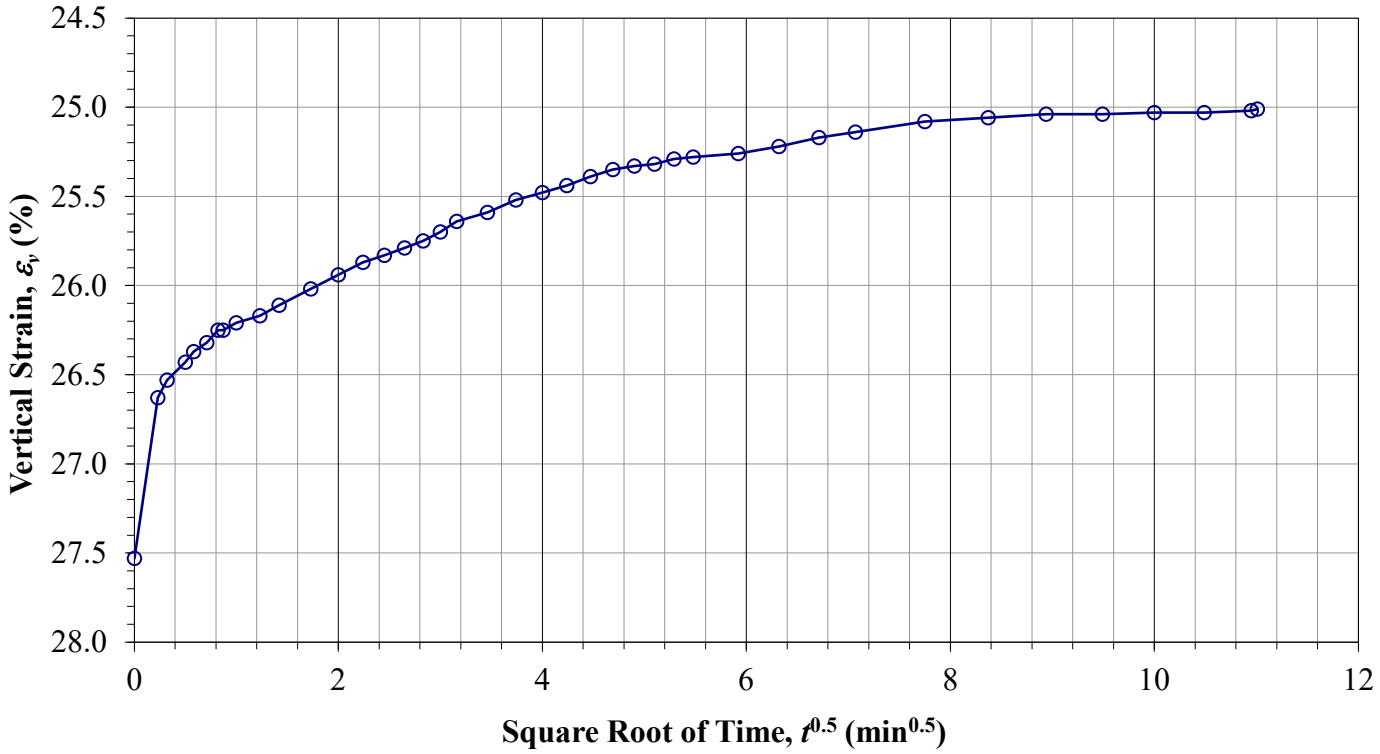
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 12 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

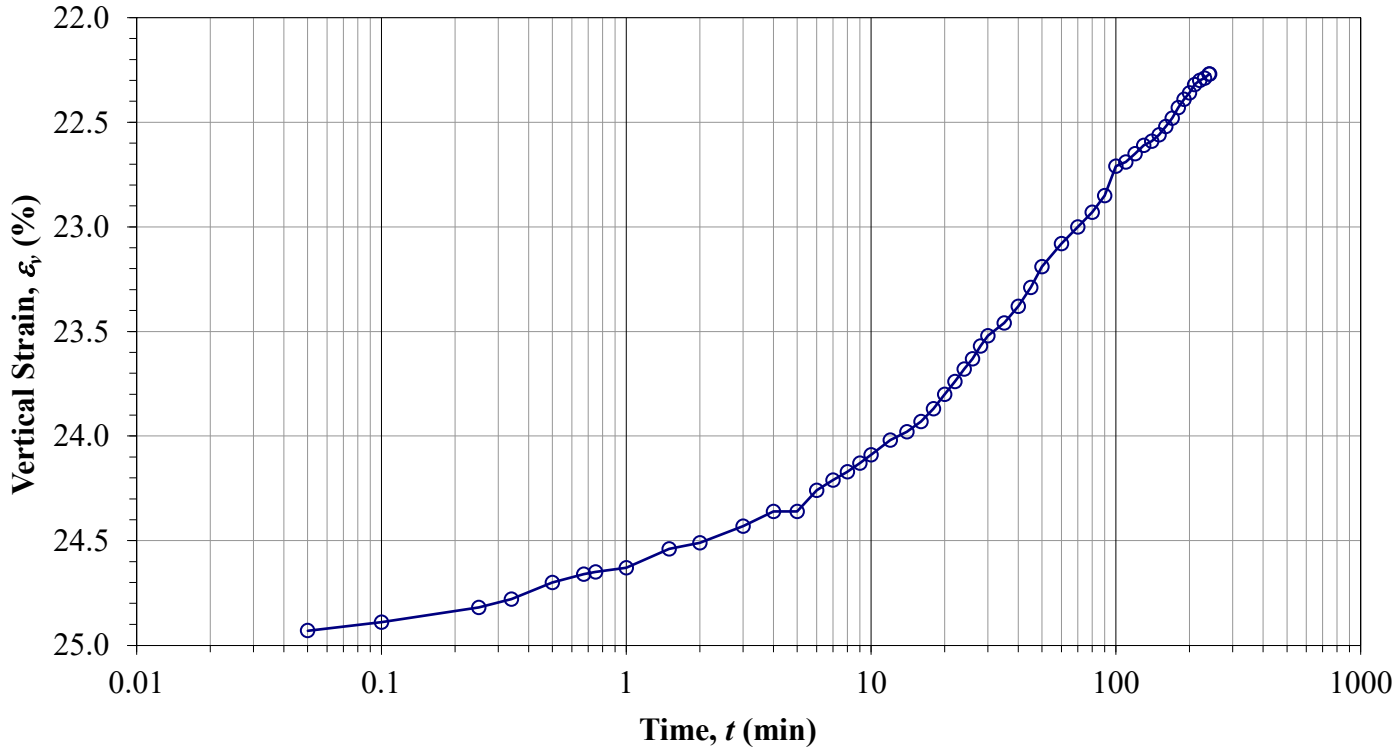
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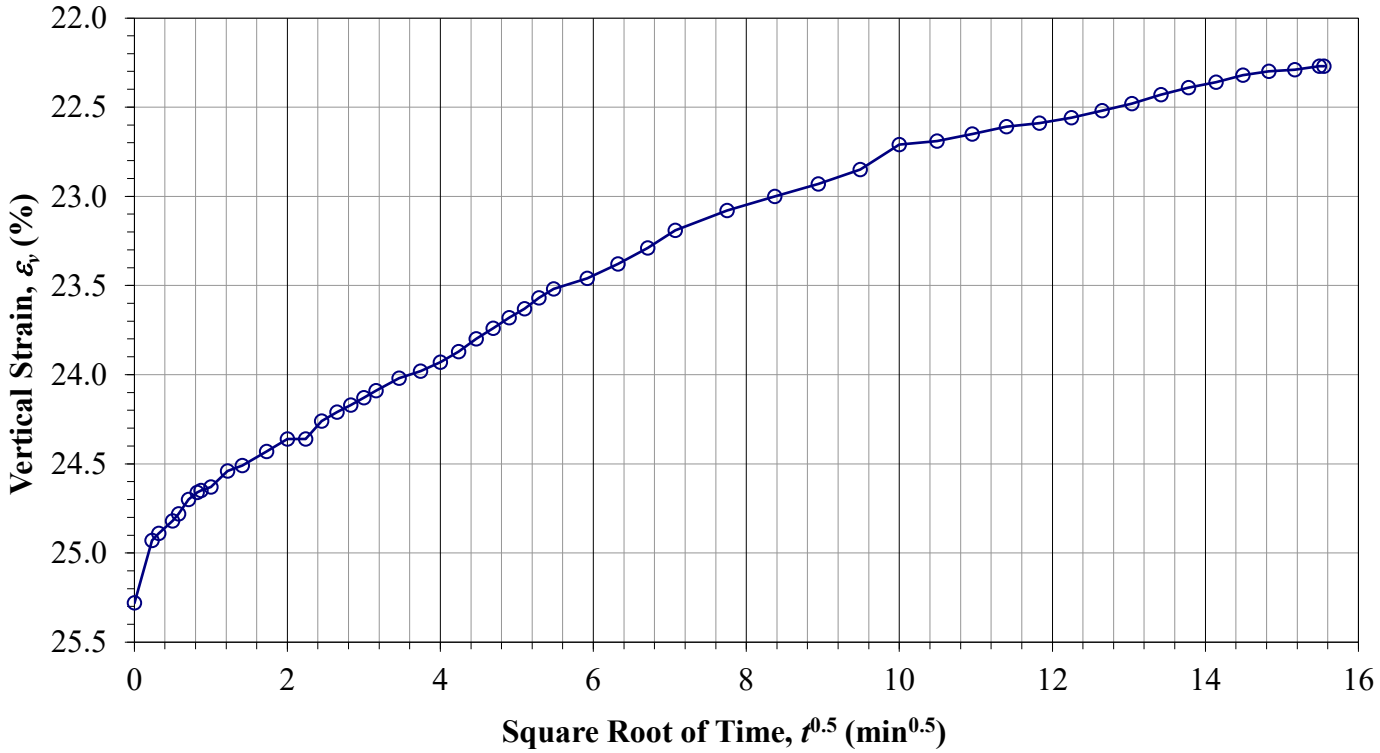
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 13 of 14
Stress: 1600 psf





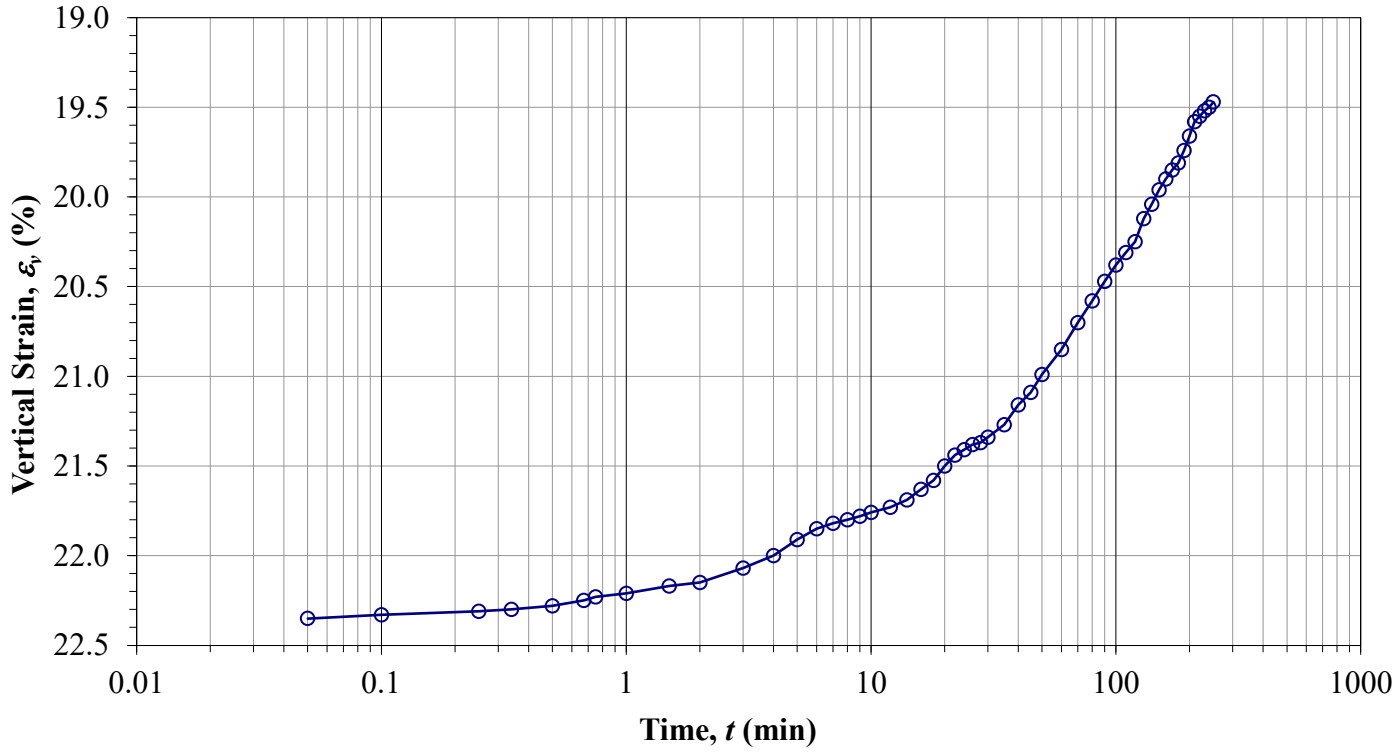
One-Dimensional Consolidation Properties of Soils
(ASTM D2435)

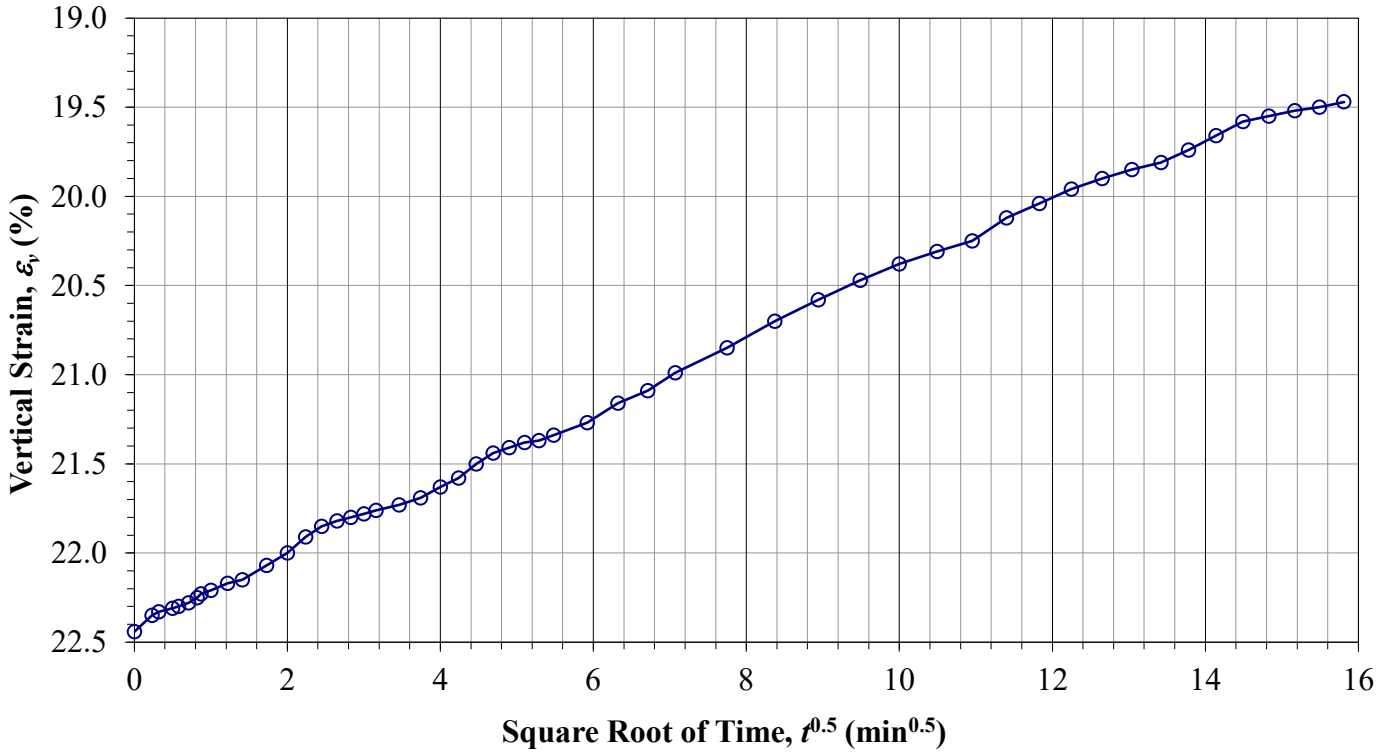
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-08
Sample: 13
Depth: 64'

Constant Load Step: 14 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/15/2021
By: EH

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

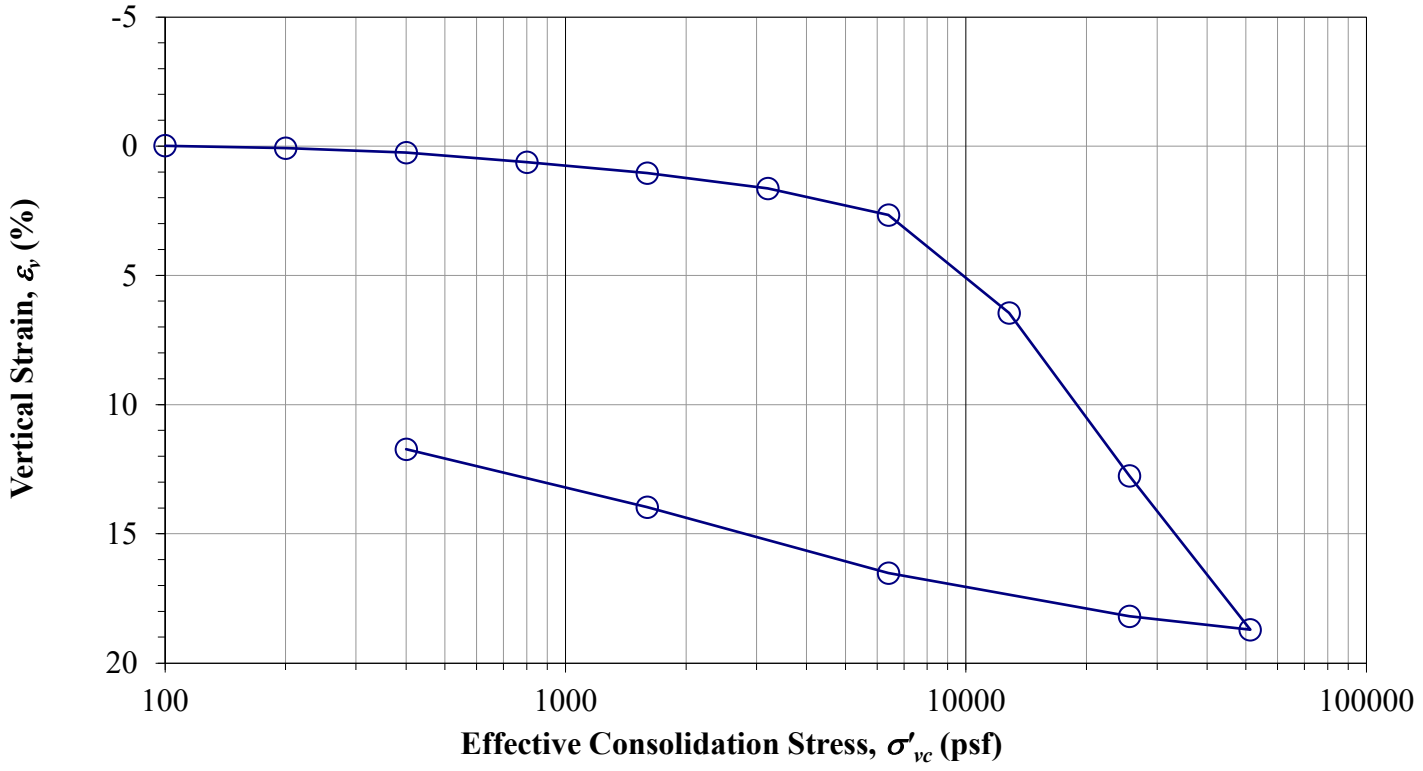
Test method:	B	
Inundation stress (psf), timing:	100	Beginning
Specific gravity, G_s	2.70	Assumed

Water type used for inundation Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.925	0.817
Sample diameter, D (in.)	2.419	2.419
Wt. rings + wet soil (g)	172.76	169.51
Wt. rings/tare (g)	45.38	45.38
Total unit wt., γ (pcf)	114.1	126.01
Wet soil + tare (g)	341.60	246.64
Dry soil + tare (g)	286.62	218.03
Tare (g)	128.47	126.69
Water content, ω (%)	34.8	31.3
Dry unit wt., γ_d (pcf)	84.7	96.0
Saturation, S	0.95	1.00

*Note: C_v, C_c, C_r, and σ_p' to be determined by Geotechnical Engineer.

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9250	0.9900
100	-0.0002	-0.02	0.9252	0.9904
200	0.0006	0.07	0.9244	0.9886
400	0.0023	0.25	0.9227	0.9850
800	0.0057	0.61	0.9193	0.9777
1600	0.0096	1.03	0.9154	0.9694
3200	0.0151	1.63	0.9099	0.9575
6400	0.0246	2.66	0.9004	0.9370
12800	0.0597	6.46	0.8653	0.8615
25600	0.1180	12.75	0.8070	0.7361
51200	0.1730	18.71	0.7520	0.6177
25600	0.1683	18.20	0.7567	0.6278
6400	0.1528	16.52	0.7722	0.6612
1600	0.1293	13.97	0.7958	0.7119
400	0.1085	11.73	0.8165	0.7566



Comments: Test specimen swelled upon inundation and at 100 psf load step.

Entered: _____
Reviewed: _____

One-Dimensional Consolidation Properties of Soils

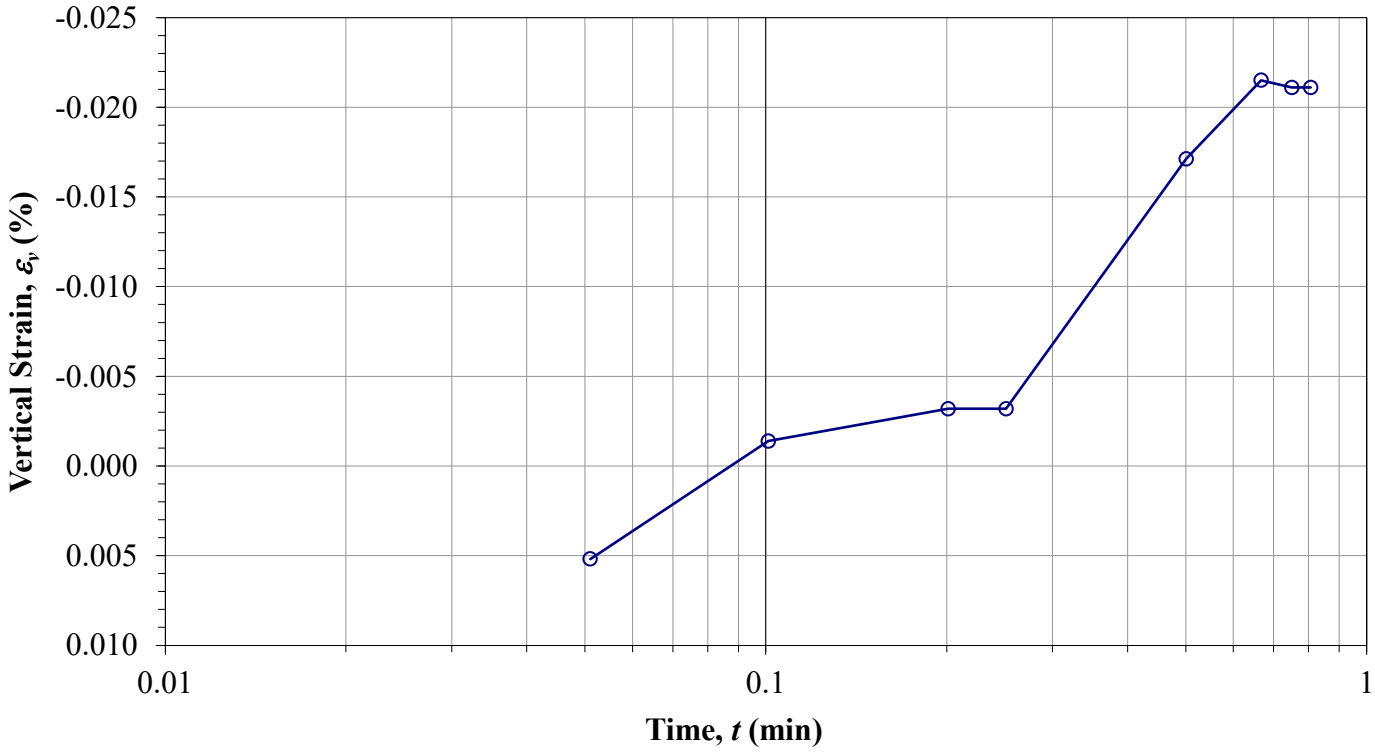
(ASTM D2435)

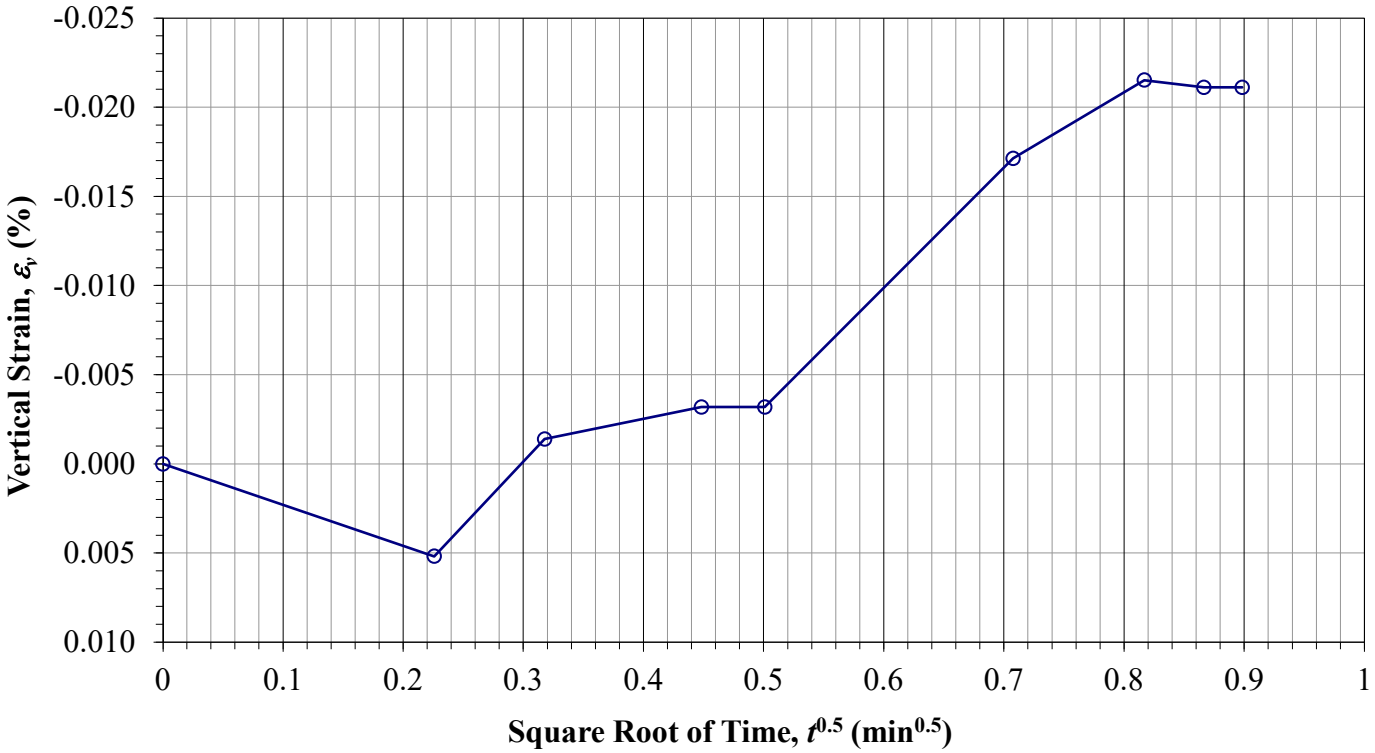
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 1 of 14
Stress: 100 psf





One-Dimensional Consolidation Properties of Soils

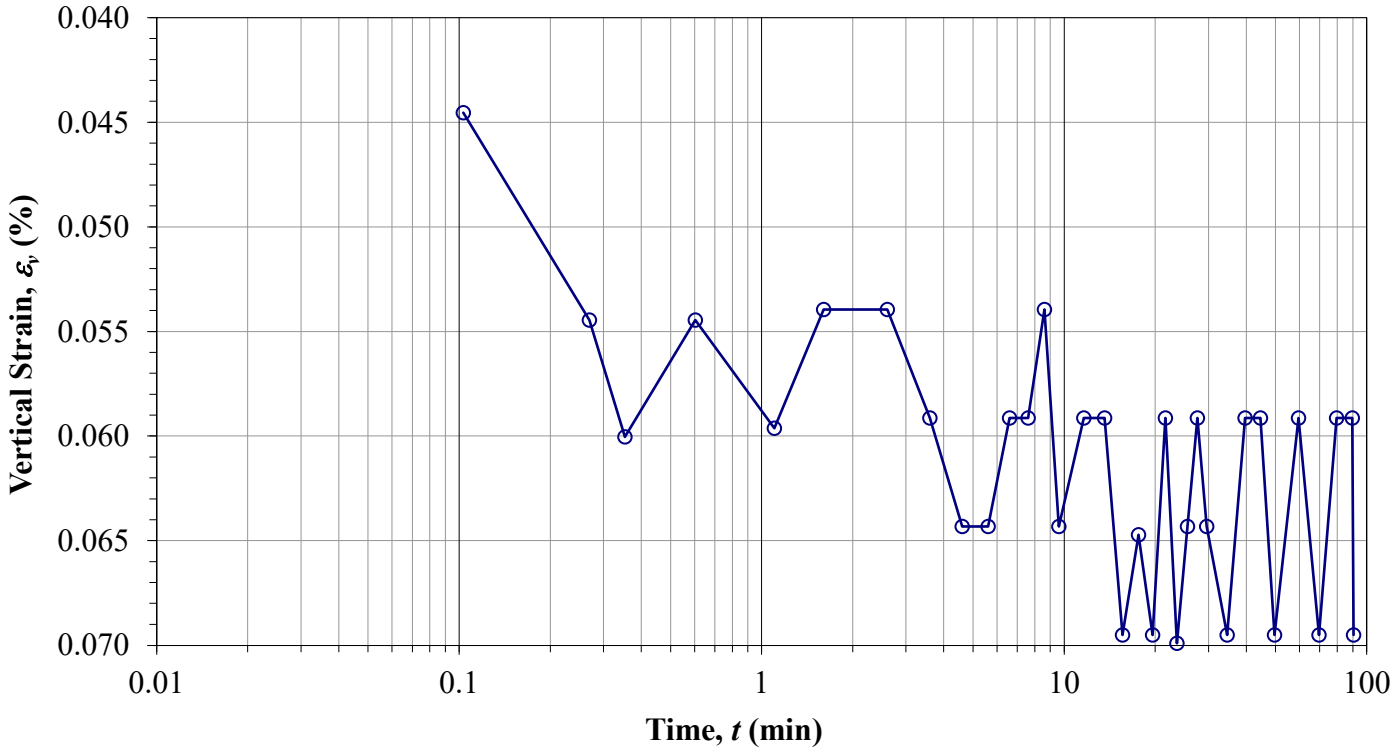
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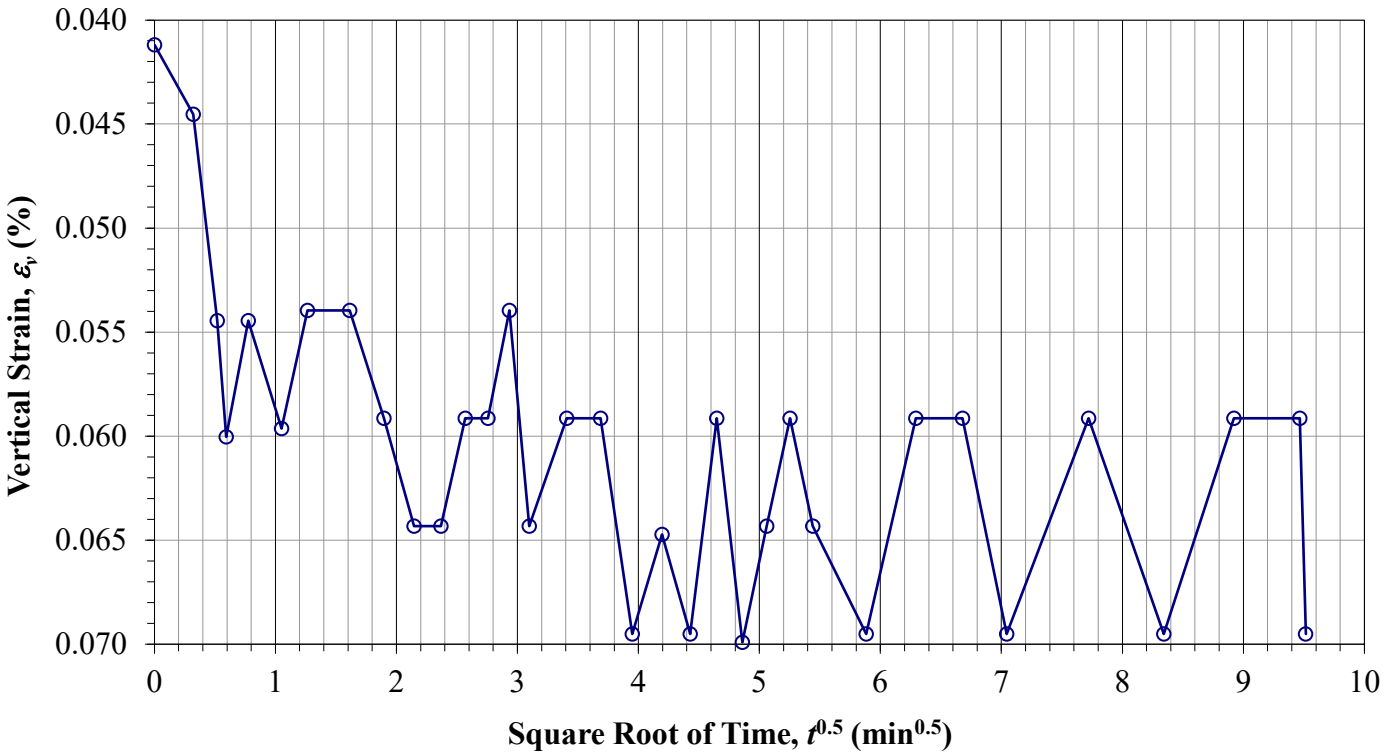
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 2 of 14
Stress: 200 psf





One-Dimensional Consolidation Properties of Soils

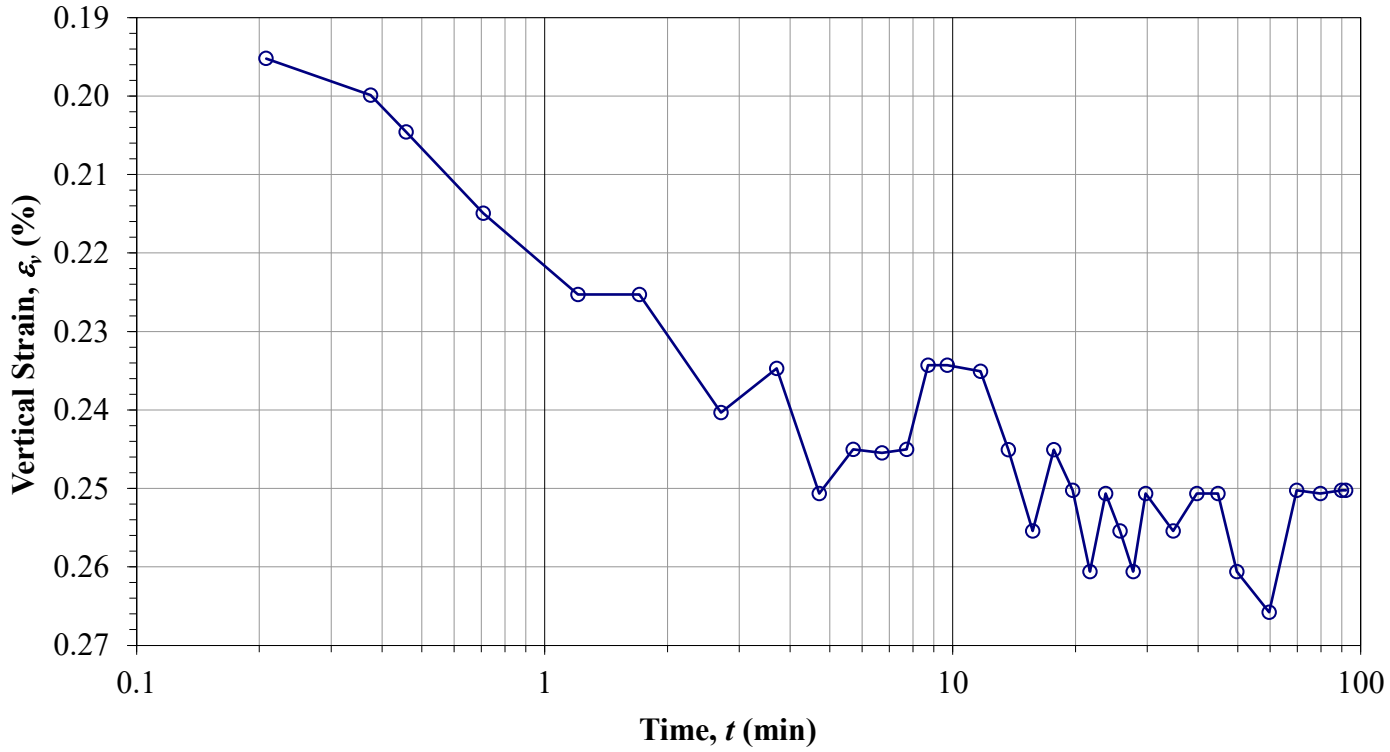
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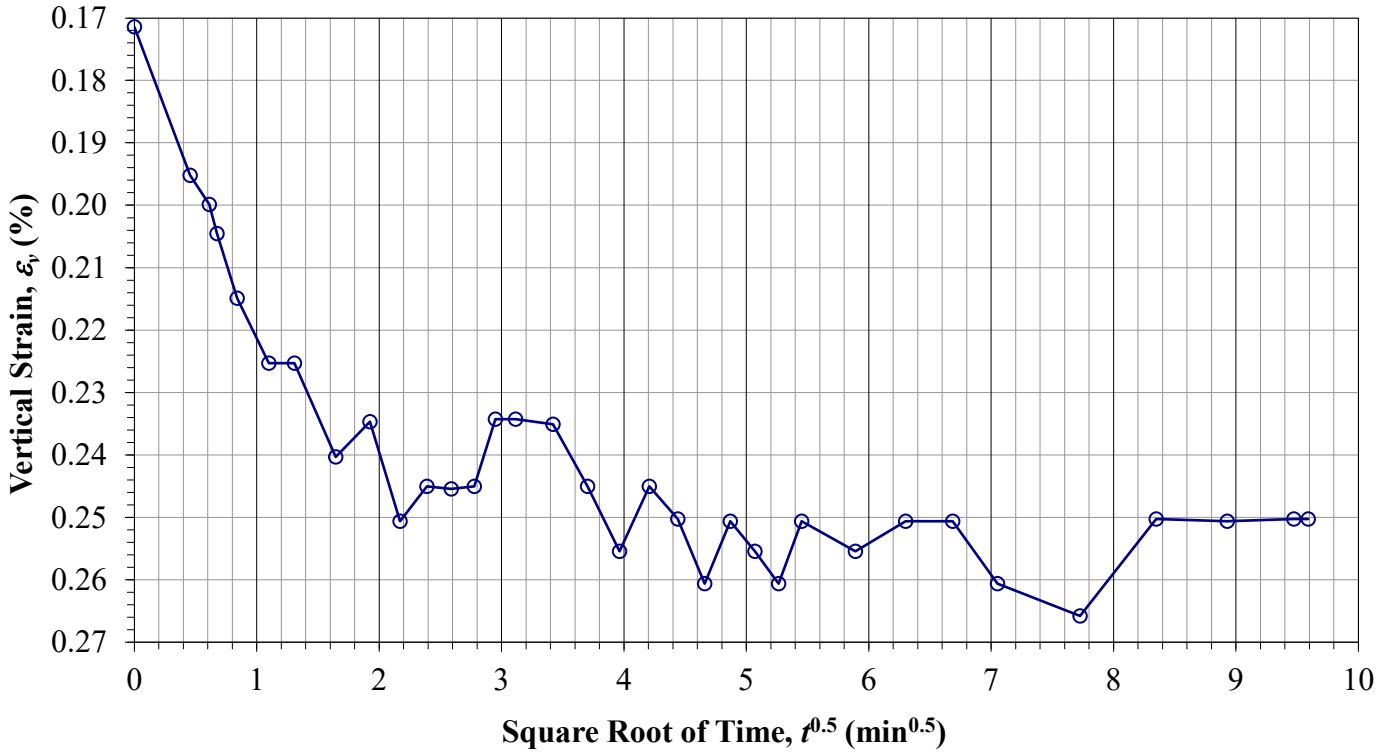
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 3 of 14
Stress: 400 psf





One-Dimensional Consolidation Properties of Soils

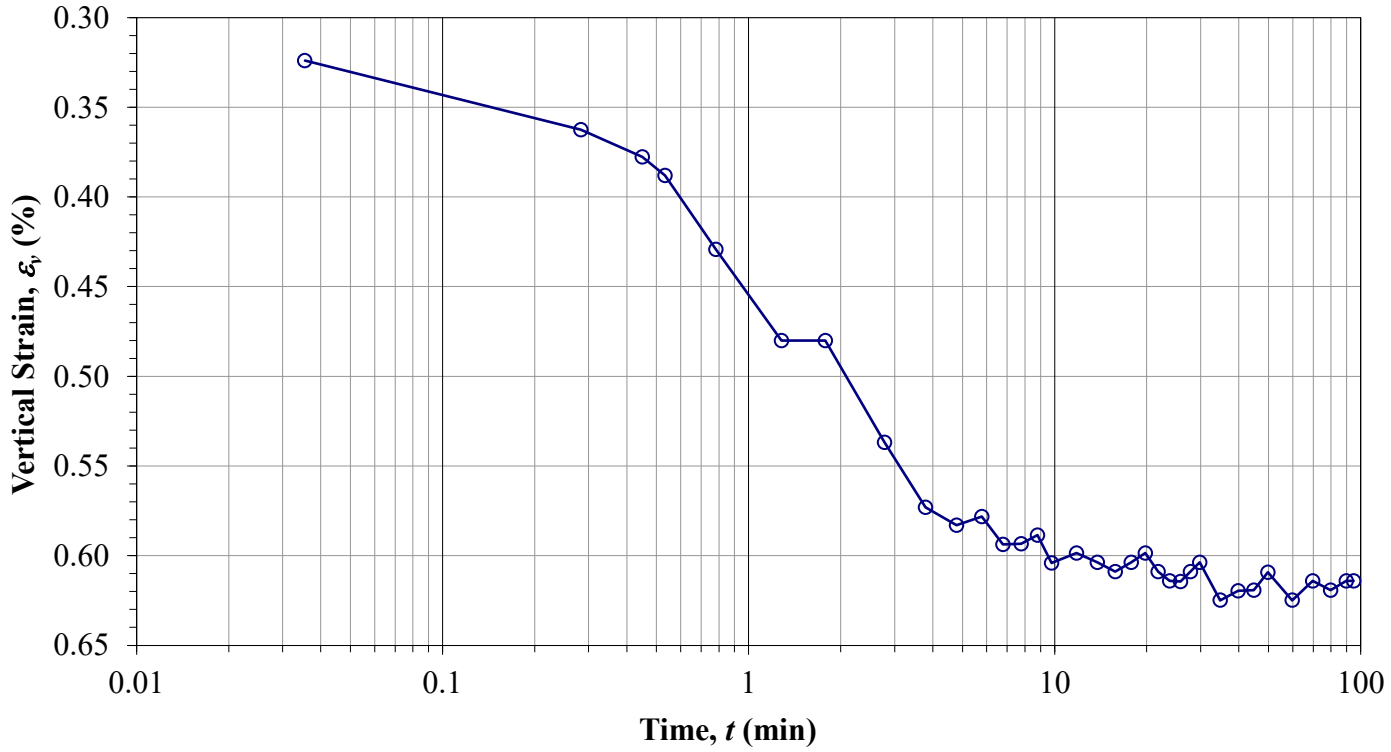
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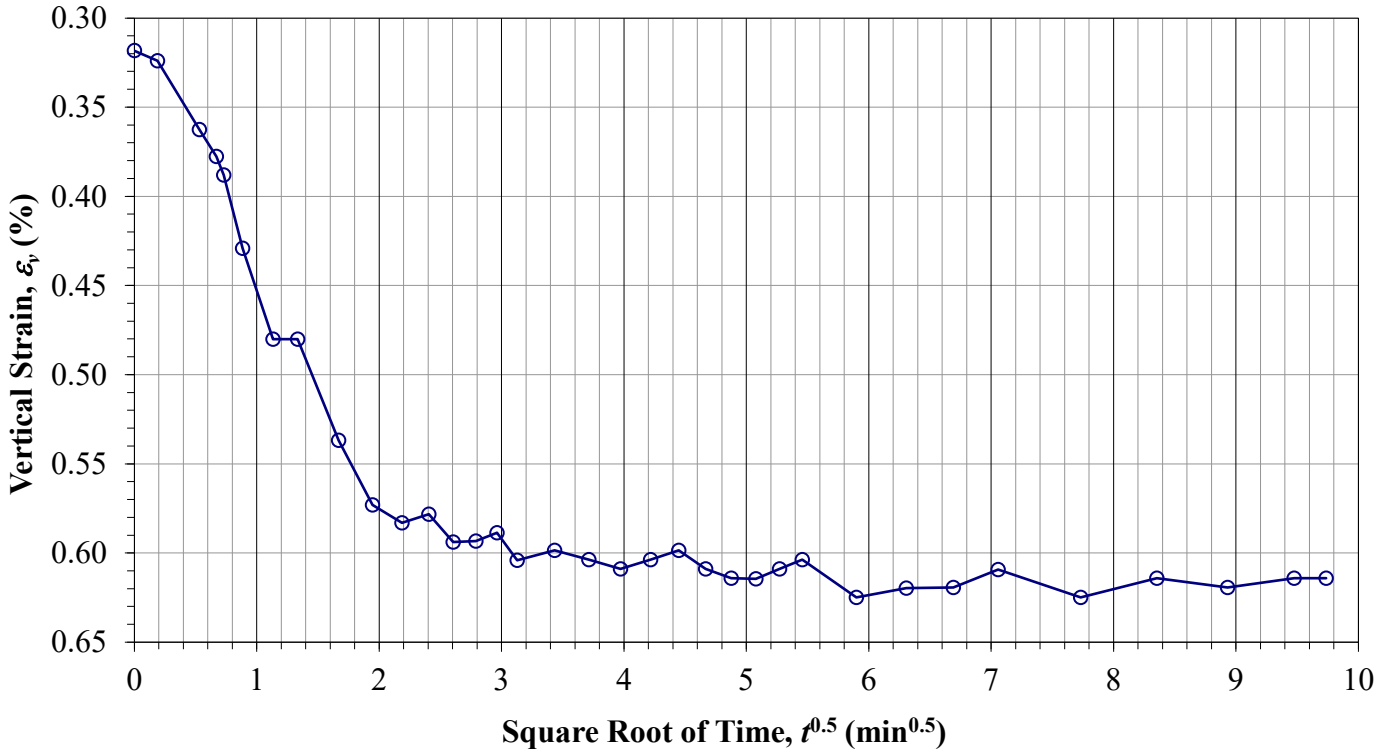
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 4 of 14
Stress: 800 psf





One-Dimensional Consolidation Properties of Soils

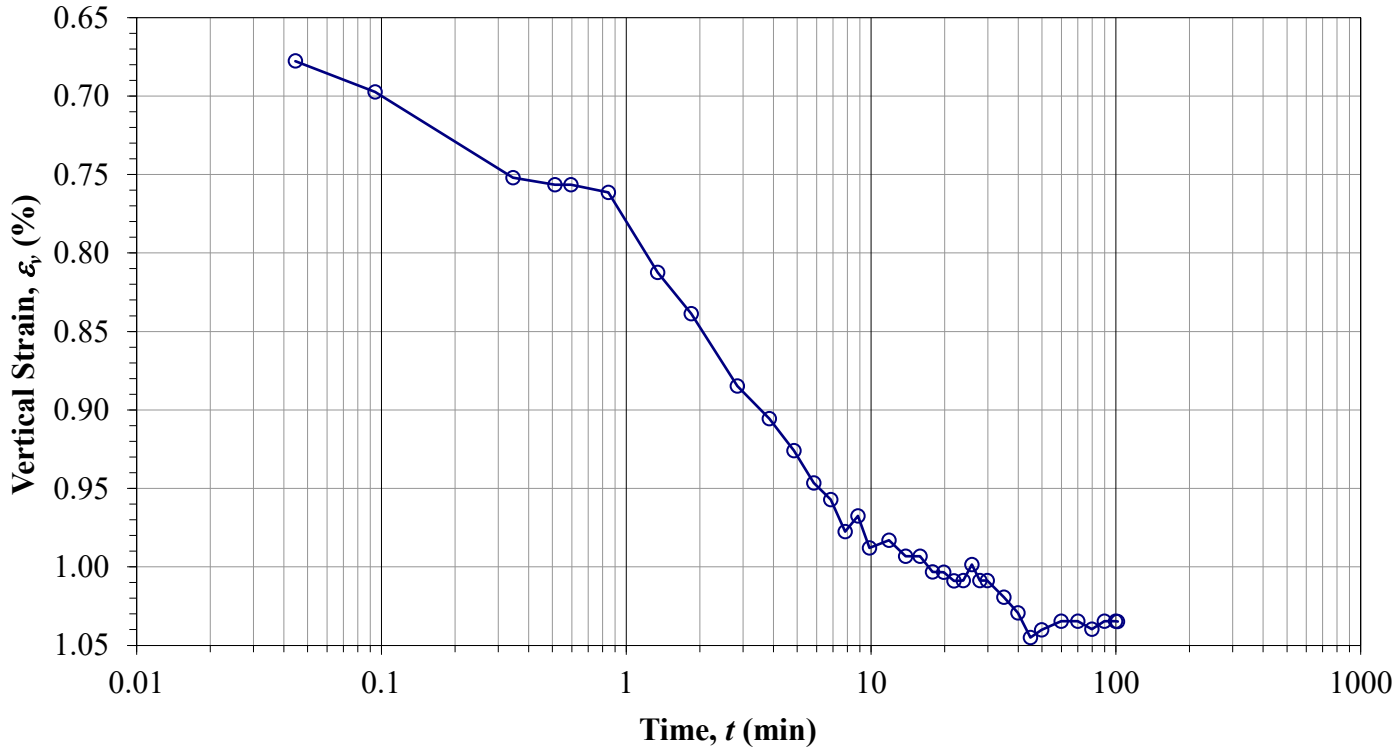
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 5 of 14
Stress: 1600 psf





One-Dimensional Consolidation Properties of Soils

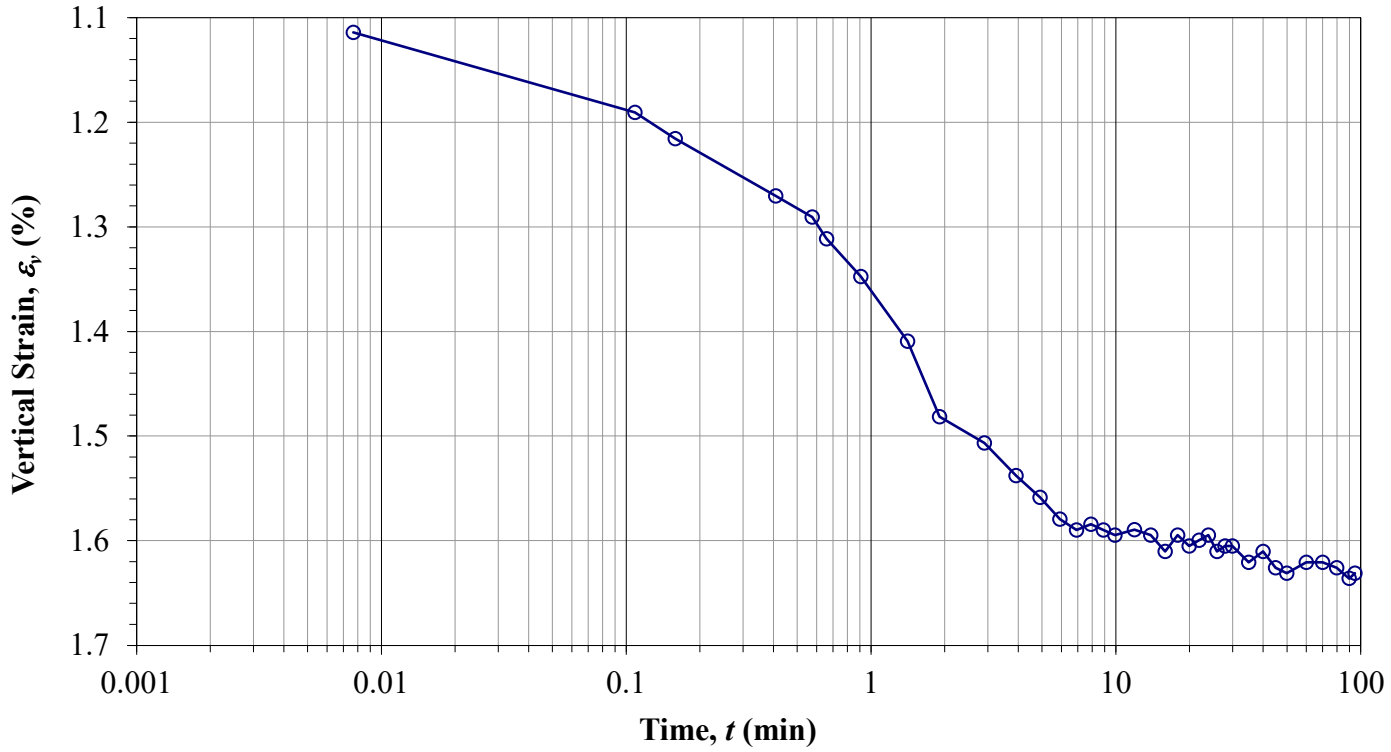
(ASTM D2435)

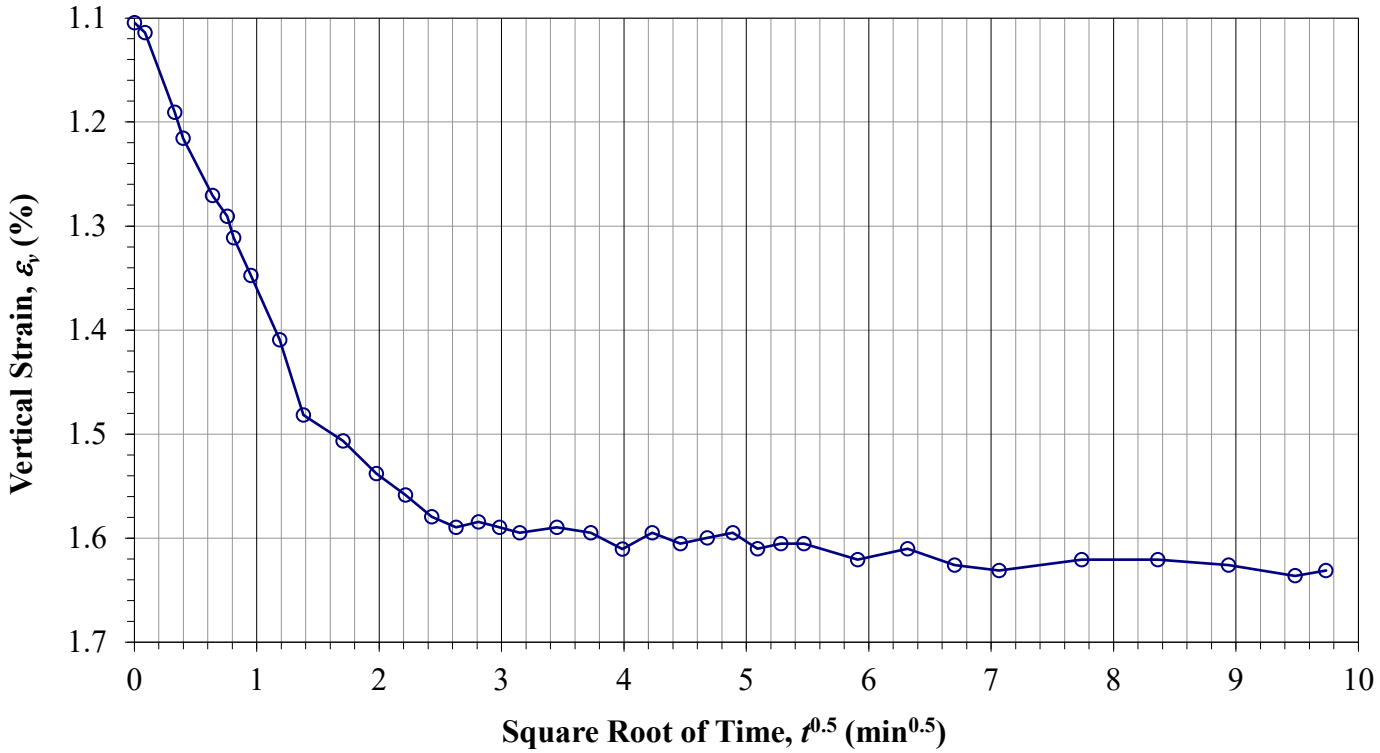
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 6 of 14
Stress: 3200 psf





One-Dimensional Consolidation Properties of Soils

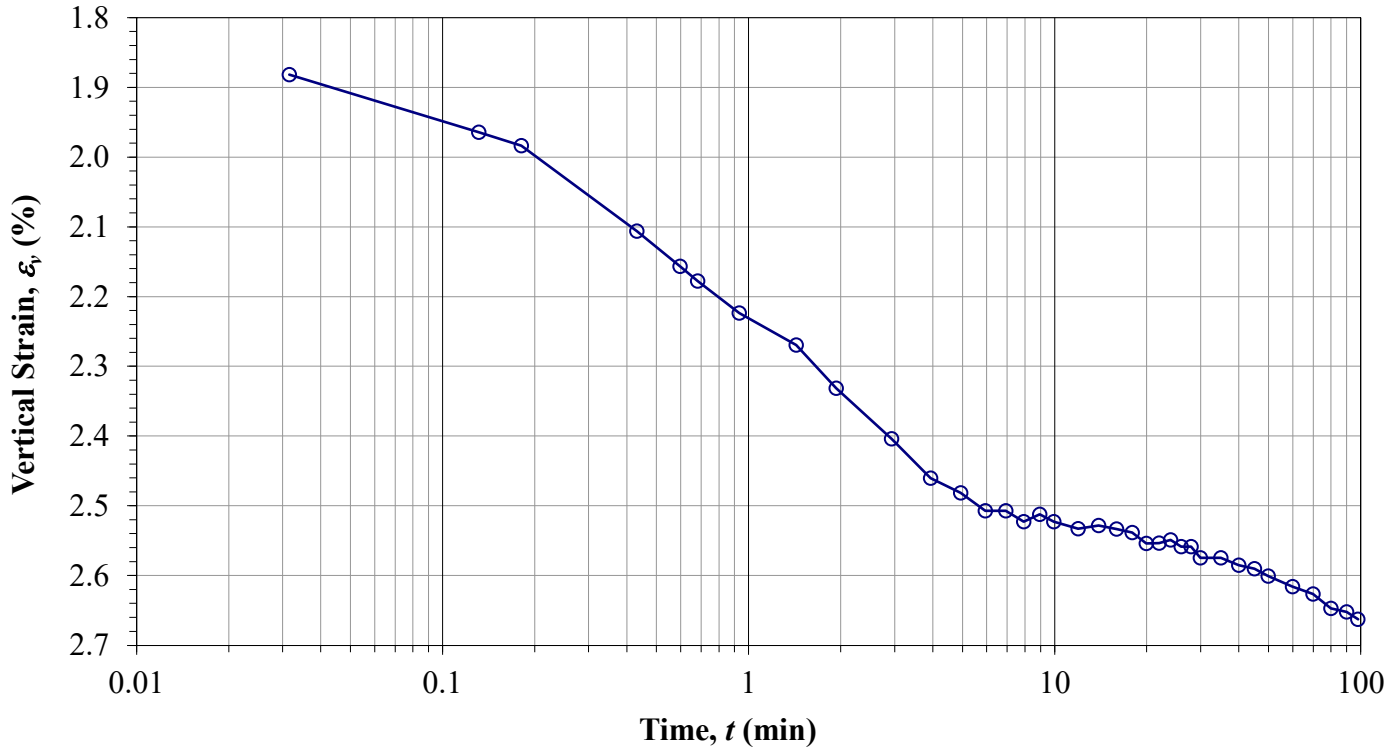
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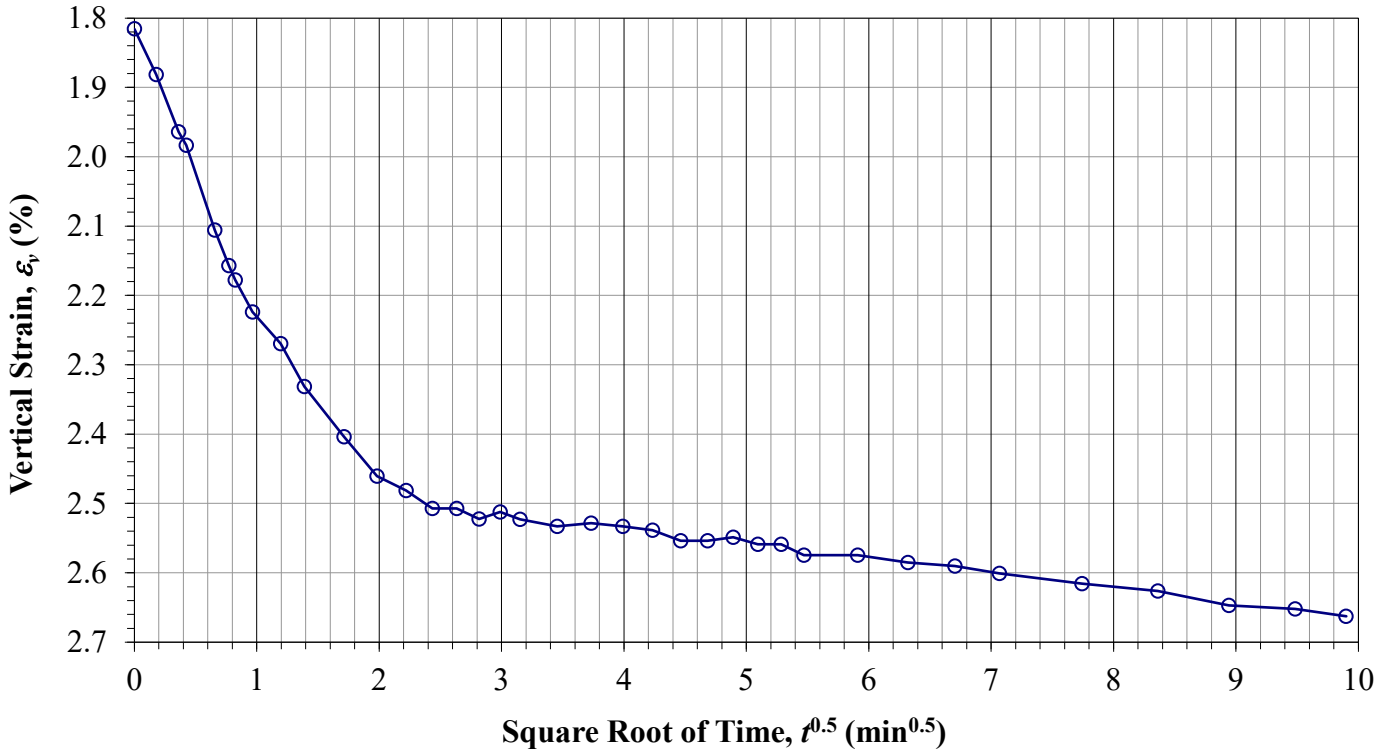
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 7 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

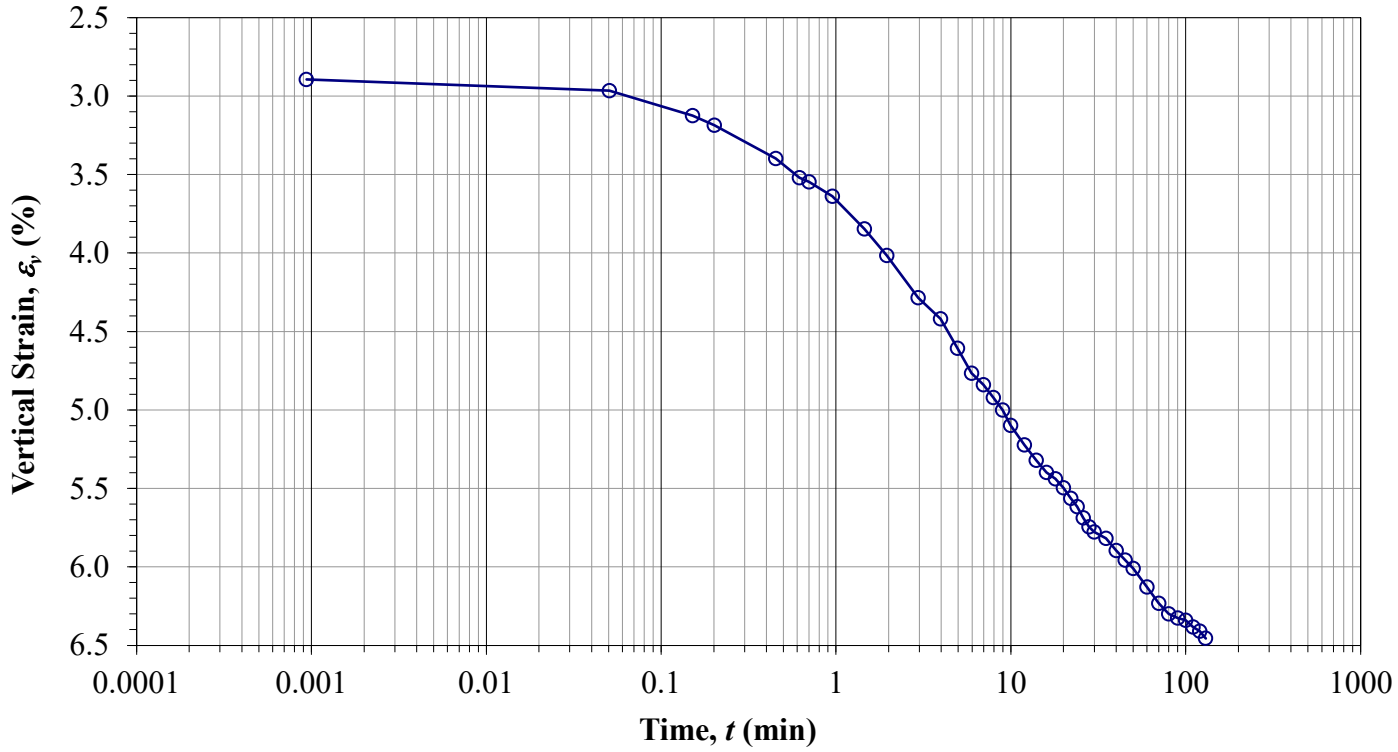
(ASTM D2435)

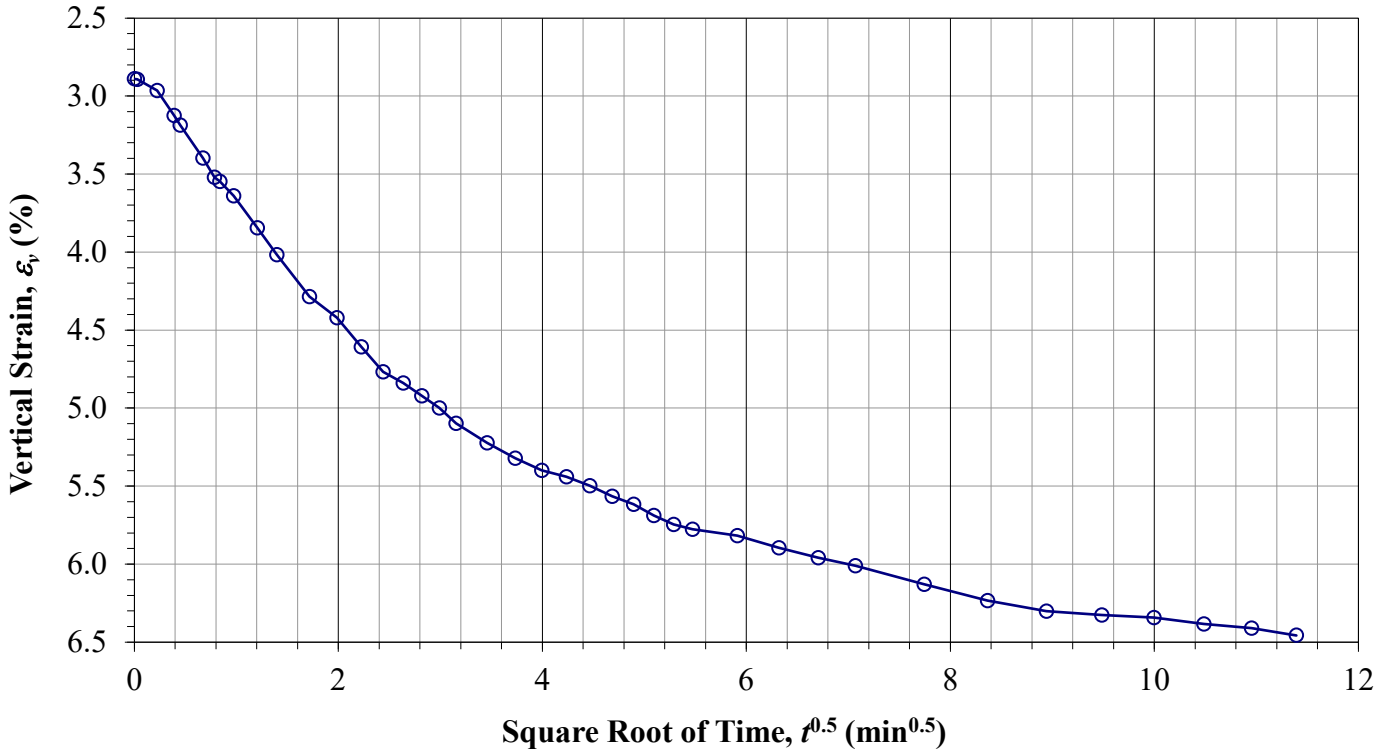
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 8 of 14
Stress: 12800 psf





One-Dimensional Consolidation Properties of Soils

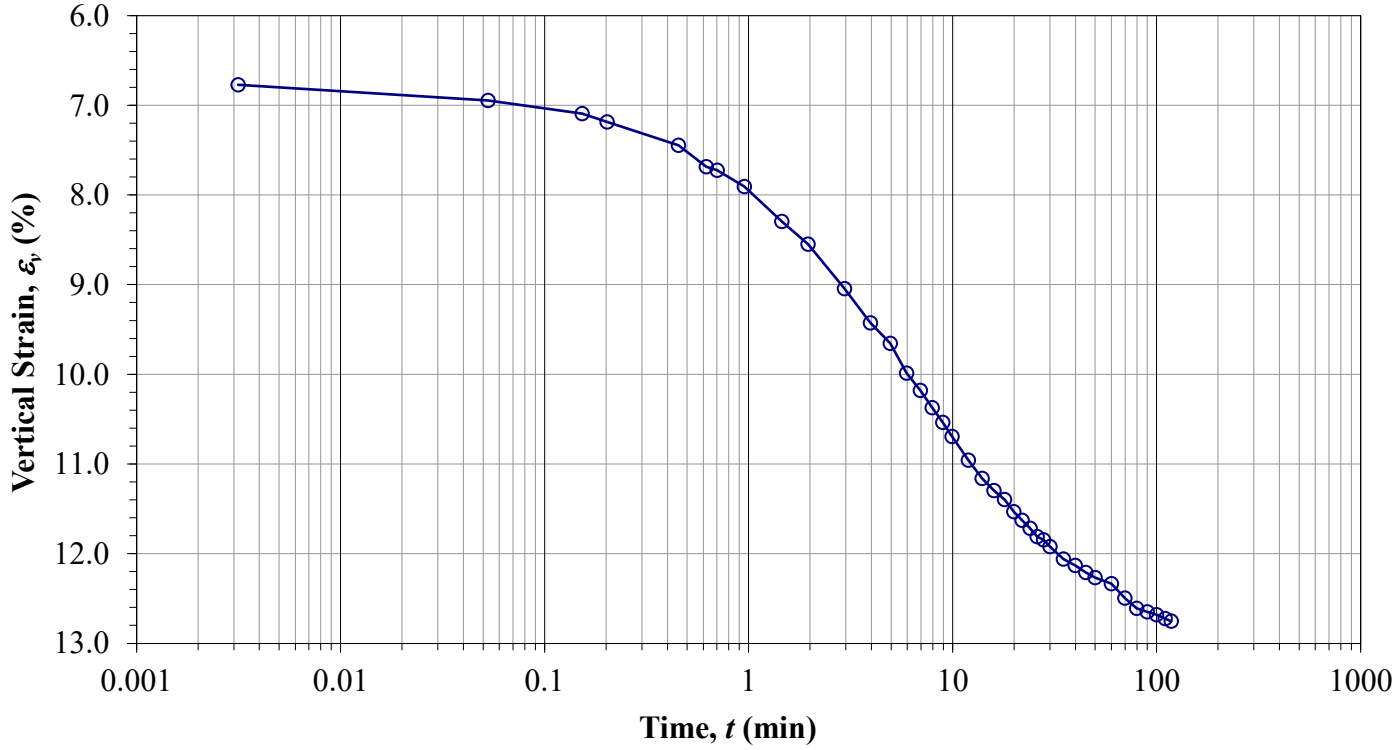
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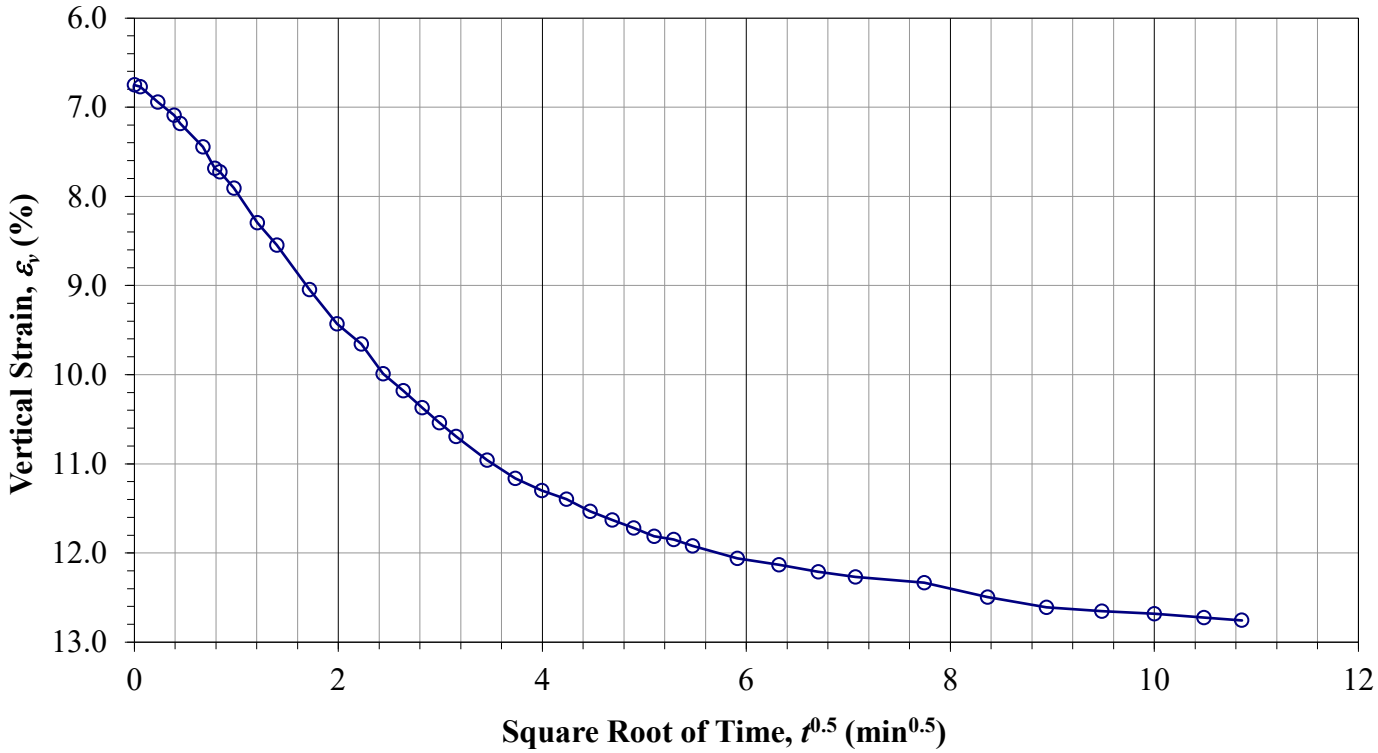
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 9 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

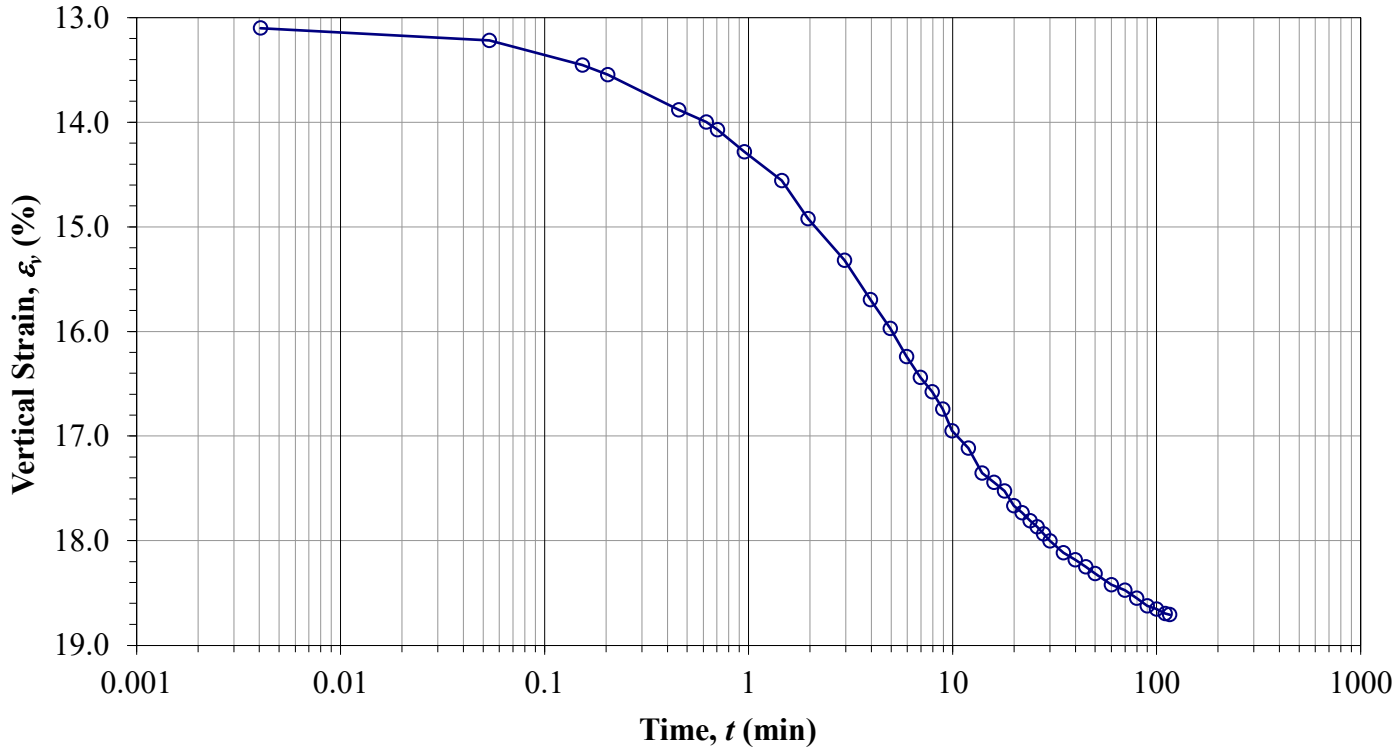
(ASTM D2435)

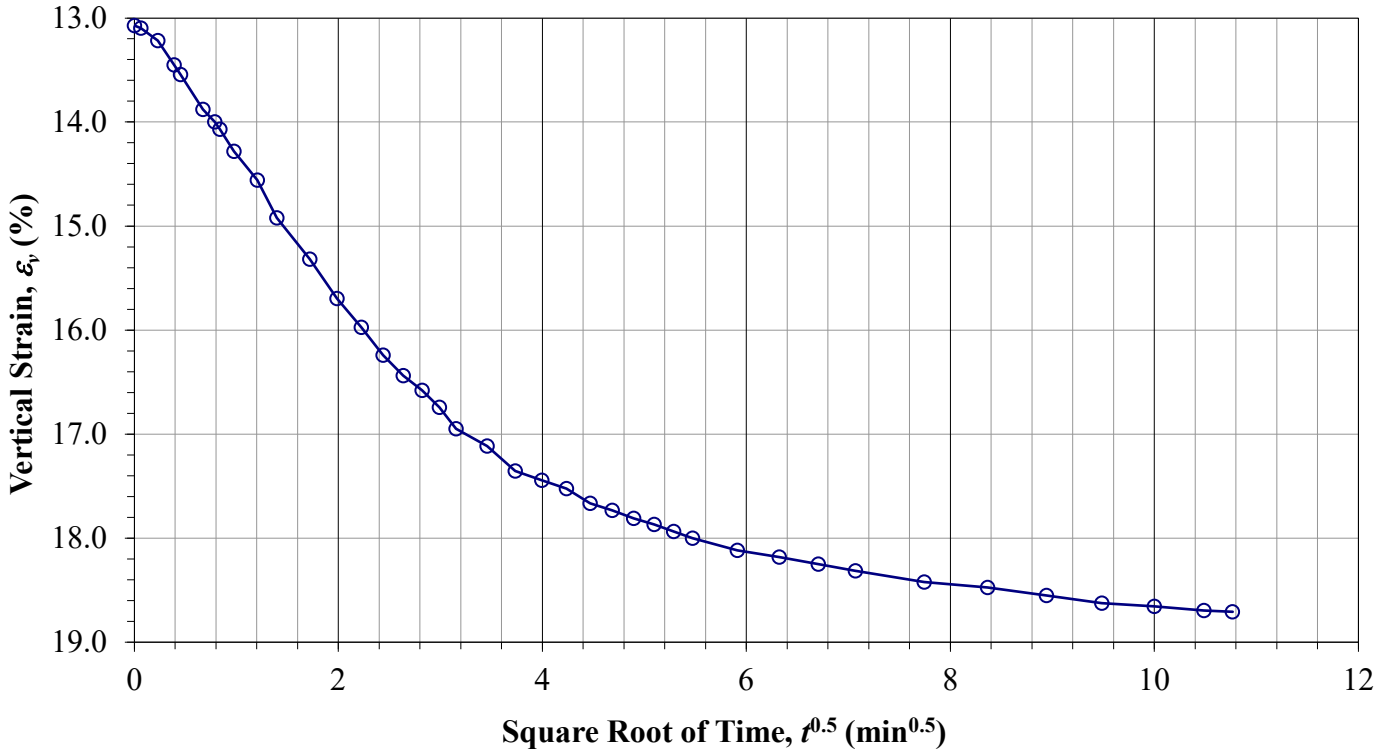
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 10 of 14
Stress: 51200 psf





One-Dimensional Consolidation Properties of Soils

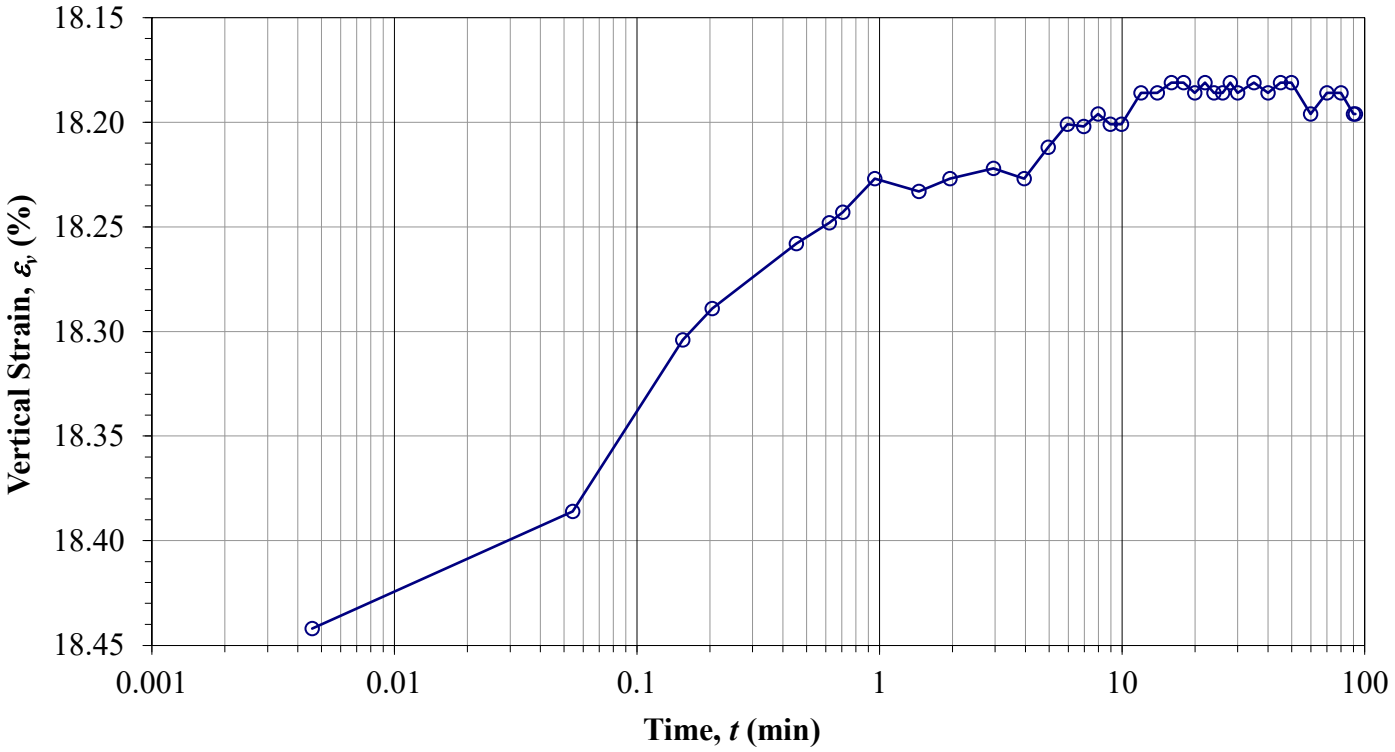
(ASTM D2435)

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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 11 of 14
Stress: 25600 psf





One-Dimensional Consolidation Properties of Soils

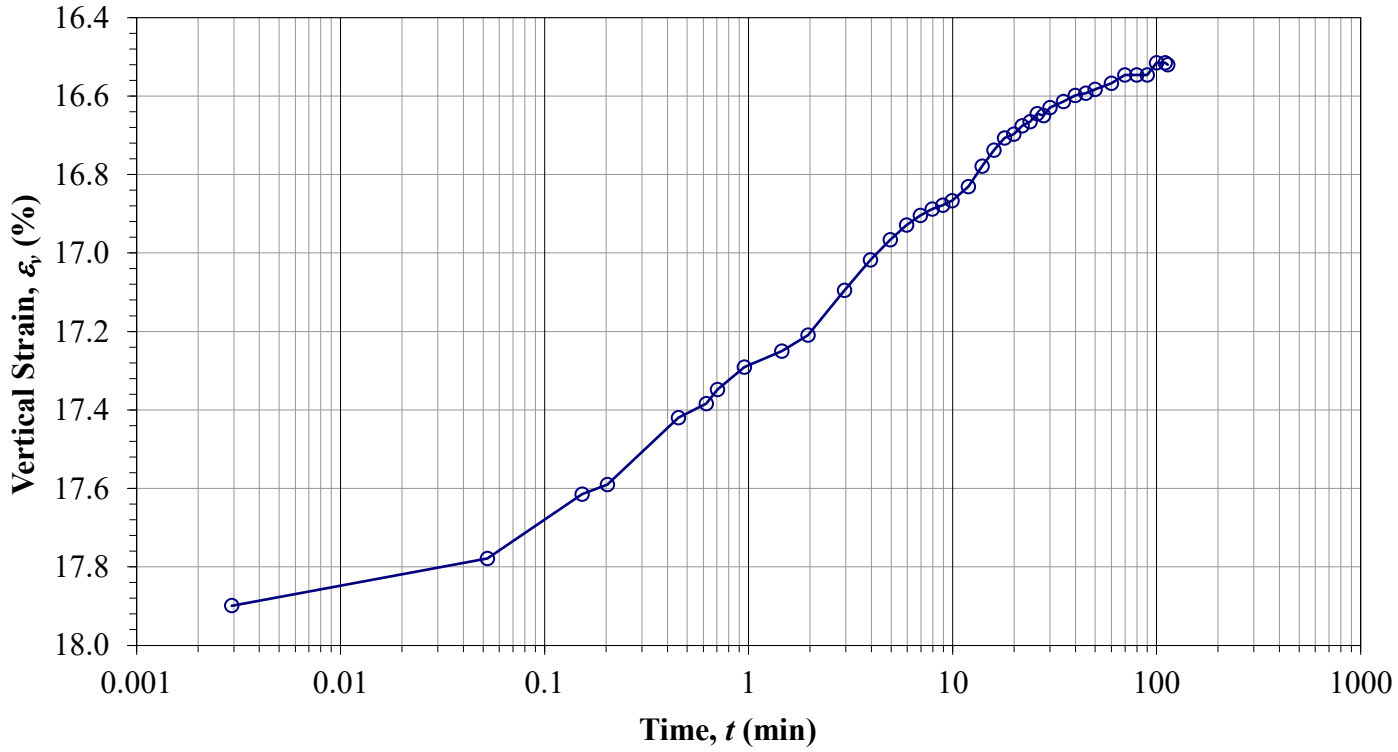
(ASTM D2435)

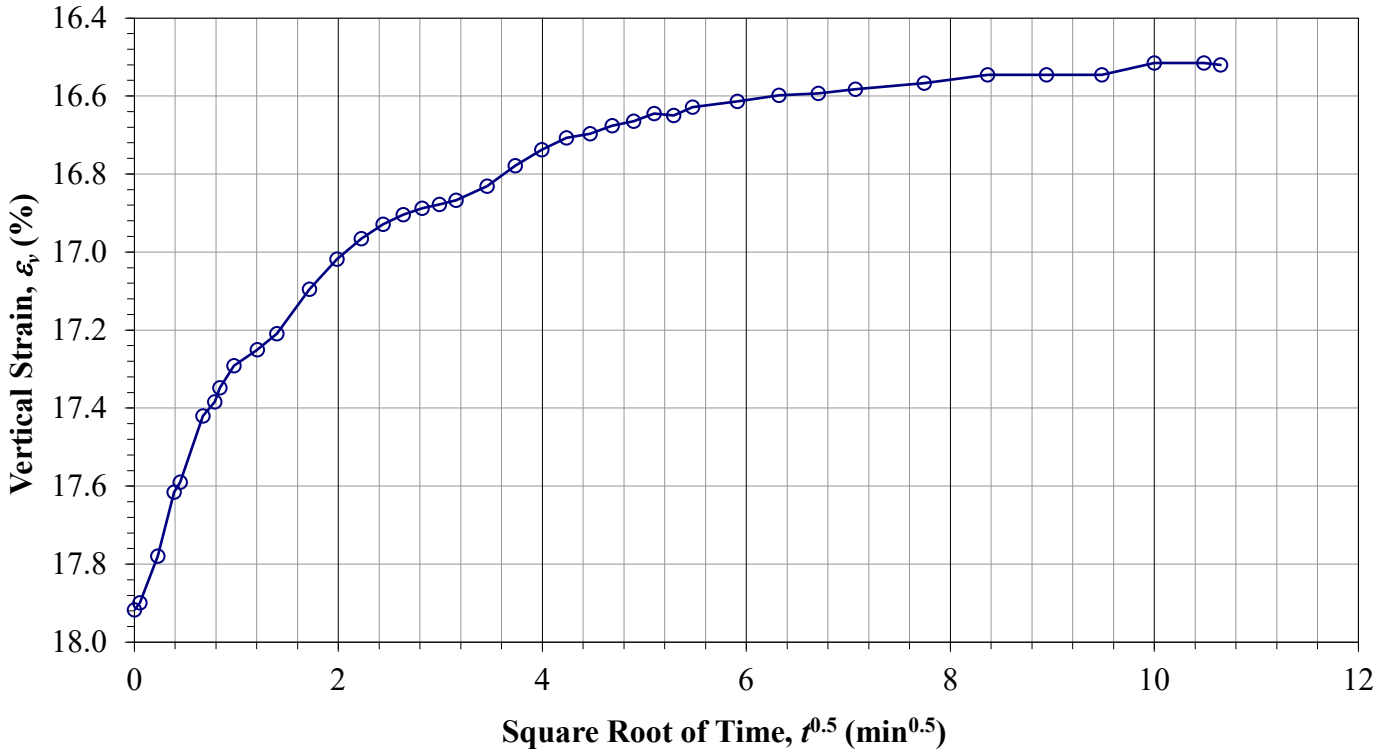
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 12 of 14
Stress: 6400 psf





One-Dimensional Consolidation Properties of Soils

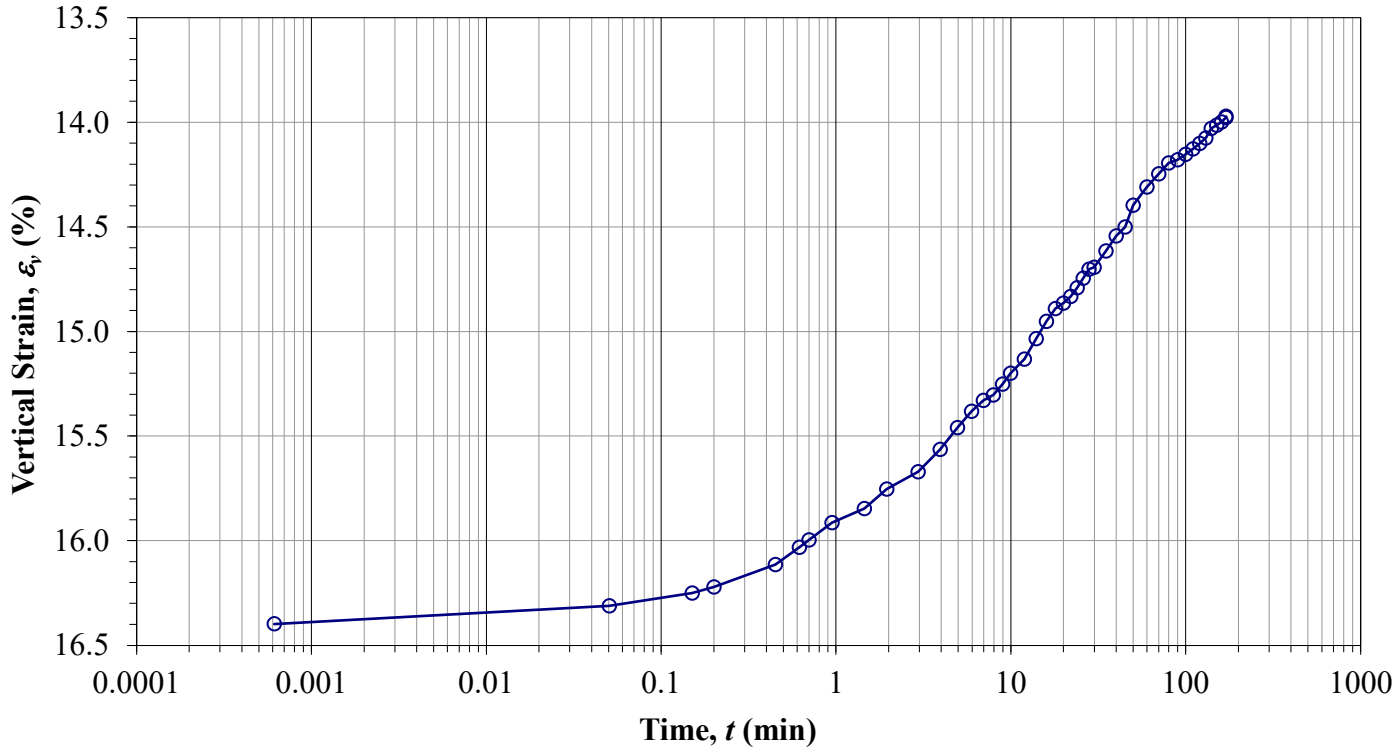
(ASTM D2435)

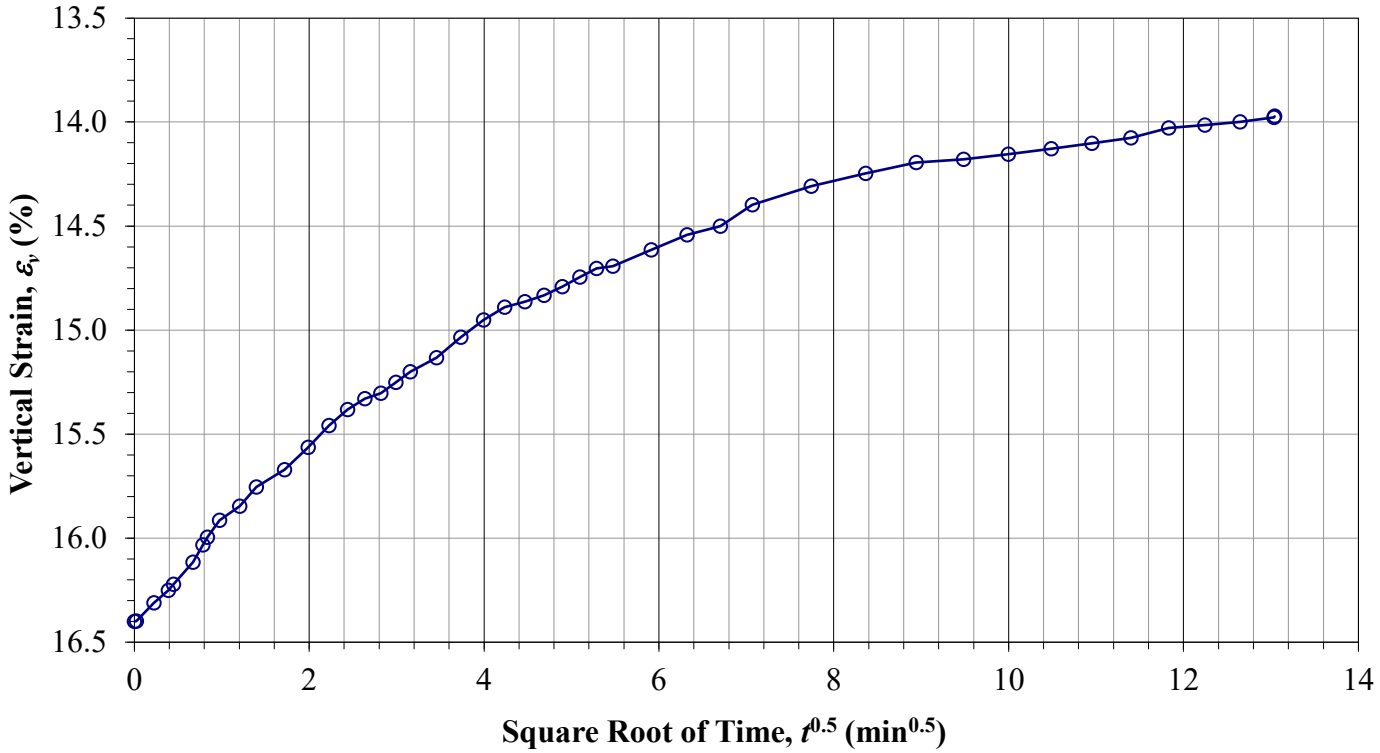
© IGES 2011, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 13 of 14
Stress: 1600 psf





Z:\PROJECTS\00100_URS\016_SLCPU_Water_Reclamation_Facility_Offsite_IPS\[CONSOL_GC+TRv1_B21-OIPS-09_18_95ft.xlsm]13

One-Dimensional Consolidation Properties of Soils

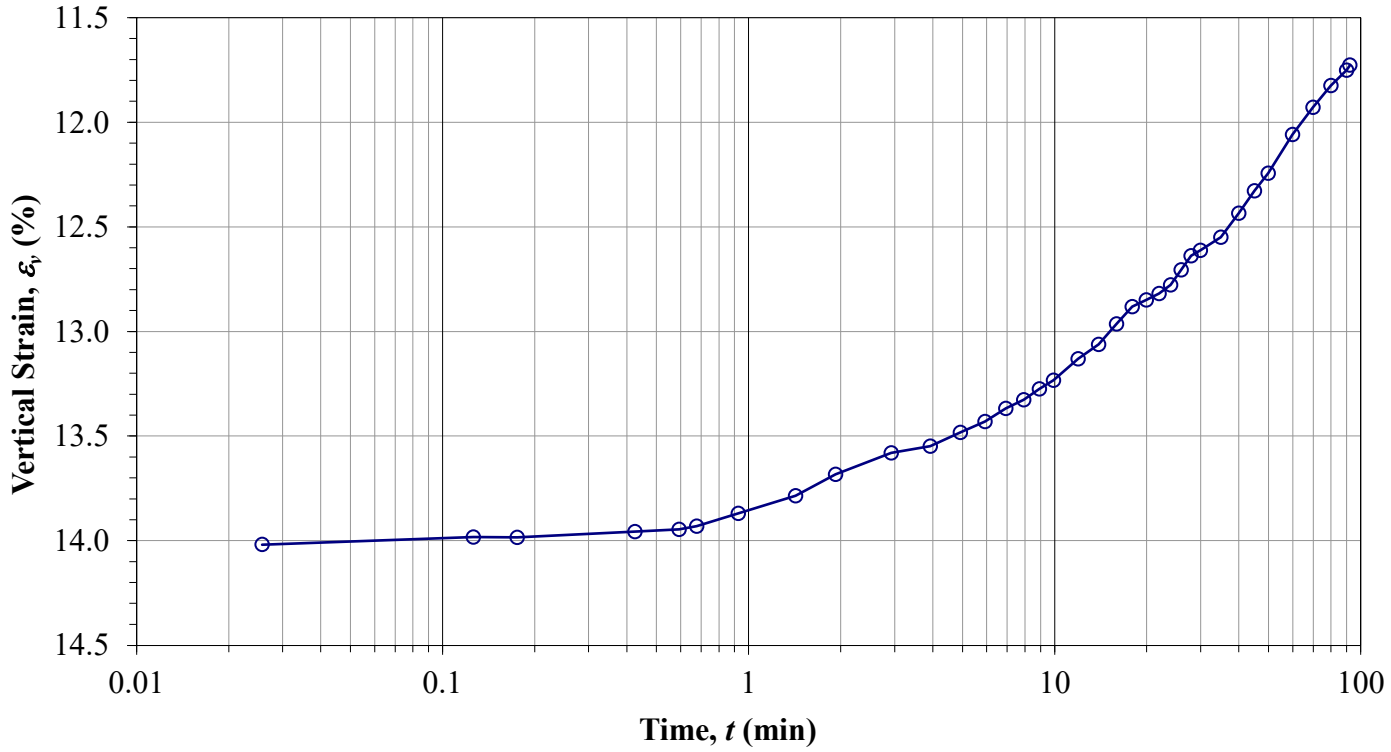
(ASTM D2435)

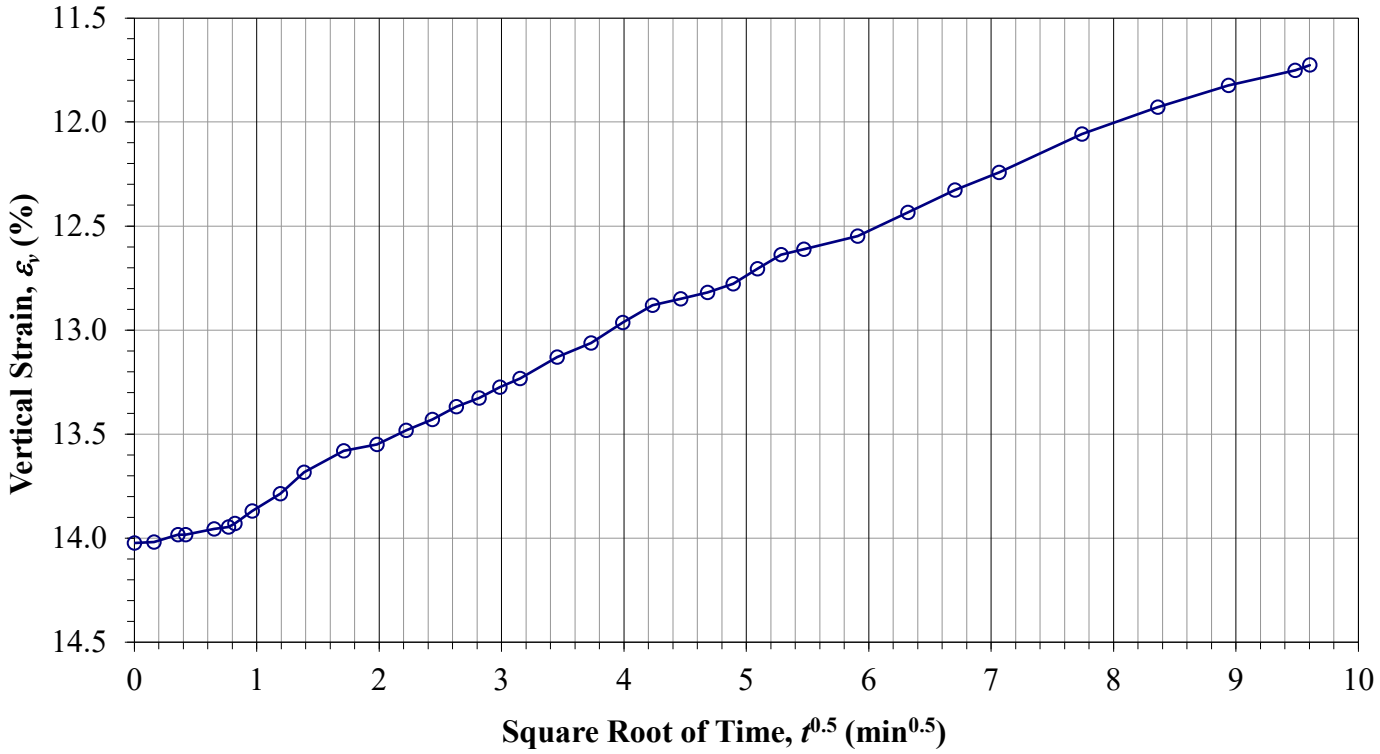
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Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS

Boring No.: B21-OIPS-09
Sample: 18
Depth: 95'

Constant Load Step: 14 of 14
Stress: 400 psf





Shear Test Results

Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

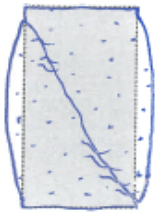
(ASTM D2850)

© IGES 2015, 2019

Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/9/2019
By: EH

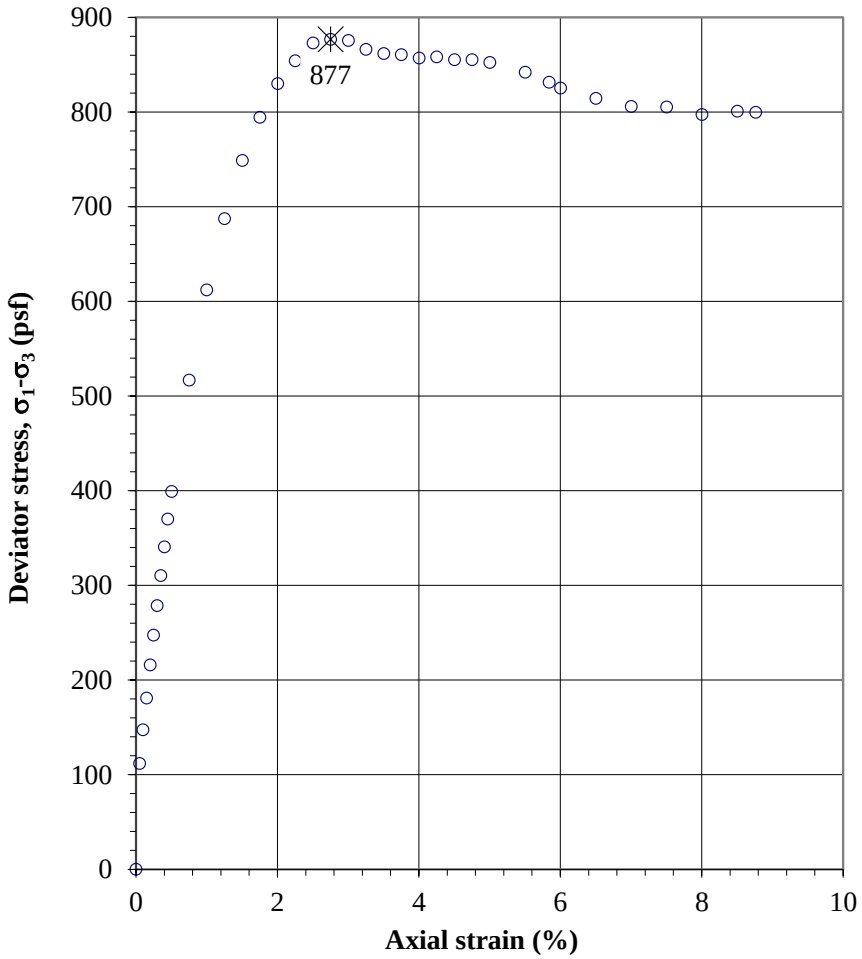
Boring No.: BH19-ITW-2
Sample:
Depth: 15.0'
Sample Description: Grey clay
Sample type: Undisturbed-trimmed from Shelby tube

Specific gravity, Gs	2.80	Assumed
Sample height, H (in.)	5.989	
Sample diameter, D (in.)	2.856	
Sample volume, V (ft^3)	0.0222	
Wt. rings + wet soil (g)	1098.19	
Wt. rings/tare (g)	0.00	
Moist soil, Ws (g)	1098.19	
Moist unit wt., γ_m (pcf)	109.0	
Dry unit wt., γ_d (pcf)	**72.4**	
Saturation (%)	99.8	
Void ratio, *e*	1.42	



Wet soil + tare (g)	877.05
Dry soil + tare (g)	629.75
Tare (g)	140.33
Water content, w (%)	**50.5**
Confining stress, σ_3 (psf)	576
Shear rate (in/min)	0.0180
Strain at failure, ε_f (%)	2.75
Deviator stress at failure, $(\sigma_1-\sigma_3)_f$ (psf)	877
Shear stress at failure, $q_f = (\sigma_1-\sigma_3)_f/2$ (psf)	438

Axial Strain (%)	σ_d $\sigma_1-\sigma_3$ (psf)	Q $1/2\ \sigma_d$ (psf)
0.00	0.0	0.0
0.05	111.9	56.0
0.10	147.4	73.7
0.15	180.9	90.5
0.20	215.9	108.0
0.25	247.4	123.7
0.30	278.6	139.3
0.35	310.4	155.2
0.40	340.7	170.4
0.45	370.1	185.1
0.50	399.2	199.6
0.75	516.8	258.4
1.00	612.1	306.1
1.25	687.4	343.7
1.50	748.9	374.4
1.75	794.3	397.1
2.00	829.9	415.0
2.25	854.0	427.0
2.50	873.0	436.5
2.75	876.7	438.4
3.00	875.6	437.8
3.25	866.2	433.1
3.50	861.7	430.9
3.75	860.6	430.3
4.00	857.2	428.6
4.25	858.1	429.1
4.50	855.2	427.6
4.75	855.2	427.6
5.00	852.2	426.1
5.50	842.0	421.0
5.84	831.5	415.7
6.00	825.4	412.7
6.50	814.4	407.2
7.00	805.8	402.9
7.50	805.3	402.7
8.00	797.5	398.7
8.50	800.8	400.4
8.76	799.7	399.8



Comments:

Top of test specimen is with sand.

Entered by:_____

Reviewed:_____

Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

(ASTM D2850)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/9/2019
By: EH

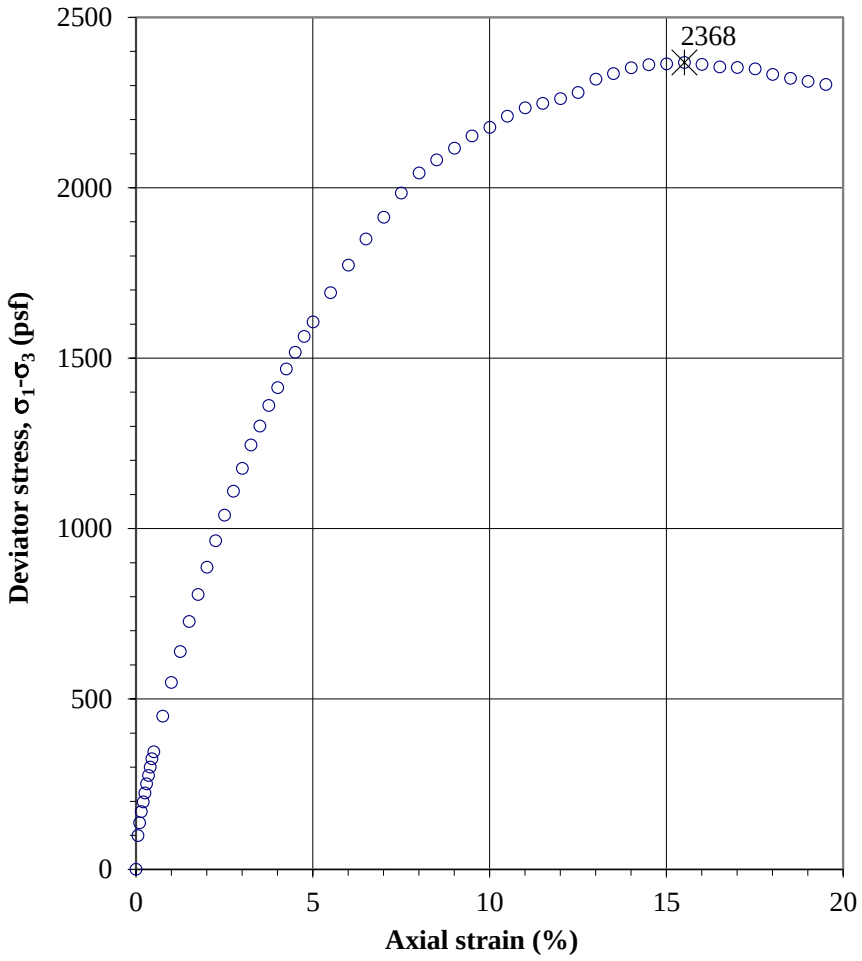
Boring No.: BH19-ITW-4
Sample:
Depth: 15.0'
Sample Description: Grey silty clay
Sample type: Undisturbed-trimmed from Shelby tube

Specific gravity, Gs	2.76	Assumed
Sample height, H (in.)	5.862	
Sample diameter, D (in.)	2.891	
Sample volume, V (ft^3)	0.0223	
Wt. rings + wet soil (g)	1220.34	
Wt. rings/tare (g)	0.00	
Moist soil, Ws (g)	1220.34	
Moist unit wt., γ_m (pcf)	120.8	
Dry unit wt., γ_d (pcf)	**91.6**	
Saturation (%)	99.6	
Void ratio, *e*	0.88	



Wet soil + tare (g)	1320.72
Dry soil + tare (g)	1030.74
Tare (g)	122.23
Water content, w (%)	**31.9**
Confining stress, σ_3 (psf)	1152
Shear rate (in/min)	0.0176
Strain at failure, ε_f (%)	15.51
Deviator stress at failure, $(\sigma_1-\sigma_3)_f$ (psf)	2368
Shear stress at failure, $q_f = (\sigma_1-\sigma_3)_f/2$ (psf)	1184

Axial Strain (%)	σ_d $\sigma_1-\sigma_3$ (psf)	Q 1/2 σ_d (psf)
0.00	0.0	0.0
0.05	99.1	49.5
0.10	136.8	68.4
0.15	169.4	84.7
0.20	198.0	99.0
0.25	223.8	111.9
0.30	251.0	125.5
0.35	275.8	137.9
0.40	300.2	150.1
0.45	324.4	162.2
0.50	345.4	172.7
0.75	449.6	224.8
1.00	548.3	274.1
1.25	639.2	319.6
1.50	726.9	363.5
1.75	806.6	403.3
2.00	887.0	443.5
2.25	964.6	482.3
2.50	1039.6	519.8
2.76	1109.6	554.8
3.01	1176.8	588.4
3.25	1244.8	622.4
3.51	1300.4	650.2
3.76	1360.9	680.5
4.01	1413.1	706.6
4.26	1468.0	734.0
4.51	1517.3	758.7
4.76	1564.2	782.1
5.01	1606.2	803.1
5.51	1691.7	845.8
6.01	1773.2	886.6
6.51	1850.0	925.0
7.01	1913.4	956.7
7.51	1984.6	992.3
8.01	2043.1	1021.6
8.51	2081.6	1040.8
9.01	2115.9	1057.9
9.51	2151.8	1075.9
10.01	2177.1	1088.5
10.51	2209.7	1104.8
11.01	2234.6	1117.3
11.51	2247.4	1123.7
12.01	2261.4	1130.7
12.51	2279.1	1139.6
13.01	2318.8	1159.4
13.51	2334.7	1167.4
14.01	2352.4	1176.2
14.51	2361.2	1180.6
15.01	2363.7	1181.9
15.51	2367.8	1183.9
16.01	2361.7	1180.9
16.51	2354.6	1177.3
17.01	2352.7	1176.4
17.51	2348.8	1174.4
18.01	2332.1	1166.0
18.51	2320.7	1160.4
19.01	2312.1	1156.0
19.51	2303.1	1151.5
20.00	2292.6	1146.3



Entered by:_____

Reviewed:_____

Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

(ASTM D2850)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/9/2019
By: EH

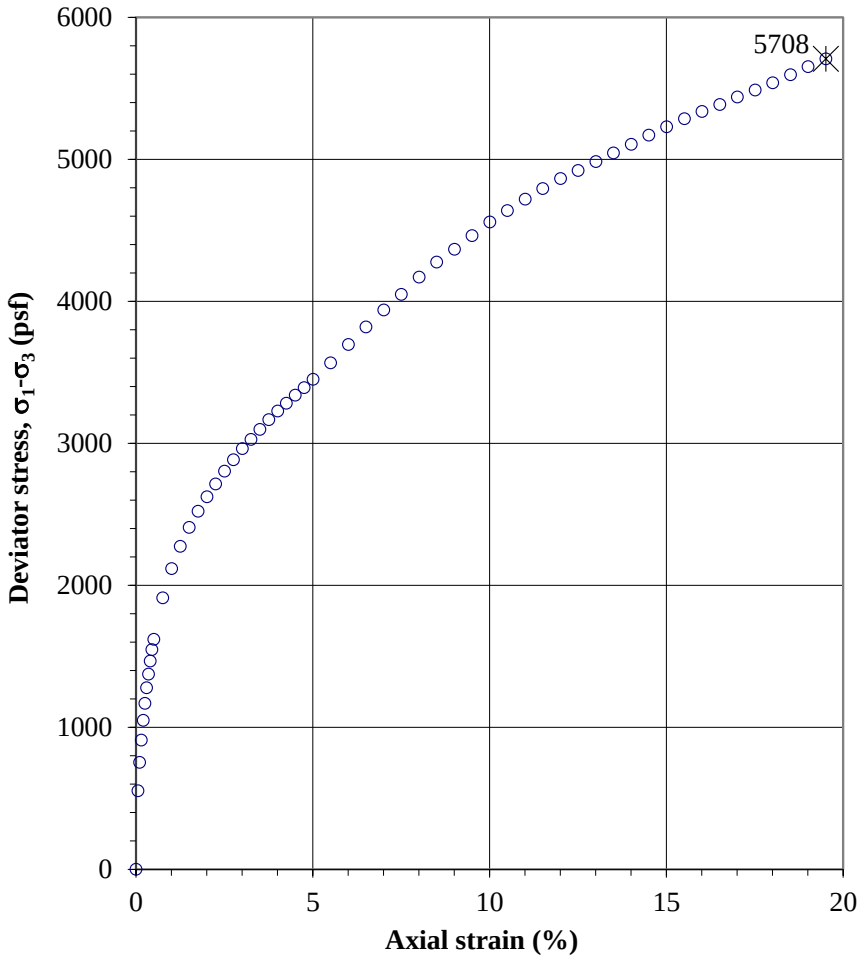
Boring No.: BH19-ITW-4
Sample:
Depth: 20.0'
Sample Description: Grey sandy silt
Sample type: Undisturbed-trimmed from Shelby tube

Specific gravity, Gs	2.72	Assumed
Sample height, H (in.)	5.537	
Sample diameter, D (in.)	2.851	
Sample volume, V (ft^3)	0.0205	
Wt. rings + wet soil (g)	1128.96	
Wt. rings/tare (g)	0.00	
Moist soil, Ws (g)	1128.96	
Moist unit wt., γ_m (pcf)	121.7	
Dry unit wt., γ_d (pcf)	**93.9**	
Saturation (%)	99.1	
Void ratio, *e*	0.81	



Wet soil + tare (g)	970.18
Dry soil + tare (g)	824.76
Tare (g)	333.16
Water content, w (%)	**29.6**
Confining stress, σ_3 (psf)	4320
Shear rate (in/min)	0.0166
Strain at failure, ε_f (%)	19.51
Deviator stress at failure, $(\sigma_1-\sigma_3)_f$ (psf)	5708
Shear stress at failure, $q_f = (\sigma_1-\sigma_3)_f/2$ (psf)	2854

Axial Strain (%)	σ_d $\sigma_1-\sigma_3$ (psf)	Q 1/2 σ_d (psf)
0.00	0.0	0.0
0.05	553.9	276.9
0.10	753.4	376.7
0.15	911.0	455.5
0.20	1048.6	524.3
0.25	1168.3	584.2
0.30	1278.1	639.1
0.35	1375.9	687.9
0.41	1467.1	733.6
0.45	1547.2	773.6
0.50	1619.4	809.7
0.75	1911.7	955.8
1.00	2118.9	1059.4
1.25	2274.2	1137.1
1.50	2407.4	1203.7
1.75	2522.3	1261.2
2.00	2624.6	1312.3
2.25	2714.0	1357.0
2.50	2803.5	1401.8
2.75	2885.1	1442.6
3.00	2963.2	1481.6
3.25	3028.0	1514.0
3.51	3097.7	1548.8
3.75	3167.3	1583.6
4.01	3228.1	1614.0
4.26	3282.8	1641.4
4.51	3338.5	1669.2
4.76	3391.5	1695.8
5.01	3452.0	1726.0
5.51	3566.5	1783.2
6.01	3697.0	1848.5
6.51	3819.4	1909.7
7.01	3939.0	1969.5
7.51	4049.9	2025.0
8.01	4170.5	2085.2
8.51	4276.6	2138.3
9.01	4367.5	2183.7
9.51	4463.7	2231.9
10.01	4558.3	2279.1
10.51	4640.1	2320.1
11.01	4719.0	2359.5
11.51	4794.4	2397.2
12.01	4865.0	2432.5
12.51	4922.4	2461.2
13.01	4983.9	2491.9
13.51	5045.3	2522.7
14.01	5105.8	2552.9
14.51	5170.1	2585.0
15.01	5229.8	2614.9
15.51	5286.4	2643.2
16.01	5337.1	2668.5
16.51	5385.8	2692.9
17.01	5438.4	2719.2
17.51	5487.8	2743.9
18.01	5538.2	2769.1
18.51	5595.2	2797.6
19.01	5652.5	2826.2
19.51	5707.9	2853.9



Comments:

Top of test specimen is silt, bottom is silty sand. Bottom 8" of this sample's Shelby tube (not tested portion) is silty sand, grey, wet.

Entered by:_____

Reviewed:_____

Consolidated Undrained Triaxial Compression Test for Cohesive Soils

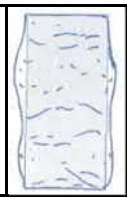
(*ASTM D4767*)

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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 12/24/2018
By: JDF

Boring No.: BH18-PC-1
Sample: 6
Depth: 39'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

		Test Number:	S1
Initial		Height, H (in)	5.929
		Diameter, D (in)	2.813
		Water content, w (%)	48.8
		Dry unit weight, γ_d (pcf)	75.2
		Saturation (%)	100.0
		Void ratio, e	1.33
		Mounting	Wet
Before shear		Water content, w (%)	36.0
		Dry unit weight, γ_d (pcf)	85.5
		Saturation[a] (%)	100.0
		Void ratio, e	1.04
		Area, A_{eoc} (in²)	5.61
		Area method	A
		B	0.95
		t_{50} (min)	150.50
		Back pressure (psf)	4752
		Strain rate (%/min)	0.00266
		Time to failure (min)	5188.0
		Strain at failure, ε_f (%)	13.80
		Filter paper correction	No
		Membrane correction	Yes
Assumed specific gravity	2.80		
Liquid limit (%)	48		
Plastic limit (%)	24		
Plasticity index (%)	24		



[a] Saturation set to 100% for phase calculations

Summary of strength parameters at peak deviator stress		
Total stress	c (psf)	0
	ϕ (deg)	18.4
Effective stress	c' (psf)	0
	ϕ' (deg)	34.4

Comments:
Specimen was very soft and began to slump before any load was applied.

Tested by:_____
Reviewed:_____

Consolidated Undrained Triaxial Compression Test for Cohesive Soils

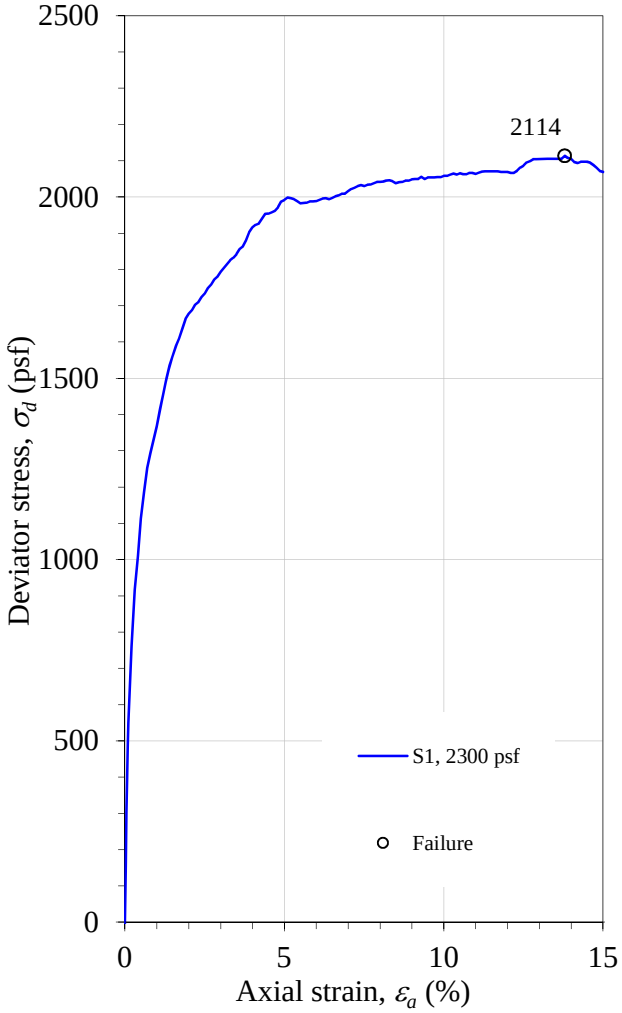
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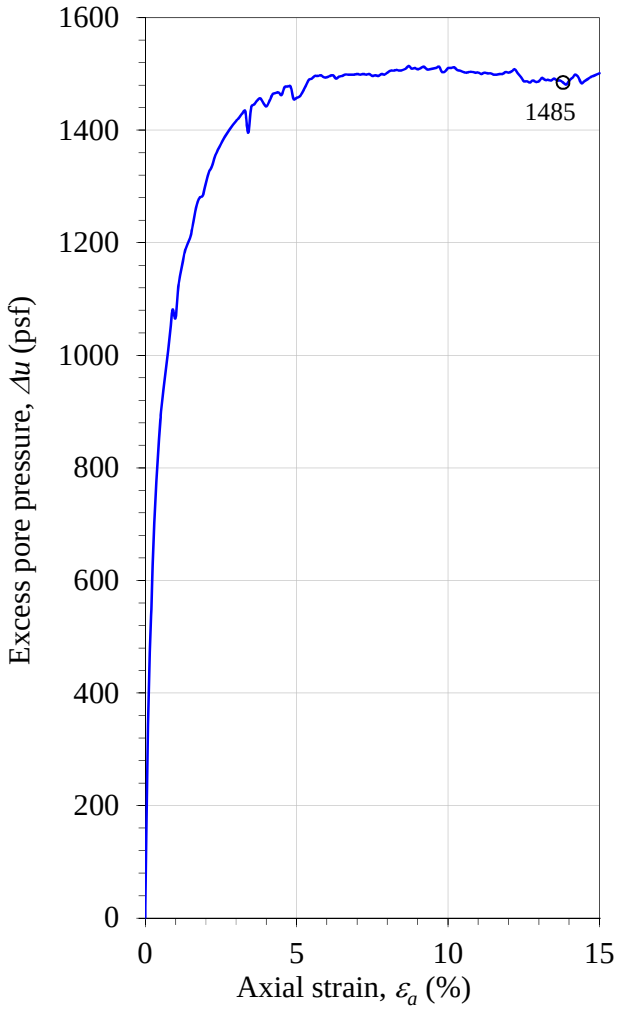
© IGES 2009, 2018

Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH18-PC-1
Sample: 6
Depth: 39'

		Test Number:	S1
Total stress		σ_3 (psf)	2300
		σ_1-σ_3 (psf)	2114
		σ_1 (psf)	4413
		$q = (\sigma_1-\sigma_3)/2$ (psf)	1057
		$p = (\sigma_1+\sigma_3)/2$ (psf)	3357
Effective stress		Δu (psf)	1485
		σ'_3 (psf)	815
		σ'_1-σ'_3 (psf)	2114
		σ'_1 (psf)	2929
		$q = (\sigma'_1-\sigma'_3)/2$ (psf)	1057
		$p' = (\sigma'_1+\sigma'_3)/2$ (psf)	1872
		σ'_1/σ'_3	3.59
		$A = \Delta u/(\sigma_1-\sigma_3)$	0.702





Consolidated Undrained Triaxial Compression Test for Cohesive Soils

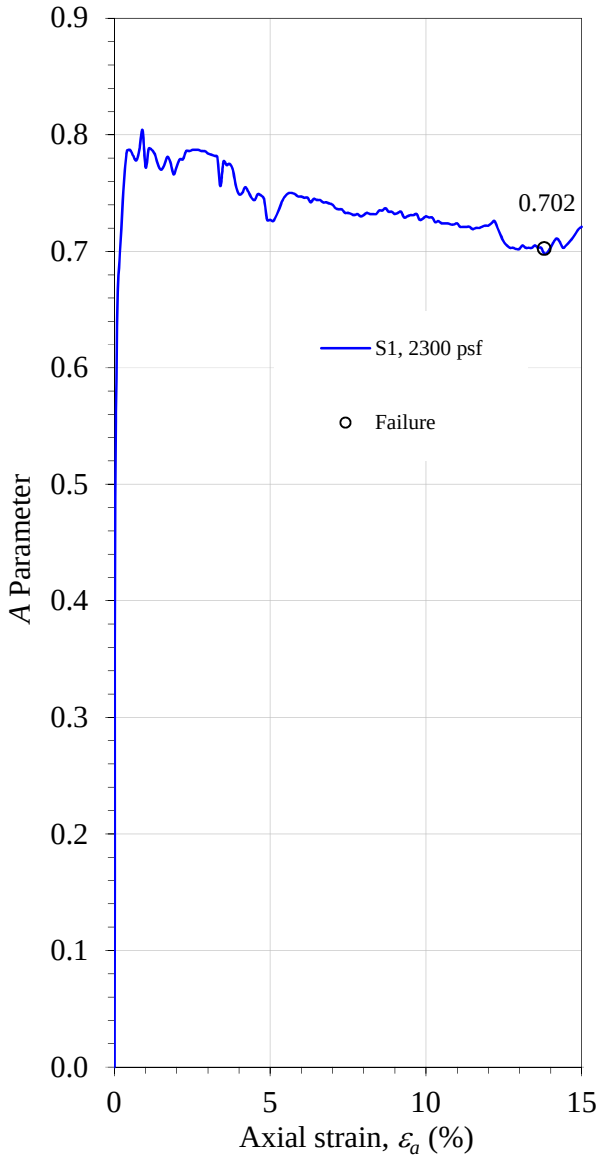
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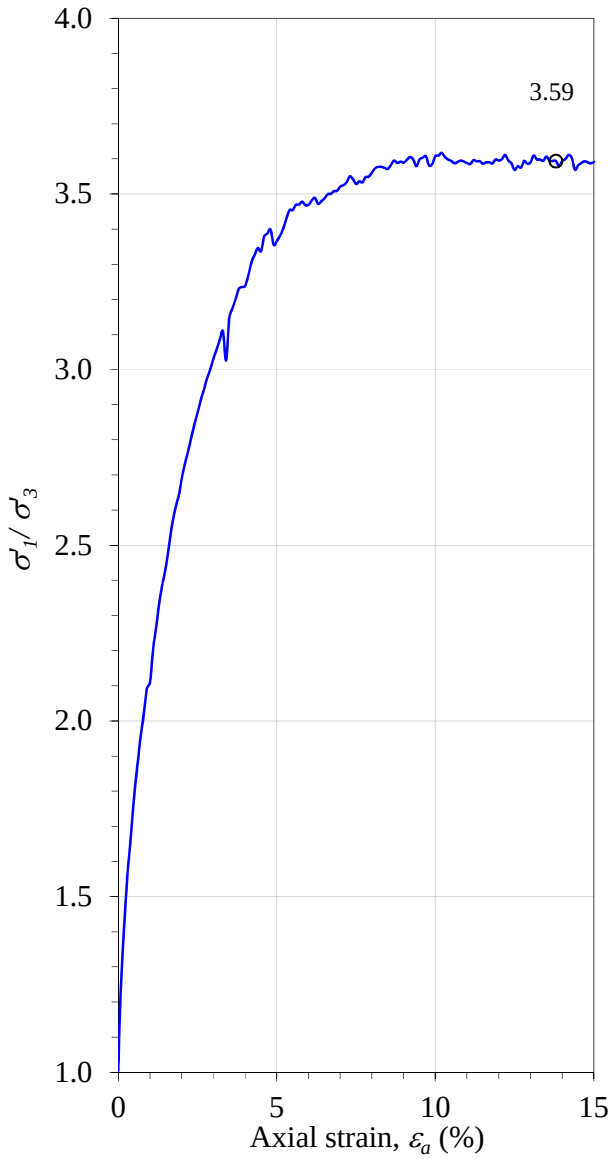
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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH18-PC-1
Sample: 6
Depth: 39'

Summary of strength parameters at peak deviator stress		
Total stress	c (psf)	0
	ϕ (deg)	18.4
Effective stress	c' (psf)	0
	ϕ' (deg)	34.4





Consolidated Undrained Triaxial Compression Test for Cohesive Soils

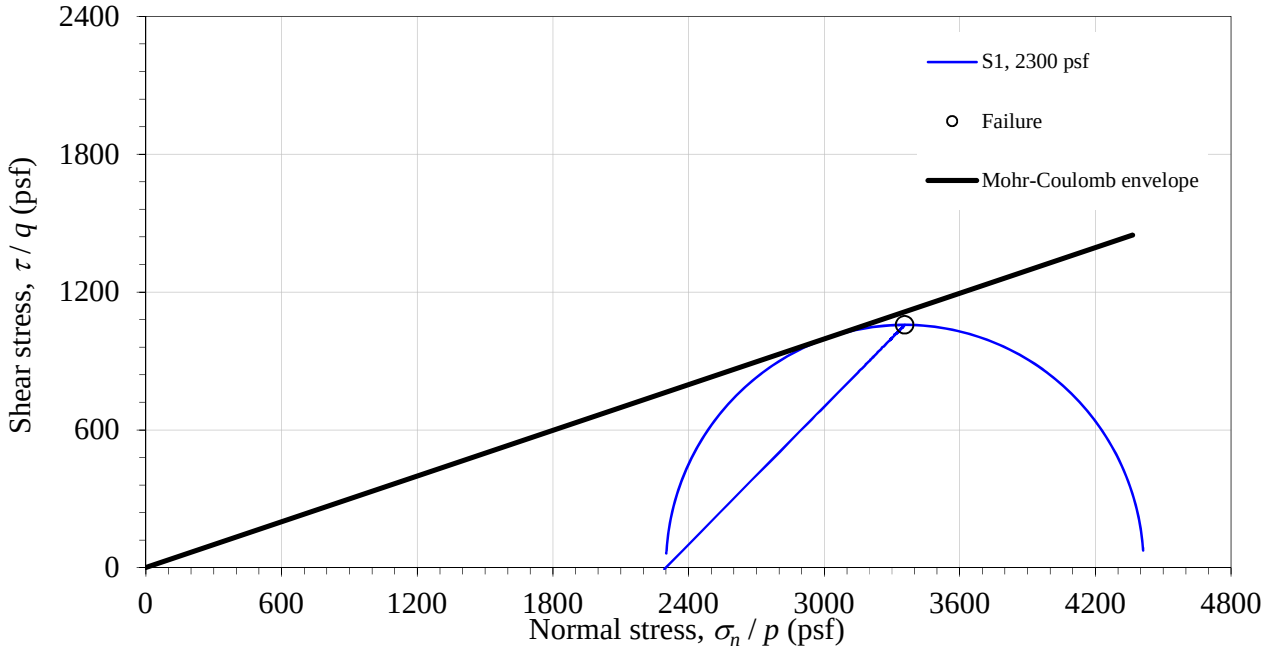
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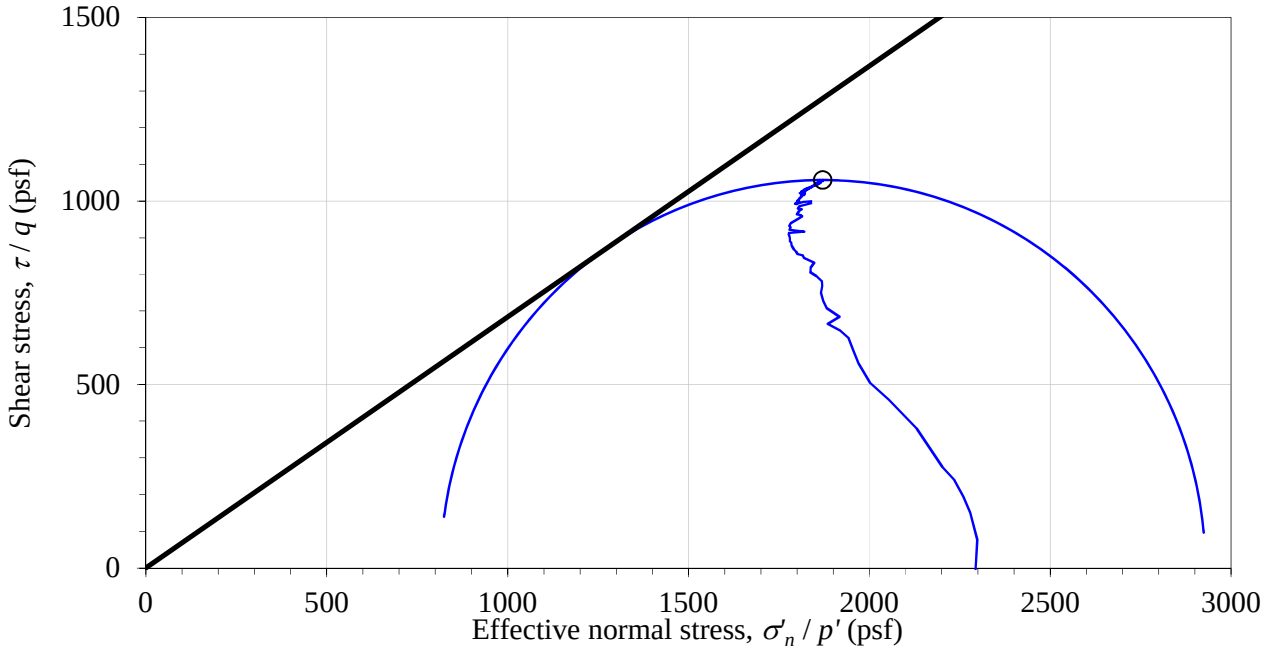
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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH18-PC-1
Sample: 6
Depth: 39'

Summary of strength parameters at peak deviator stress		
Total stress	c (psf)	0
	ϕ (deg)	18.4
Effective stress	c' (psf)	0
	ϕ' (deg)	34.4





Z:\PROJECTS\00100_URS\015_SLCity_Public_Utilities_Waste Water_\V\[GTXCU1v2_BH18-PC-1_6_39ft_2300psf.xlsm]Summary

Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

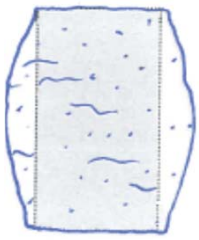
(ASTM D2850)

© IGES 2015, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 7/29/2019
By: EH

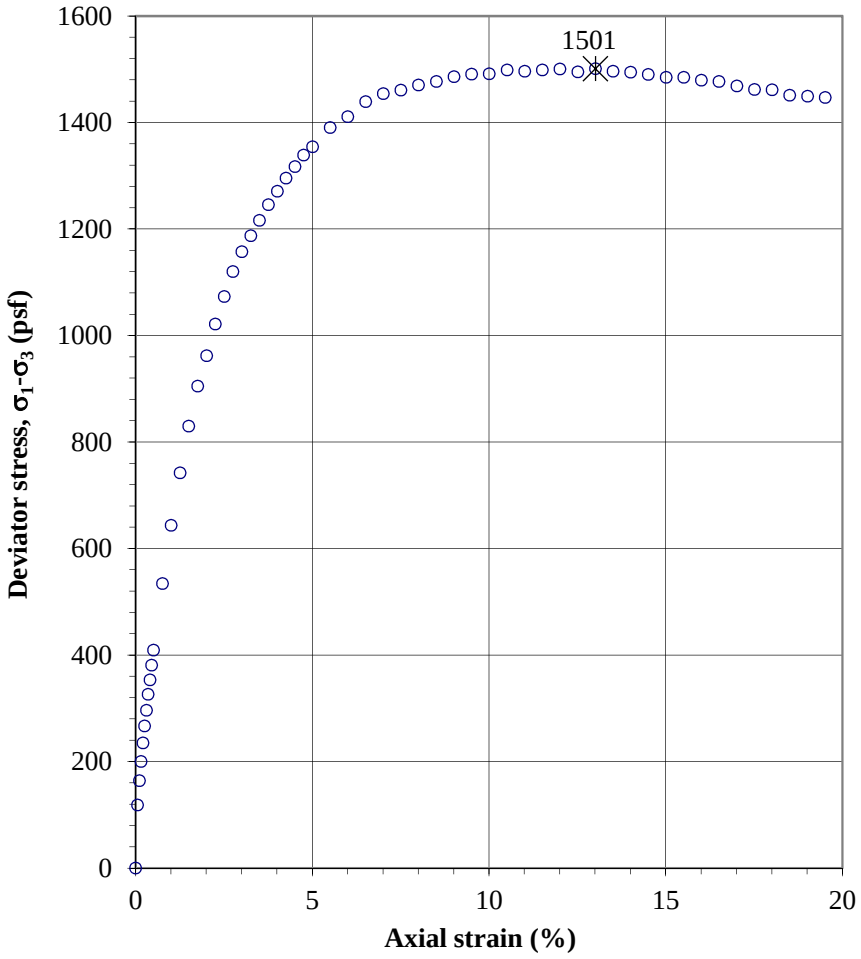
Boring No.: BH19-ES-2
Sample: 6
Depth: 20'
Sample Description: Greenish grey clay
Sample type: Undisturbed-trimmed from Shelby tube

Specific gravity, Gs	2.70	Assumed
Sample height, H (in.)	5.666	
Sample diameter, D (in.)	2.867	
Sample volume, V (ft^3)	0.0212	
Wt. rings + wet soil (g)	1863.02	
Wt. rings/tare (g)	757.39	
Moist soil, Ws (g)	1105.63	
Moist unit wt., γ_m (pcf)	115.1	
Dry unit wt., γ_d (pcf)	**84.1**	
Saturation (%)	99.0	
Void ratio, *e*	1.01	



Wet soil + tare (g)	1561.08
Dry soil + tare (g)	1265.16
Tare (g)	465.08
Water content, w (%)	**37.0**
Confining stress, σ_3 (psf)	1800
Shear rate (in/min)	0.0170
Strain at failure, ε_f (%)	13.01
Deviator stress at failure, $(\sigma_1-\sigma_3)_f$ (psf)	1501
Shear stress at failure, $q_f = (\sigma_1-\sigma_3)_f/2$ (psf)	751

Axial Strain (%)	σ_d $\sigma_1-\sigma_3$ (psf)	Q $1/2\ \sigma_d$ (psf)
0.00	0.0	0.0
0.05	118.6	59.3
0.10	163.9	81.9
0.15	200.1	100.1
0.20	235.2	117.6
0.25	267.1	133.5
0.30	296.3	148.2
0.35	326.3	163.1
0.40	353.5	176.7
0.45	381.0	190.5
0.50	409.3	204.7
0.75	534.1	267.0
1.00	643.7	321.9
1.25	742.5	371.2
1.50	830.1	415.0
1.75	905.3	452.6
2.00	962.4	481.2
2.25	1021.8	510.9
2.50	1073.5	536.7
2.75	1120.1	560.0
3.00	1157.2	578.6
3.25	1187.8	593.9
3.50	1216.1	608.0
3.75	1246.0	623.0
4.00	1271.1	635.6
4.25	1295.4	647.7
4.50	1317.1	658.5
4.75	1339.2	669.6
5.00	1354.7	677.4
5.50	1390.5	695.2
6.00	1411.3	705.7
6.50	1439.2	719.6
7.00	1454.3	727.2
7.50	1461.0	730.5
8.00	1470.5	735.3
8.50	1477.4	738.7
9.00	1486.2	743.1
9.50	1490.9	745.5
10.00	1491.3	745.6
10.50	1498.8	749.4
11.00	1496.7	748.3
11.50	1498.7	749.3
12.00	1500.4	750.2
12.51	1495.4	747.7
13.01	1501.2	750.6
13.51	1496.5	748.3
14.01	1494.6	747.3
14.51	1490.4	745.2
15.01	1485.2	742.6
15.51	1485.2	742.6
16.01	1479.4	739.7
16.51	1476.9	738.4
17.01	1469.0	734.5
17.51	1461.8	730.9
18.01	1461.2	730.6
18.51	1451.5	725.8
19.01	1449.5	724.7
19.51	1447.3	723.6
20.01	1444.8	722.4



Entered by:_____

Reviewed:_____

Consolidated-Drained Triaxial Shear Testing of Soils
(ASTM D7181)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/13/2019
By: JDF

Boring No.: BH19-ITW-4
Sample:
Depth: 15.0'
Sample Description: Grey silty clay with sand
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

	Test Number:	S1
Initial	Height, H (in)	5.829
	Diameter, D (in)	2.803
	Water content, ω (%)	30.7
	Dry unit weight, γ_d (pcf)	96.4
	Saturation (%)	100.0
	Void ratio, e	0.85
	Mounting	Wet
Before shear	Water content, ω (%)	31.6
	Dry unit weight, γ_d (pcf)	92.4
	Saturation[a] (%)	100.0
	Void ratio, e	0.93
	B	0.95
	t_{100} (min)	19.65
	Back pressure (psf)	9794
	Strain rate (%/min)	0.05
	Time to failure (min)	156.0
	Axial strain at failure, ε_f (%)	7.80
	Volumetric strain at failure, ε_{fv} (%)	0.6880
	Filter paper correction	No
	Membrane correction	Yes
Assumed specific gravity	2.85	
Liquid limit (%)	26	
Plastic limit (%)	19	
Plasticity index (%)	7	



[a] Saturation set to 100% for phase calculations

Summary of strength parameters at peak deviator stress	
c' (psf)	0
ϕ' (deg)	39.3

Tested by:_____
Reviewed:_____

Consolidated-Drained Triaxial Shear Testing of Soils

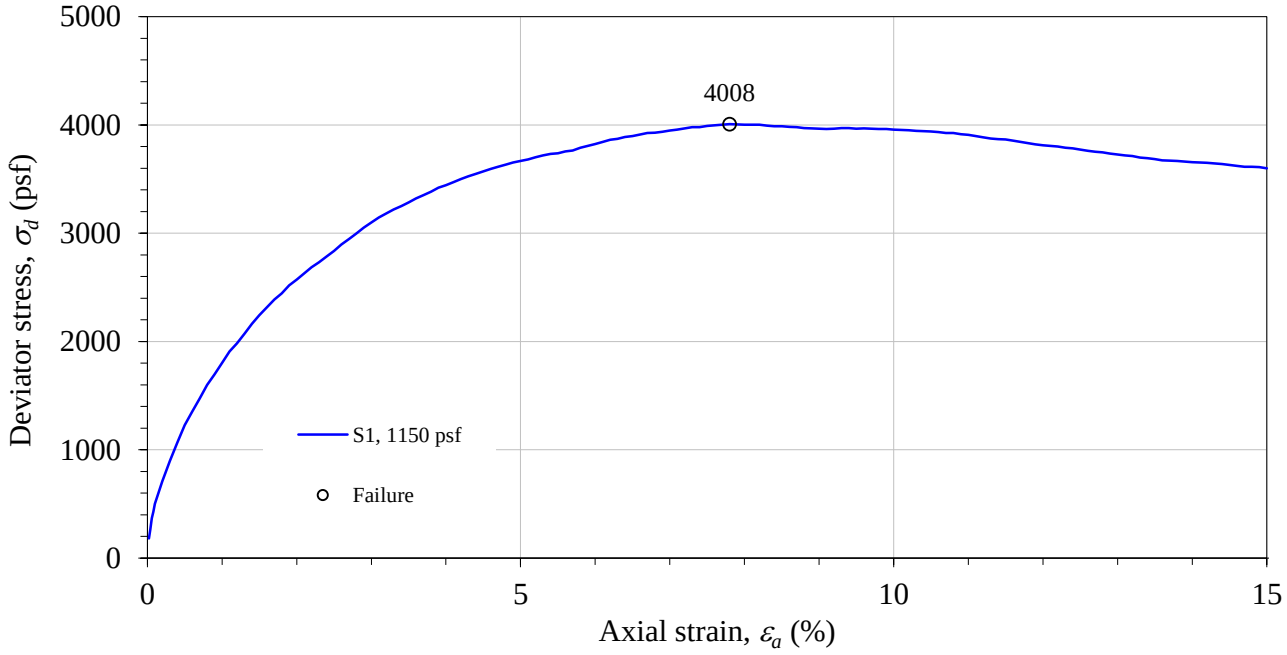
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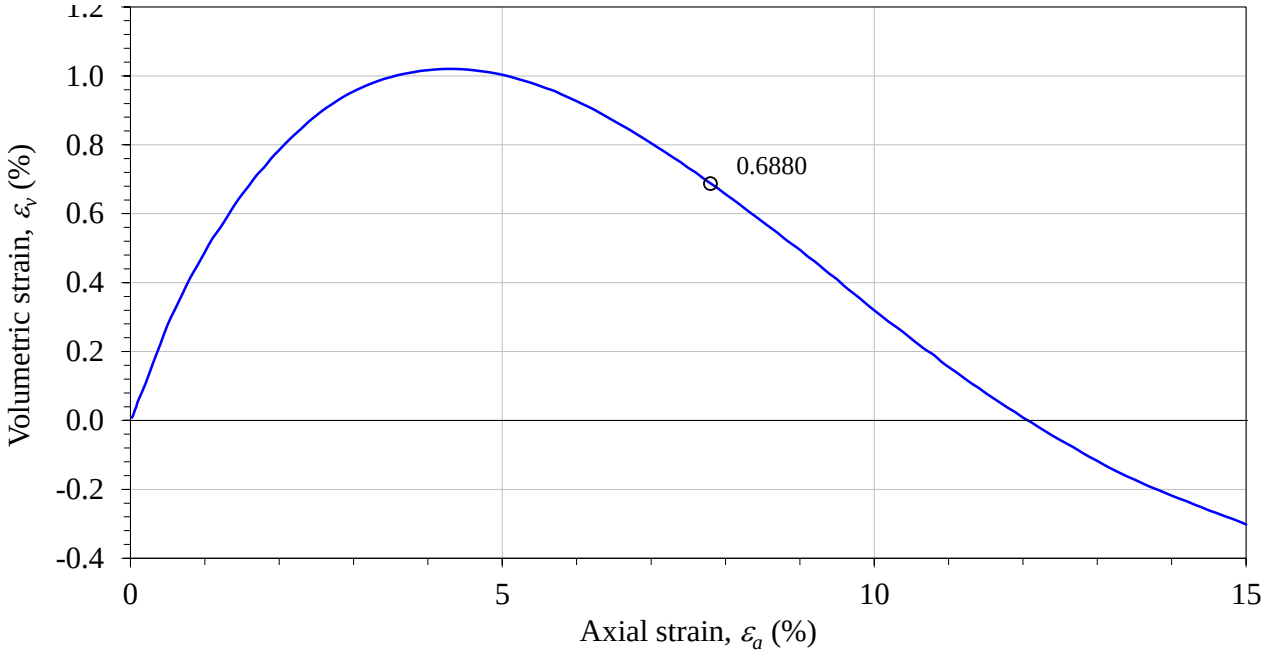
© IGES 2009, 2019

Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake

Boring No.: BH19-ITW-4
Sample:
Depth: 15.0'

	Test Number:	S1
Effective stress	σ'_3 (psf)	1159
	σ'_1-σ'_3 (psf)	4008
	σ'_1 (psf)	5167
	$q = (\sigma'_1-\sigma'_3)/2$ (psf)	2004
	$p' = (\sigma'_1+\sigma'_3)/2$ (psf)	3163
	σ'_1/σ'_3	4.46





Consolidated-Drained Triaxial Shear Testing of Soils

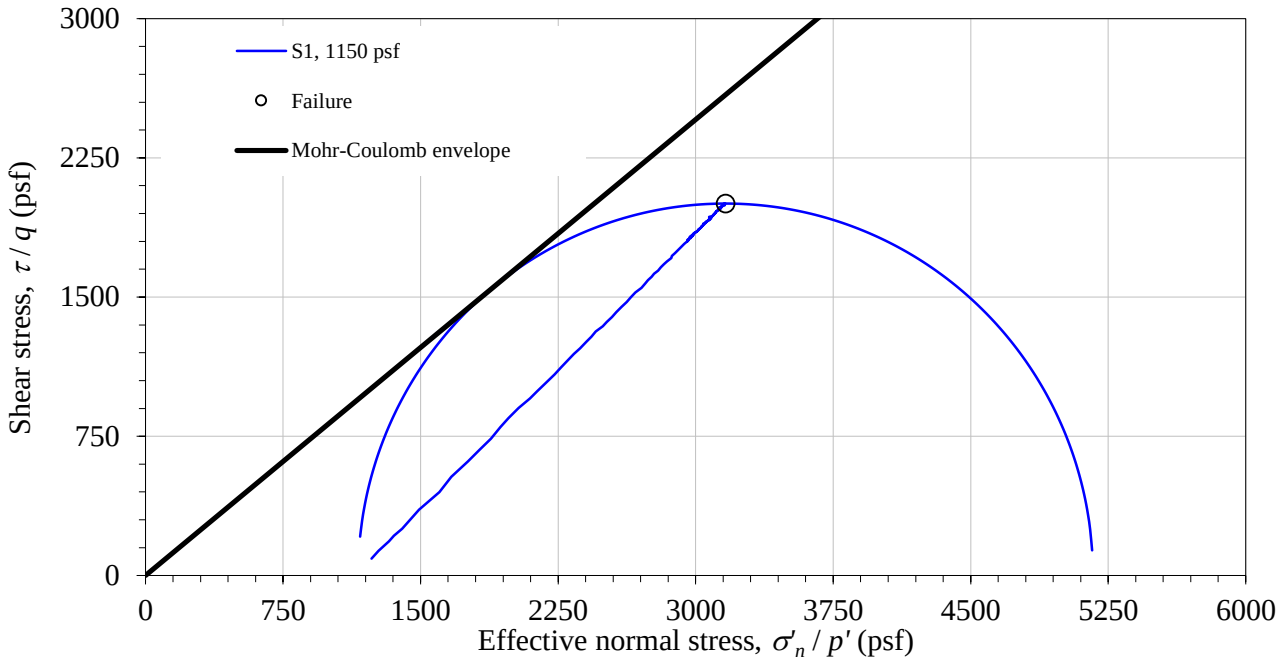
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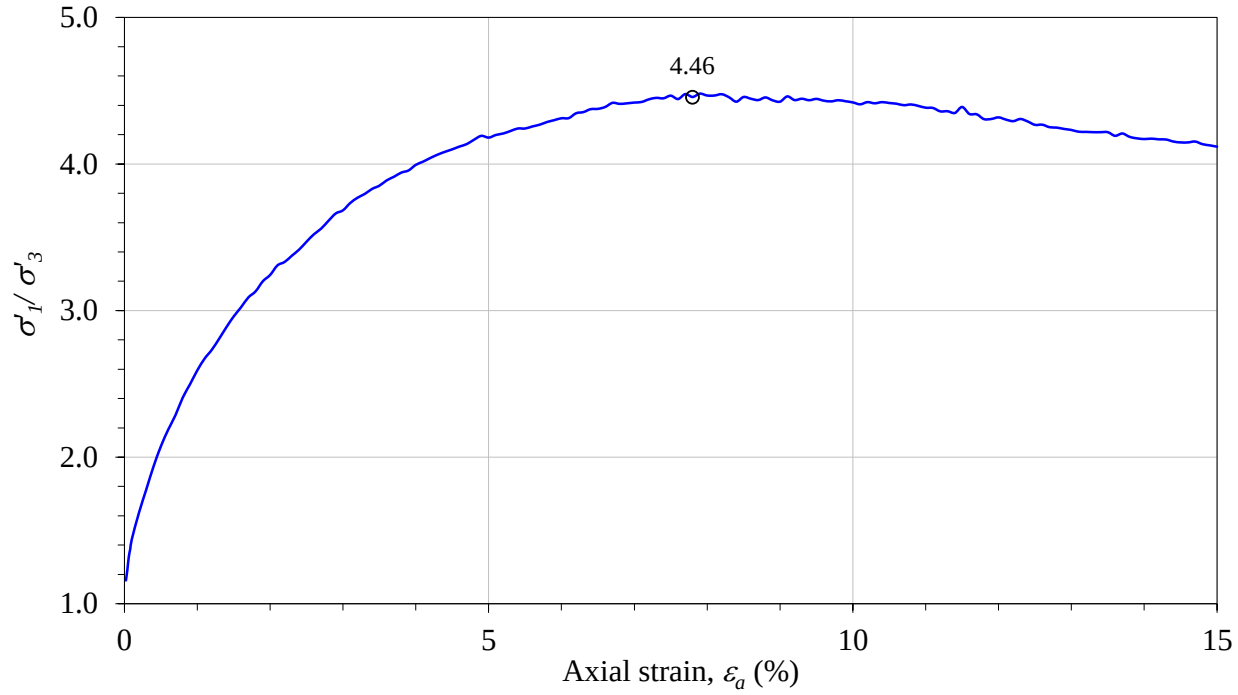
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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake

Boring No.: BH19-ITW-4
Sample:
Depth: 15.0'

Summary of strength parameters at peak deviator stress	
c' (psf)	0
ϕ' (deg)	39.3





Consolidated-Drained Triaxial Shear Testing of Soils

(ASTM D7181)

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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake
Date: 5/16/2019
By: JDF/NB

Boring No.: BH19-ITW-2
Sample:
Depth: 15.0'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

	Test Number:	S1
Initial	Height, H (in)	5.994
	Diameter, D (in)	2.834
	Water content, ω (%)	59.5
	Dry unit weight, γ_d (pcf)	64.2
	Saturation (%)	98.9
	Void ratio, e	1.62
	Mounting	Wet
Before shear	Water content, ω (%)	59.9
	Dry unit weight, γ_d (pcf)	64.4
	Saturation[a] (%)	100.0
	Void ratio, e	1.62
	B	0.95
	t_{100} (min)	53.80
	Back pressure (psf)	4750
	Strain rate (%/min)	0.0214
	Time to failure (min)	182.2
	Axial strain at failure, ε_f (%)	3.90
	Volumetric strain at failure, ε_{fv} (%)	1.7902
	Filter paper correction	No
	Membrane correction	Yes

Assumed specific gravity	2.70
Liquid limit (%)	42
Plastic limit (%)	22
Plasticity index (%)	20



[a] Saturation set to 100% for phase calculations

Summary of strength parameters at peak deviator stress	
c' (psf)	0
ϕ' (deg)	34.4

Tested by:_____
Reviewed:_____

Consolidated-Drained Triaxial Shear Testing of Soils

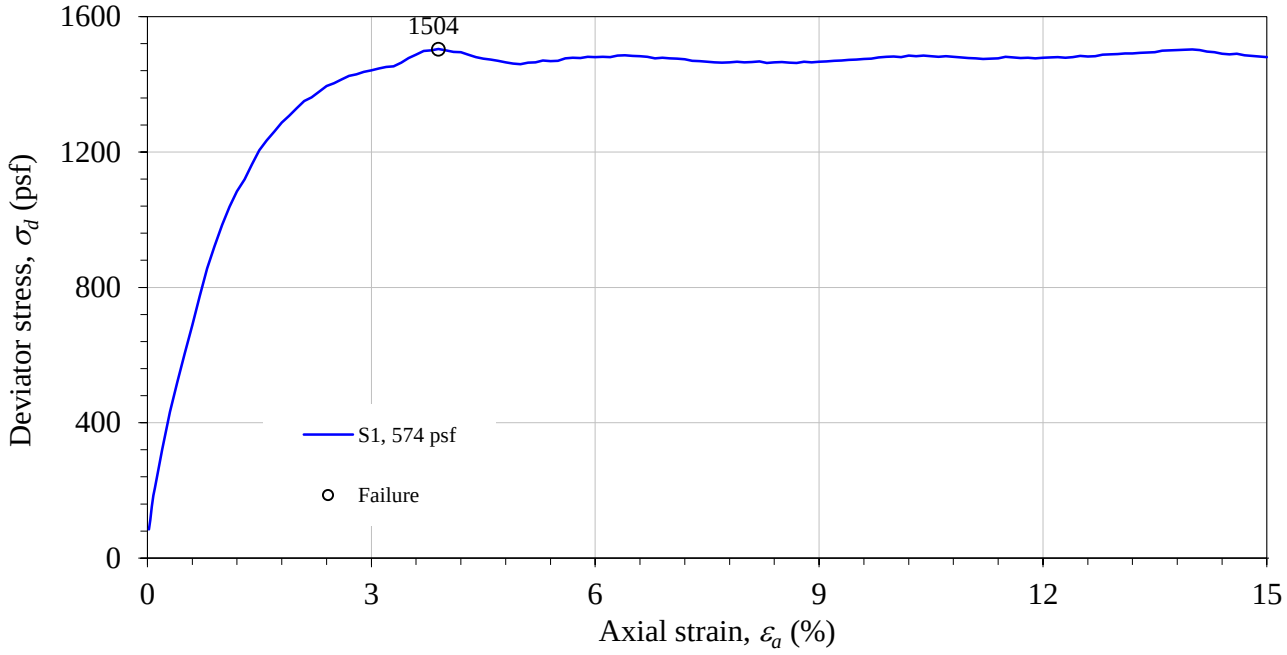
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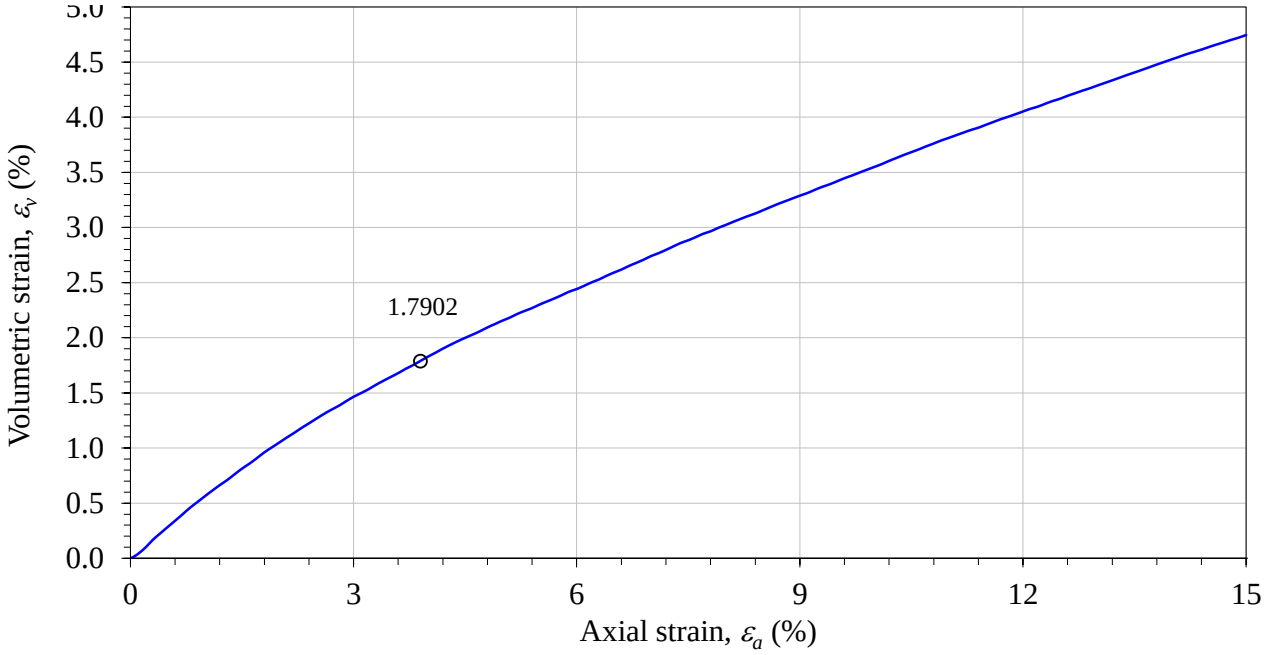
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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake

Boring No.: BH19-ITW-2
Sample:
Depth: 15.0'

	Test Number:	S1
Effective stress	σ'_3 (psf)	580
	σ'_1-σ'_3 (psf)	1504
	σ'_1 (psf)	2085
	$q = (\sigma'_1-\sigma'_3)/2$ (psf)	752
	$p' = (\sigma'_1+\sigma'_3)/2$ (psf)	1332
	σ'_1/σ'_3	3.59





Consolidated-Drained Triaxial Shear Testing of Soils

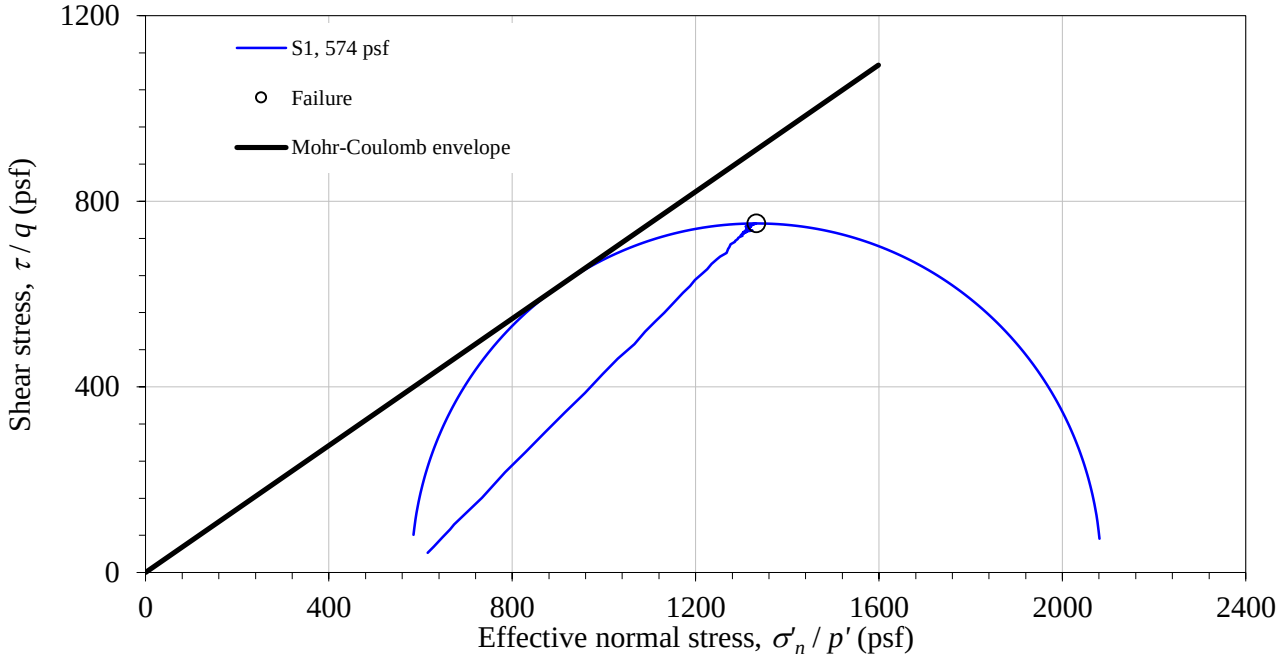
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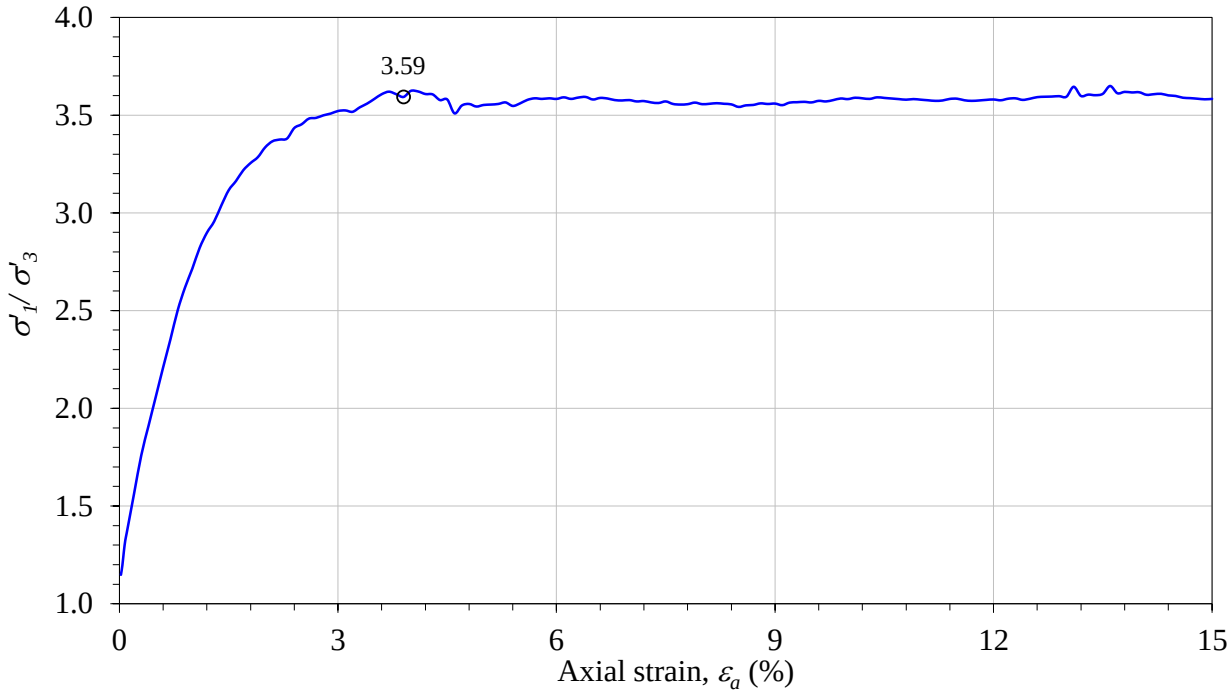
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Project: SLCWRF
No: 00100-015, 3G2 (XI)
Location: N. Salt Lake

Boring No.: BH19-ITW-2
Sample:
Depth: 15.0'

Summary of strength parameters at peak deviator stress	
c' (psf)	0
ϕ' (deg)	34.4





Corrosion Test Results

Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and Ions in Water by Chemically Suppressed Ion Chromatography *(AASHTO T 288, T 289, ASTM D4327, and C1580)*

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Project: AECOM
No: 00100-015; 3G2 (V)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 12/6/2018
By: BF

Sample info.	Boring No.	BH18-HW-1				BH18-PC-1			
	Sample	5				1			
	Depth	35'				16'			
Water content data	Wet soil + tare (g)	90.04				110.40			
	Dry soil + tare (g)	78.98				103.79			
	Tare (g)	37.29				37.92			
	Water content (%)	26.5				10.0			
Chem. data	pH^	8.26				8.43			
	Soluble chloride* (ppm)	1450				62.4			
	Soluble sulfate* (ppm)	1560				98.5			
	Soluble sulfide** (ppm)	<0.0476				<0.0364			
	Total soluble salts# (ppm)	5120				400			
Resistivity data	Pin method	2				2			
	Soil box	Miller Small				Miller Small			
		Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)
		As Is	877	0.67	588	As Is	9410	0.67	6305
		+3	460	0.67	308	+3	7250	0.67	4858
		+6	330	0.67	221	+6	5690	0.67	3812
		+9	260	0.67	174	+9	4850	0.67	3250
		+12	245	0.67	164	+12	4500	0.67	3015
		+15	250	0.67	168	+15	4670	0.67	3129
	Minimum resistivity (Ω-cm)	**164**				**3015**			

^Performed by AWAL using SW9045D

* Performed by AWAL using EPA 300.0
** Performed by AWAL using SM4500-S2-D

Performed by AWAL using SM2450C

Entered by:_____
Reviewed:_____

Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and Ions in Water by Chemically Suppressed Ion Chromatography *(AASHTO T 288, T 289, ASTM D4327, and C1580)*

© IGES 2014, 2019

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 8/7/2019
By: RT

Sample info.	Boring No.	BH19-ES-1							
	Sample	#3							
	Depth	13'							
Water content data	Wet soil + tare (g)	124.02							
	Dry soil + tare (g)	90.38							
	Tare (g)	23.62							
	Water content (%)	50.4							
Chem. data	pH*	8.14							
	Soluble chloride* (ppm)	163							
	Soluble sulfate** (ppm)	303							
	Soluble sulfide (ppm)	0.156							
	Total Soluble salts (ppm)	1120							
Resistivity data	Pin method	2							
	Soil box	Miller Small							
		Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)
		As Is	5340	0.67	3578				
		+3	3650	0.67	2446				
		+6	2580	0.67	1729				
		+9	1890	0.67	1266				
		+12	1330	0.67	891				
		+15	1270	0.67	851				
		+18	1250	0.67	838				
		+21	1230	0.67	824				
		+24	1190	0.67	797				
		+27	1230	0.67	824				
	Minimum resistivity (Ω-cm)	**797**							

* Performed by AWAL using EPA 300.0

** Performed by AWAL using ASTM C1580

Comments: Water content taken after test.

Entered by:_____
Reviewed:_____

Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and Ions in Water by Chemically Suppressed Ion Chromatography *(AASHTO T 288, T 289, ASTM D4327, and C1580)*

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Project: AECOM
No: 00100-015-3G2 (XXII)
Location: SLCity Public Utilities Waste Water Reclamation Facility
Date: 3/31/2021
By: BSS

Sample info.	Boring No.	BH-21							
	Sample	#6							
	Depth	17.5'							
Water content data	Wet soil + tare (g)	100.12							
	Dry soil + tare (g)	93.98							
	Tare (g)	37.47							
	Water content (%)	10.9							
Chem. data	pH*	8.12							
	Soluble chloride* (ppm)	1370							
	Soluble sulfate** (ppm)	720							
	Soluble sulfide (ppm)	0.0286							
	Total Soluble salts (ppm)	4380							
Resistivity data	Pin method	2							
	Soil box	Miller Small							
		Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)
		As Is	2995	0.67	2007				
		+3	1962	0.67	1315				
		+6	1473	0.67	987				
		+9	1047	0.67	701				
		+12	888	0.67	595				
		+15	477	0.67	320				
		+18	523	0.67	350				
		+21	350	0.67	235				
		+24	279	0.67	187				
		+27	259	0.67	174				
		+30	246	0.67	165				
		+33	251	0.67	168				
	Minimum resistivity (Ω-cm)	**165**							

* Performed by AWAL using EPA 300.0

** Performed by AWAL using ASTM C1580

Comments: Water content taken after test.

Entered by:_____
Reviewed:_____

Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and Ions in Water by Chemically Suppressed Ion Chromatography *(AASHTO T 288, T 289, ASTM D4327, and C1580)*

© IGES 2014, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/8/2021
By: FB

Sample info.	Boring No.	B21-IS-01				B21-IS-03			
	Station	1				2			
	Depth	5'				6'			
Water content data	Wet soil + tare (g)	84.10				64.29			
	Dry soil + tare (g)	74.86				58.95			
	Tare (g)	23.32				12.49			
	Water content (%)	17.9				11.5			
Chem. data	pH*	8.75				8.74			
	Soluble chloride* (ppm)	381				244			
	Soluble sulfate** (ppm)	498				148			
	Total Soluble Salts*** (ppm)	1020				408			
Resistivity data	Pin method	2				2			
	Soil box	Miller Small				Miller Small			
		Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)
		As-Is	968	0.67	649	As-Is	3285	0.67	2201
		+3%	646	0.67	433	+3%	2269	0.67	1520
		+6%	525	0.67	352	+6%	1586	0.67	1063
		+9%	522	0.67	350	+9%	1075	0.67	720
		+12%	503	0.67	337	+12%	1056	0.67	708
		+15%	500	0.67	335	+15%	1040	0.67	697
		+18%	506	0.67	339	+18%	1009	0.67	676
						+21%	1070	0.67	717
	Minimum resistivity (Ω-cm)	**335**				**676**			

* Performed by AWAL using EPA 300.0

** Performed by AWAL using ASTM C1580

*** High RPD due to suspected sample non-homogeneity or matrix interference.

Entered by:_____
Reviewed:_____

Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and Ions in Water by Chemically Suppressed Ion Chromatography *(AASHTO T 288, T 289, ASTM D4327, and C1580)*

© IGES 2014, 2021

Project: AECOM
No: 00100-016
Location: SLCPU Water Reclamation Facility-Offsite IPS
Date: 9/8/2021
By: RT/BFS

Sample info.	Boring No.	B21-IS-04				B21-OIPS-08			
	Station	2				12			
	Depth	8'				58'			
Water content data	Wet soil + tare (g)	65.46				70.84			
	Dry soil + tare (g)	60.99				64.65			
	Tare (g)	23.58				23.35			
	Water content (%)	11.9				15.0			
Chem. data	pH*	8.38				8.79			
	Soluble chloride* (ppm)	1300				227			
	Soluble sulfate** (ppm)	84.1				598			
	Total Soluble Salts*** (ppm)	2800				8760			
Resistivity data	Pin method	2				2			
	Soil box	Miller Small				Miller Small			
		Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)
		As-Is	1275	0.67	854	As-Is	2612	0.67	1750
		+3%	563	0.67	377	+3%	1143	0.67	766
		+6%	330	0.67	221	+6%	728	0.67	488
		+9%	310	0.67	208	+9%	574	0.67	385
		+12%	310	0.67	207	+12%	505	0.67	338
		+15%	306	0.67	205	+15%	489	0.67	327
		+18%	301	0.67	201	+18%	476	0.67	319
		+21%	301	0.67	202	+21%	488	0.67	327
	Minimum resistivity (Ω-cm)	**201**				**319**			

* Performed by AWAL using EPA 300.0

** Performed by AWAL using ASTM C1580

*** High RPD due to suspected sample non-homogeneity or matrix interference.

Entered by:_____
Reviewed:_____

Appendix F Calculations

F01 IPS Liquefaction Calculation Package
F02 IPS Bearing Capacity Calculation Package
F03 IPS Settlement Calculation Package
F04 IPS Lateral Earth Pressure Calculation Package
F05 Composite Soil Constrained Modulus E' Calculation Package

Salt Lake City Water Reclamation Facility Influent Pump Station Liquefaction Calculation

Purpose

This calculation summarizes the methodology and results of the assessment of liquefaction potential and associated hazards for the influent pump station (IPS) proposed facility at the Salt Lake City New Water Reclamation Facility (New WRF). The proposed new IPS facilities (positioned to the south of an existing pump station), which include IPS electrical building, IPS generator pad, IPS odor control, and Influent Force Main Pipeline (extending from the new IPS facilities towards the Headworks facilities at the main New WRF site) are covered in this calculation package.

Data Available

AECOM performed geotechnical explorations of subsurface conditions within, or in the vicinity of, the footprint of proposed IPS facilities. The subsurface exploration program for the new IPS facilities was performed between July 2018 and August 2021. The explorations performed by AECOM included 22 CPTs and 20 exploratory borings. Additionally, two (2) CPTs and eight (8) exploratory borings were performed by Intermountain GeoEnvironmental Services, Inc. (IGES) of South Salt Lake, a subconsultant to AECOM, within the footprint of the proposed IPS facilities. The summary of exploration information is provided in Table 1.

Spectral Analysis of Surface Waves (SASW) and Multichannel Analysis of Surface Waves (MASW) were performed between September 10 and September 15, 2018, to help assess seismic site class in the project area. Laboratory testing was performed on samples selected from the borings in order to help select engineering properties of encountered subsurface materials.

Blowcount and tip resistance normalization was performed using the assumed depth to groundwater, which is based on pore pressure dissipation tests performed during the subsurface exploration program. However, for the liquefaction analysis, the groundwater depth at the time of the earthquake is assumed to be approximately two (2) feet higher (shallower) than the assumed depth to account for potential groundwater fluctuations. A portion of the drilling occurred during the winter when groundwater levels were lower than other times of the year, and precipitation levels have been lower than average over the last several years. In large part, this assumption has little effect on the overall calculation, but considers the liquefaction potential in some relatively shallow soil layers not saturated at the time the field explorations were performed.

Table 1. Summary of IPS Subsurface Explorations

Field Investigation	Ground Surface Elevation [1] (feet)	Total Depth (feet)	Groundwater Depth [2] (feet)
CP18-PC-1	4221.6	120.1	9.8
CP20-IPSEL-01	4222.6	60.2	9.2
BH19-ES-1	4221.4	120.0	-
BH19-ES-2	4221.0	122.0	-
BH19-IT-1	4221.4	120.1	-
BH19-IT-5	4215.6	60.0	-
BH19-IT-6	4217.8	58.0	-
CP19-ES-1	4221.4	120.1	10.0
CP19-ES-2	4221.0	120.1	9.8
CP21-OIPS-01	4217.6	86.5	0.6
CP21-OIPS-02	4217.5	85.5	9.4
CP21-OIPS-03	4217.9	85.5	12.5

Field Investigation	Ground Surface Elevation [1] (feet)	Total Depth (feet)	Groundwater Depth [2] (feet)
CP21-OIPS-04	4221.0	88.4	10.8
CP21-OIPS-05	4217.4	137.5	10.0
CP21-OIPS-06	4216.0	85.1	9.1
CP21-OIPS-07	4216.5	160.8	7.6
CP21-OIPS-08	4215.7	131.4	11.2
B21-OIPS-01	4217.5	52.0	-
B21-OIPS-02	4217.1	52.0	-
B21-OIPS-03	4218.1	49.0	-
B21-OIPS-04	4219.9	52.0	-
B21-OIPS-05	4217.2	102.0	-
B21-OIPS-06	4216.5	52.0	-
B21-OIPS-07	4216.5	100.0	-
B21-OIPS-08	4216.1	102.0	-
B21-OIPS-09	4215.6	102.0	-
CP19-ITW-3[4]	4217.5	50.0	3.3
CP19-ITW-4[4]	4214.1	50.0	5.4
BH19-ITW-0[4]	4219.0	52.0	-
BH19-ITW-1[4]	4216.8	52.0	-
BH19-ITW-2[4]	4217.0	42.0	-
BH19-ITW-3N[4]	4218.0	52.0	-
BH19-ITW-3S[4]	4214.8	52.0	-
BH19-ITW-4[4]	4216.1	52.0	-
BH19-ITW-5[4]	4215.1	52.0	-
BH19-ITW-6[4]	4216.5	52.0	-
CP20-IS-01[3]	4218.9	124.0	12.1
CP20-IS-02	4215.9	75.1	8.5
CP20-IS-03	4214.8	120.9	7.4
CP20-IS-04	4217.2	75.1	9.4
CP20-IS-05	4216.0	120.1	6.6
CP21-IS-06	4218.0	123.9	7.4
CP21-IS-07	4215.4	122.1	3.3
CP21-IS-08	4216.9	120.1	4.4
CP21-IS-09	4217.1	75.4	2.7
CP21-IS-10	4215.6	120.3	2.9
B21-IS-01	4215.6	37.0	-
B21-IS-02	4215.9	32.0	-
B21-IS-03	4216.0	35.0	-
B21-IS-04	4218.1	37.0	-
B21-IS-05	4215.6	35.0	-
B21-IS-06	4216.9	37.0	-

Notes: ft = feet; '-' denotes a blank entry

1. Surveyed elevation is based on North American Vertical Datum of 1988. Northing and Easting coordinates are provided on the boring logs in North American Datum of 1983 based on the Utah Central State Plane Projection
2. Because of the selected mud-rotary drilling method for borings, the groundwater depth was neither readily observed nor measured in the field. For CPT explorations, the groundwater depth is inferred, based on the results of the shallowest pore pressure dissipation test performed within each sounding, assuming 100 percent hydrostatic conditions.
3. This CPT was not used in liquefaction analysis since it is no longer on the pipeline alignment.
4. Exploration was overseen by Intermountain GeoEnvironmental Services, Inc. of South Salt Lake, a subconsultant to AECOM.

CPT soundings were completed using a piezocone penetrometer with a 15 square centimeter (cm^2) tip and net area ratio of 0.8. Exploratory borings were completed with a CME-75 truck-mounted drill, equipped with a 4-7/8-inch drag bit, or a CME-55 track-mounted drill rig equipped with a 3-3/4-inch outer diameter drag bit. Penetration resistances were obtained from the number of hammer blows observed to drive a split-spoon standard penetration test (SPT) sampler using a 140-pound automatic hammer dropped from a height of 30 inches. The resistance to sampler penetration into a subsurface layer is

noted as blow counts (N) on the logs and refers to the number of hammer blows to advance the sampler a distance of 12 inches, beginning after 6-inches of penetration into the subsurface materials (i.e. the number of hammer blows for 18 inches of sampler penetration minus the number of hammer blows for the first 6 inches of penetration). Based on recent calibration testing, the calibrated energy transfer ratio may be assumed to be 87 percent for the hammer equipped on the CME-75 drilling equipment. Calibration for energy transfer was not available for the hammer equipped on the CME-55 drill used by Inberg-Miller Engineers until after this study was essentially complete; consequently, an energy transfer ratio of 85 percent was assumed for the analyses, based on experience with similar equipment. Laboratory testing was performed on selected soil samples collected from exploratory borings to aid in classification of potentially liquefiable soils.

Design ground motion parameters used for this liquefaction analysis are consistent with a seismic event having a 2 percent probability of exceedance in 50 years (2PE50) associated with an approximate return period of 2,475 years. A site-specific, probabilistic seismic hazard analysis (PSHA) was performed for the site, and the peak ground acceleration and earthquake magnitudes shown in Table 2 are parameters provided by the PSHA (LCI, 2018). The modal earthquake magnitude was used for the liquefaction analysis.

Table 2. Summary of 2,475-Year Return Period Ground Motion Design Parameters

Source	Mean Earthquake Magnitude, M (-)	Mean Source-Site Distance, D (km)	Modal Earthquake Magnitude, M (-)	Modal Source-Site Distance, D (km)	Peak Ground Acceleration, PGA (g)	Peak Ground Acceleration adjusted for Site Class effects, PGA_M (g)
PSHA, 2018[1]	7.1	3.2	7.1	2.5	0.62	0.62

Notes: g = acceleration due to gravity; km = kilometer; PGA = peak ground acceleration

1. "Site-Specific Seismic Hazard Analyses and Development of Seismic Design Ground Motions for the Salt Lake City Water Reclamation Facility, Utah." LCI, 2018.

Assumptions

The following assumptions were made regarding this calculation and supporting data:

- Laboratory tests were performed in accordance with the referenced American Society for Testing and Materials (ASTM) standards and are reported accurately by the subcontracted testing facility.
- Samples tested in the laboratory are representative of the soil unit from which they were obtained. Further, the results of the testing are indicative of material properties for the soil unit.
- Clay and other soils with a plasticity index (PI) more than 7 ($\geq$ 8), are not susceptible to liquefaction (Idriss and Boulanger 2008).
- Soils classified from CPTs with a normalized soil behavior type (SBTn) greater than or equal to five (5) are considered susceptible to liquefaction and its effects.
- Soil layers thinner than approximately 6 inches with a normalized soil behavior type (SBTn) greater than or equal to five (5) are neglected from post-liquefaction settlement calculations (Ahmadi and Robertson 2011; Moss et al. 2006; Youd et al. 2001).
- Based on the available pore pressure dissipation tests performed during the subsurface exploration program, the long-term groundwater elevation at the time of the seismic event was assumed to be 4,213, while the groundwater elevation at the time of drilling was assumed to be 4,211.

Methodology

Liquefaction is used to describe strength loss and deformation in saturated sands and other cohesionless materials resulting from seismically-induced pore pressure generation (Idriss and Boulanger 2008). Clays and elastic silts are not considered in this analysis.

The liquefaction triggering analysis was performed using a pseudo-probabilistic procedure where the ground motion parameters (magnitude and peak ground acceleration) were derived probabilistically and then a deterministic analysis was performed using the probabilistically-derived ground motion parameters. AECOM selected the Idriss and Boulanger (2008) methodology (including the 2014 update to magnitude scaling factor and CPT fines content prediction) to assess liquefaction

triggering. A spreadsheet was used to calculate the factor of safety against liquefaction triggering by comparing the estimated cyclic resistance ratio (CRR) of the soil to the earthquake-induced cyclic stress ratio (CSR). The ratio of these two parameters (CRR/CSR) is the factor of safety against liquefaction triggering. For this analysis, the modal earthquake magnitude is used because deaggregation data indicates that a seismic event from the nearby Wasatch fault is the largest single contributor to the seismic hazard.

Thin, coarse-grained layers were encountered in borehole explorations and CPT explorations throughout the site. Based on a review of available publications (Ahmadi and Robertson 2005; Moss et al. 2006; Youd 2018; Youd et al. 2001), thin layers affect in-situ field measurements such that the soil density is inferred to be looser than the actual in-situ state. A thin-layer correction was applied to coarse-grained layers with thicknesses up to 3 feet according to the procedure described by Moss (Moss et al, 2006). Values for the correction factor that fall between the curves generated from the case histories were linearly interpolated. The correction factor was capped at the recommended maximum value of 1.8. Coarse-grained layers with thicknesses up to 6 inches were considered to not contribute to post-liquefaction settlement. A representative value for tip resistance was applied to the entirety of the thin layer where the correction was applicable. Data from laboratory samples was used to further refine the analysis. Samples from layers that appeared continuous in several CPTs were used to refine the input fines contents or plasticity indices for coarse-grained layers that were producing post-liquefaction settlement, but which were not screened out with the thin-layer correction. For borehole explorations, a blowcount correction was applied to the SPT blowcounts.

The CSR was calculated using the following relationship, which is based on Equations 2.1 and 2.2 in the referenced document by Boulanger and Idriss (2014):

$$CSR_{M,\sigma'_v} = 0.65 \frac{\sigma_v}{\sigma'_v} \frac{a_{max}}{g} r_d$$

where, σ_v = Vertical Total Stress
σ'_v = Vertical Effective Stress
a_{max} = Maximum Horizontal Acceleration at Ground Surface (2PE50)
g = Acceleration of Gravity
r_d = Shear Stress Reduction Factor

The CRR was calculated using the following relationships, which estimates the CRR based on Equations 2.24 and 2.25 in the referenced document by Boulanger and Idriss (2014):

$$CRR_{M,\sigma'_v} = exp\left[\frac{q_{c1Ncs}}{113} + \left(\frac{q_{c1Ncs}}{1000}\right)^2 - \left(\frac{q_{c1Ncs}}{140}\right)^3 + \left(\frac{q_{c1Ncs}}{137}\right)^4 - 2.80\right] \times MSF \times K_\sigma$$

where, q_{c1Ncs} = Normalized Overburden-Corrected Equivalent Clean Sand Tip Resistance
MSF = Magnitude Scaling Factor [Equations 2.19 and 2.20 (Boulanger and Idriss 2014)]
K_σ = Overburden Correction Factor [Equations 2.16a and 2.16b (Boulanger and Idriss 2014)]

$$CRR_{M,\sigma'_v} = exp\left[\frac{(N_1)_{60cs}}{14.1} + \left(\frac{(N_1)_{60cs}}{126}\right)^2 - \left(\frac{(N_1)_{60cs}}{23.6}\right)^3 + \left(\frac{(N_1)_{60cs}}{25.4}\right)^4 - 2.80\right] \times MSF \times K_\sigma$$

where, $(N_1)_{60cs}$ = Normalized Overburden-Corrected Equivalent Clean Sand Blowcount
MSF = Magnitude Scaling Factor [Equations 2.19 and 2.21 (Boulanger and Idriss 2014)]
K_σ = Overburden Correction Factor [Equations 2.16a and 2.16c (Boulanger and Idriss 2014)]

Surface deformations were considered using the liquefaction triggering results from this procedure and the following:

- One-dimensional vertical settlement using curves and equations as presented in the Idriss and Boulanger (2008) monograph for estimating volumetric strains, which is derived from Ishihara and Yoshimine (1992) volumetric strain charts.
- Lateral displacement index, which is an indication of lateral spread potential, using the methodology presented in the referenced document by Idriss and Boulanger (2008).
- Lateral spread displacements after Youd et al. (2002), which requires input of earthquake magnitude, source to site distance, ground slope or free face ratio (if applicable), fines content, D_{50}, and the thickness of liquefiable cohesionless soil layers with blowcounts, $(N_1)_{60}$, less than 15 ($(N_1)_{60} < 15$ indicates a liquefiable layer).

Results

Post-Liquefaction Settlement

The results of the liquefaction triggering analysis and estimates of liquefaction-induced settlement are presented in Table 3. Estimated Post-Liquefaction Settlements for IPS FacilitiesTable 3 and Attachment 1. The results shown in Table 3 include the post-liquefaction settlement estimates at both the ground surface and the proposed bearing elevations, for each of the IPS facilities. Liquefaction triggering analyses based on CPT field measurements indicate that a low to moderate liquefaction hazard exists at the location of IPS facilities. Fines contents and plasticity indices determined for SPT samples were used to supplement the correlated values in the liquefaction triggering analyses based on CPT field measurements. Winckler published research that allows a state parameter (Ψ) to be determined from a plot of normalized friction ratio (F_r) versus normalized cone resistance (Q_{tn}) for a given soil layer (Winckler et al. 2014). Based on this research, a threshold of Ψ = -0.05 was used to determine whether a given soil layer would exhibit contractive or dilative behavior in a seismic event; Ψ values greater than -0.05 for a layer would suggest contractive behavior, and Ψ values less than -0.05 would suggest dilative behavior. Additionally, the dynamic and static pore pressures were compared to determine if dilative pore pressures were present in the same layer. Dilative pore pressures occur if the dynamic pore pressure values are less than the static pore pressure values for a given layer. If both the state parameter and pore pressures for a given layer show dilative behavior, the layer was screened out in the liquefaction analysis. If the state parameter showed contractive behavior, even with dilative pore pressures, the layer was still considered liquefactionsusceptible. The laboratory results, which were used to supplement the CPT-based liquefaction analyses, and the justifications for any refinement of layers is presented in Attachment 2.

Table 3. Estimated Post-Liquefaction Settlements for IPS Facilities

Exploration	Estimated Post-Liquefaction Settlement at Ground Surface (inches)	Estimated Post-Liquefaction Settlement at Base of Foundation (inches)	Nearest Proposed Facilities
CP18-PC-1	--[2]	--[2]	Area near Influent Force Main Pipeline
CP20-IS-02	1.0	0.6	Influent Pipeline
CP20-IS-03	0.3	--[2]	Influent Pipeline
CP20-IS-04	0.7	0.2	Influent Pipeline
CP20-IS-05	0.9	0.6	Influent Pipeline
CP21-IS-06	0.7	0.6	Influent Pipeline
CP21-IS-07	0.6	0.1	Influent Pipeline
CP21-IS-08	1.0	--[2]	Influent Pipeline
CP21-IS-09	0.2	0.2	Influent Pipeline
CP21-IS-10	0.3	0.3	Influent Pipeline
CP21-OIPS-01	0.6	0.6	IPS Electrical Building

Exploration	Estimated Post-Liquefaction Settlement at Ground Surface (inches)	Estimated Post-Liquefaction Settlement at Base of Foundation (inches)	Nearest Proposed Facilities
CP21-OIPS-02	--[2]	--[2]	IPS Generator Pad
CP21-OIPS-03	0.2	0.2	IPS Odor Control Building
CP21-OIPS-04	--[2]	--[2]	IPS Generator Pad
CP21-OIPS-05	0.4	0.1	Influent Pump Station
CP21-OIPS-06	0.7	0.7	Influent Pipeline, IPS, and IPS Generator Pad
CP21-OIPS-07	0.9	0.9	Influent Pipeline and IPS
CP21-OIPS-08	0.4	--[2]	Influent Pump Station

Notes:

1. Paired boring and CPT.
2. Post-liquefaction settlement for the given scenario is negligible.

Surface manifestation of liquefaction, which includes post-liquefaction settlement and lateral spread, has generally been concentrated in shallow liquefiable layers. The effects of liquefaction that occur below a depth of approximately 50 to 60 feet are generally not observed at the ground surface (Bartlett and Youd 1995; Cetin et al. 2009). The lowest liquefiable layer for the site is estimated to be near elevations ranging from approximately 4,164 to 4,166 feet. Some deeper layers may have been estimated to trigger based on Idriss and Boulanger (2008) procedure; however, in consideration of the lack of surface manifestation of deep liquefaction reported in the publications by Bartlett and Youd and Cetin et al., layers deeper than 60 feet were not considered to contribute to vertical deformations at the surface. It is also estimated that these deeper layers are late Pleistocene in age and have a low susceptibility to triggering.

Estimated total and differential post-liquefaction settlements were assessed by facility. Predicted post-liquefaction settlements at the base of each structure for each associated exploration are displayed in Table 3. However, estimated post-liquefaction settlement experienced by structures may be less than estimated ground surface settlement due to planned ground improvements and depth of proposed structures. Estimated post-liquefaction settlement beneath proposed IPS facilities is summarized below, grouped by facility.

IPS

Based on the deep bearing elevation of the new IPS (approximately 4,169.5 feet) and liquefaction analyses for explorations in the vicinity, the magnitude of post-liquefaction settlement estimated to be experienced by the IPS is in the order of 0.1 inch and negligible. The liquefaction triggering analysis indicated that there are materials above the design bearing elevation for the IPS which may be susceptible to liquefaction and associated vertical settlement. While the deeper bearing elevation reduces the magnitude of estimated post-liquefaction settlement beneath the IPS, it is anticipated that the ground surface settlements could be on the order of 1 inch in the area around the structure. Accordingly, it is recommended that differential settlements between the structure and the surrounding ground be considered in design, such as through the use of trenching, vaults, and/or flexible connections of shallow utilities coming into or going out of the IPS. Additionally, it is anticipated that sidewalks and flatwork could experience post-liquefaction settlement on the order of 1 inch, and associated maintenance and repairs may be needed following a seismic event. The settlement calculation package for the IPS discusses and analyzes settlement in more detail than is discussed here.

IPS Electrical Building

Based on planned structure elevations for the IPS electrical building (approximately 4,219 feet), and liquefaction analyses for explorations in the vicinity, the magnitude of post-liquefaction settlement estimated to be experienced by this structure is on the order of less than one inch with possible differential settlements of up to 1 inch over 100 feet of length beneath the structure, corresponding to an angular distortion of approximately 0.001 radians.

IPS Odor Control

Based on planned structure elevations for the IPS odor control (approximately 4,219 feet), and liquefaction analyses for explorations in the vicinity, the magnitude of post-liquefaction settlement estimated to be experienced by this structure is negligible.

IPS Generator Pad

Based on planned structure elevations for the IPS generator pad (approximately 4,219 feet), and liquefaction analyses for explorations in the vicinity, the magnitude of post-liquefaction settlement estimated to be experienced by this structure is on the order of less than 1 inch.

Influent Force Main Pipeline

Based on planned structure elevations for the influent pipeline (approximately 4,211.5), and liquefaction analyses for explorations in the vicinity, the magnitude of post-liquefaction settlement estimated to be experienced by this pipeline is on the order of 1 inch, with possible differential settlements of up to 1 inch over 100 feet of length beneath the structure, corresponding to an angular distortion of approximately 0.001 radians.

Lateral Spread

Generally, there were no continuous liquefiable layers across the area of the new IPS. There are some portions along the influent force mains alignment where a shallow, 2-foot thick, liquefiable layer appeared somewhat continuous in our explorations. This layer was encountered in the area where the force mains alignment is within approximately 200 feet of the Jordan River. This apparent continuous, liquefiable layer coincides approximately with the spring line elevation of the influent pipelines. In a potential lateral spreading event, soils above the spring line of the pipes could deform in the direction of the Jordan River.

Calculations were performed to investigate lateral spread potential for this zone using the revised multilinear regression equations for predicting lateral spread displacement proposed by Youd et al. (2002) for a scenario with gently sloping ground (Equation 1), and for a scenario with a free face (Equation 2). For one case where the influent pipeline alignment is close to the Jordan River, a free face case was considered for the potentially liquefiable zone. All other lateral spreading calculations assumed a gently sloping ground scenario. For the gently sloping ground lateral spreading calculations, a regional slope of 1.5% was assumed for the site. For all performed lateral spread calculations, the cumulative thickness of the coarse-grained, non-plastic layers falls outside of the bounds established by the case histories (as noted on the exports included in Attachment 1). The free face ratio used for the calculations is also outside of the bounds established by case histories. Thus, the procedure proposed by Youd et al. (2002) may over-predict the amount of lateral spread that this zone will produce. Accordingly, the lateral spread evaluation is likely conservative and over-predicts the displacement. Youd (2018) also expounded on data and the approach presented in the earlier publication indicating that non-glacial and non-sensitive sediments with fines content over 50 percent should be screened out of the analysis. Furthermore, a general geologic characterization of these soils indicates that this zone may be Pleistocene or Holocene in origin. Available literature suggests that soils of Pleistocene age have a low susceptibility to liquefaction and lateral spread (Youd and Perkins 1978).

$$\log D_h = -16.213 + 1.532 * M - 1.406 * \log\left[R + 10^{(0.89*M-5.64)}\right] - 0.012 * R + 0.338 * \log S + 0.540 * \log T_{15} + 3.413 * \log(100 - F_{15}) - 0.795 * \log(D50_{15} + 0.1mm) \quad (1)$$

where,

D_h = Free Face Lateral Spread Distance (m)

M = Earthquake Moment Magnitude

R = Horizontal Distance to Seismic source (km)

S = Slope in ground (%)

T_{15} = Cumulative Thickness of Liquefiable Layers ($N_{1(60)} < 15$) (m)

$D50_{15}$ = Average Mean Grain Size in T_{15} Liquefiable Layers (mm)

F_{15} = Average Fines in T_{15} Liquefiable Layers (%)

$$\log D_h = -16.713 + 1.532 * M - 1.406 * \log\left[R + 10^{(0.89*M-5.64)}\right] - 0.012 * R + 0.592 * \log W + 0.540 * \log T_{15} + 3.413 * \log(100 - F_{15}) - 0.795 * \log(D50_{15} + 0.1mm) \quad (2)$$

where, D_h = Free Face Lateral Spread Distance (m)
M = Earthquake Moment Magnitude
R = Horizontal Distance to Seismic source (km)
W = Free face Ratio [Height of Free Face/Distance to Base of Free Face]
T_{15} = Cumulative Thickness of Liquefiable Layers ($N_{1(60)} < 15$) (m)
$D50_{15}$ = Average Mean Grain Size in T_{15} Liquefiable Layers (mm)
F_{15} = Average Fines in T_{15} Liquefiable Layers (%)

The slope was determined regionally for the site. This analysis assumes that lateral displacements of the IPS site would be in a northwestward direction, except in the case where a free face scenario occurs, and lateral spreading would move towards the canal, and Jordan River. A modal magnitude of 7.1 and source-to-site distance of 2.5 kilometers were used (in the case of influent pipeline, source-to-site distance of 2.9 kilometers was used). The modal magnitude and distance were used instead of the mean magnitude and distance because of the significant seismic hazard contribution from the nearby Wasatch Fault Section. The fines content for the T15 soil layers was determined by using laboratory data for relevant samples or fines content correlations for relevant CPT explorations. The cumulative thickness of layers that may contribute to lateral spread falls outside of the range of case histories data. Potential lateral spreading deformations are on the order of 2 to 8 inches in the vicinity of the force main pipeline.

The Youd et al. (2002) model is sensitive to fines content. Tested soils with corrected blowcounts less than 15 typically consisted of silts/silty sands with fines contents between 20 and 65 percent. High fines contents when used with the Youd et al. (2002) model will predict markedly lower lateral displacements than clean granular soil layers.

The Youd et al. (2002) model has bounds of F15 and D5015 for which their lateral displacement values are verified. Combinations of F15 and D50 that fall outside of the recommended limits are not susceptible to lateral spread (Youd 2018). If actual D50 values are less than what was assumed for this analysis, results from the Youd et al. (2002) model may have high uncertainty or may be unreliable. Youd et al. (2009) suggest that the prediction of lateral spread displacements may be estimated in fine-grained materials, even though the fines content may exceed the specified 70 percent limit; however, this limit should be reduced to 50 percent based on a later publication (Youd 2018).

In addition to the model limitations mentioned above, lateral spread is heavily reliant on layer continuity. Subsurface investigations suggest that soils in which lateral spread is predicted are fluvial and alluvial deposits. Layers deposited in alluvial or fluvial environments are commonly discontinuous, winding, braided, and lensed. The lateral spread analyses predictions shown in Attachment 1 assume the worst-case scenario where these layers are continuous. Due to the depositional environment, discontinuous nature of liquefaction-susceptible soils, age of deeper sediments (Pleistocene soils are generally characterized as having low liquefaction potential), and variable plasticity and fines content of Holocene liquefaction-susceptible soils, it is our opinion that lateral spreading in the vicinity of the IPS facilities should not be anticipated.

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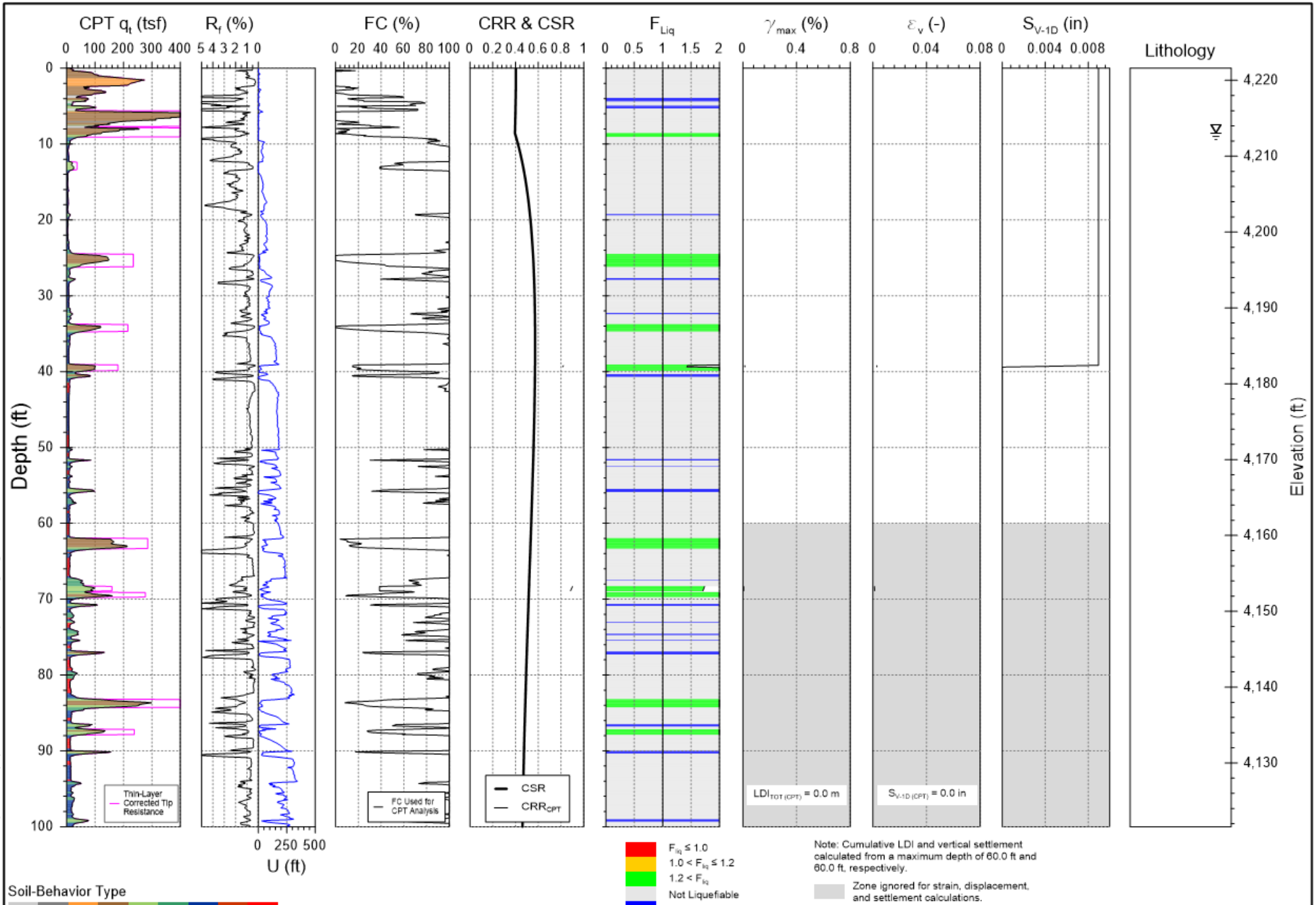
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Attachments

Attachment 1: Standard Method Liquefaction Results and Lateral Spread Results

Attachment 2: Laboratory Results and Layer Parameter Change Justification

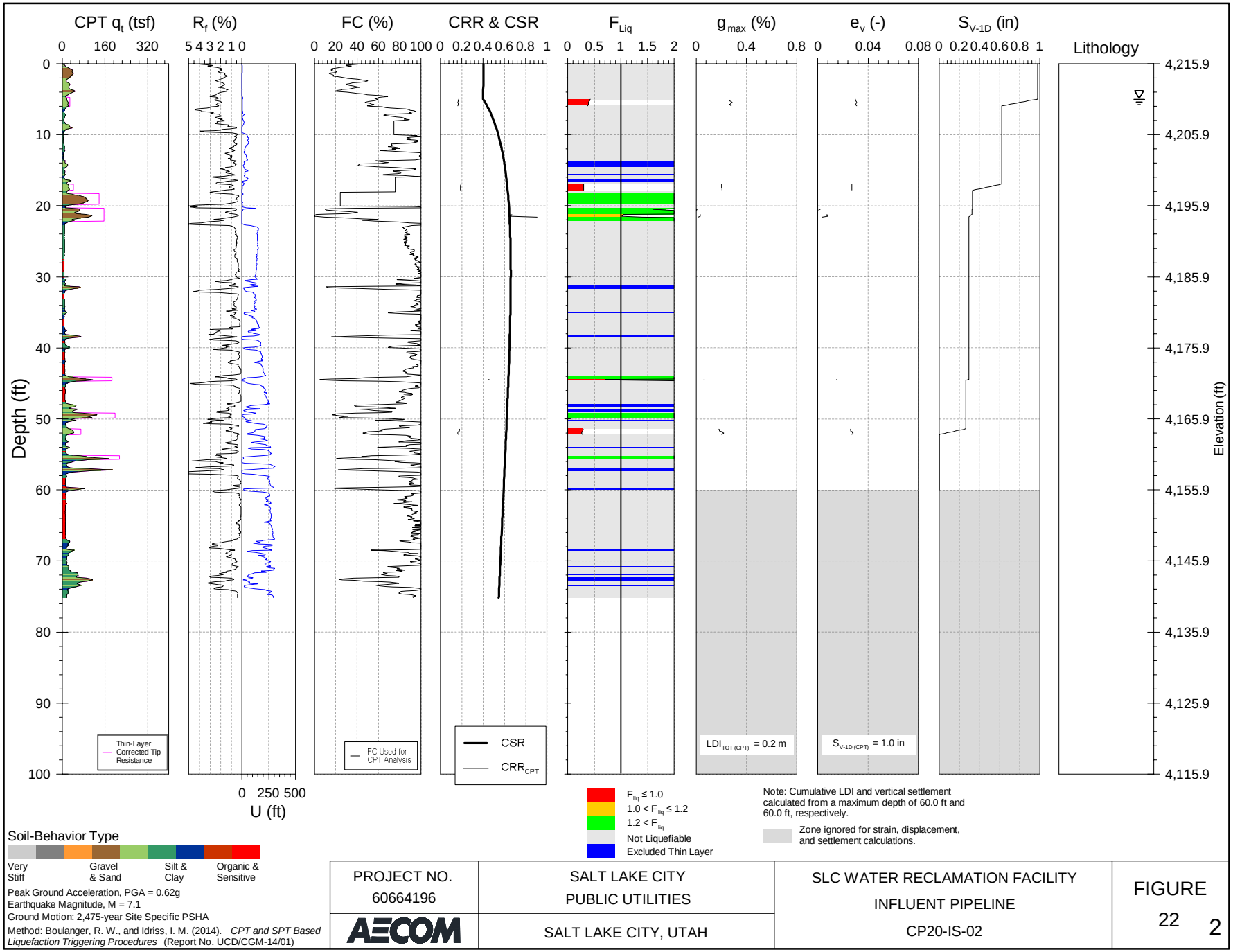
Attachment 1

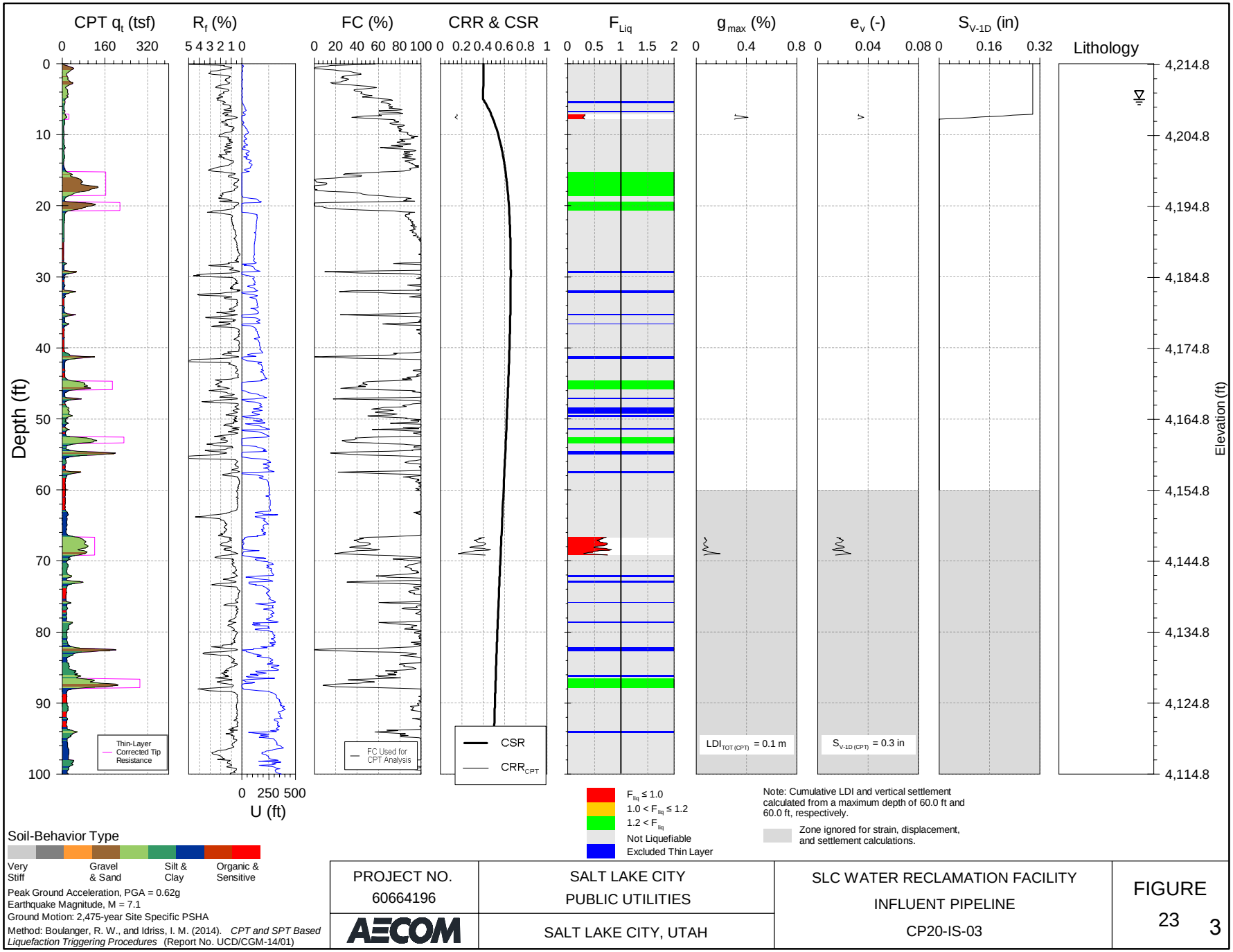


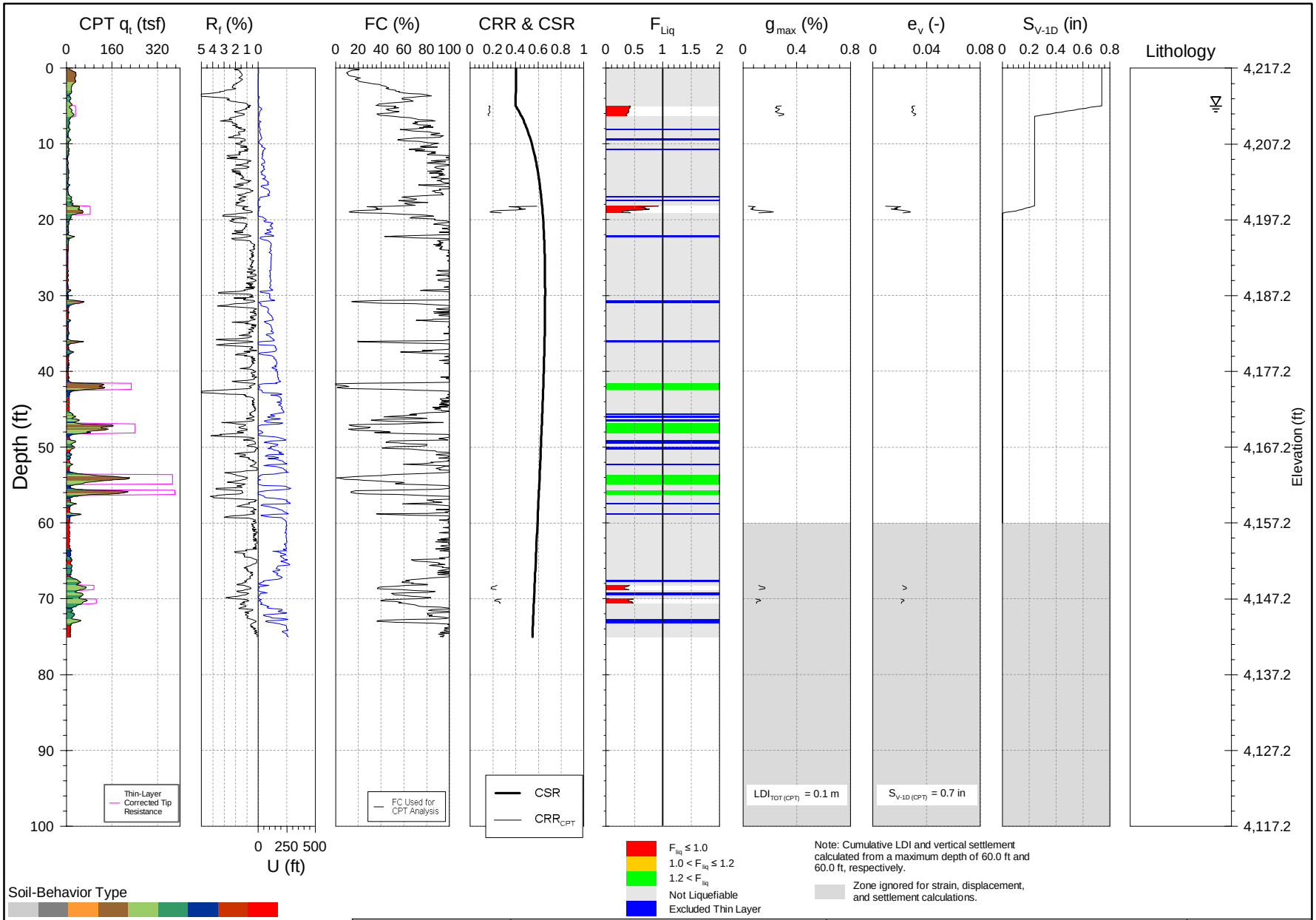
PROJECT NO. 60572288	SALT LAKE CITY PUBLIC UTILITIES	WATER RECLAMATION FACILITY LIQUID TRAIN CP18-PC-1	FIGURE 13 1
AECOM	SALT LAKE CITY, UTAH		

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CPT q_t (tsf)
R_f (%)
FC (%)
CRR & CSR
F_{Liq}
g_{max} (%)
e_v (-)
S_{V-1D} (in)
Lithology
Depth (ft)
Elevation (ft)
U (ft)
Thin-Layer Corrected Tip Resistance
FC Used for CPT Analysis
CSR
CRR_{CPT}
$LDI_{TOT\ (CPT)}$ = 0.2 m
$S_{V-1D\ (CPT)}$ = 1.0 in
$F_{liq} \leq 1.0$
$1.0 < F_{liq} \leq 1.2$
$1.2 < F_{liq}$
Not Liquefiable
Excluded Thin Layer
Note: Cumulative LDI and vertical settlement calculated from a maximum depth of 60.0 ft and 60.0 ft, respectively.
Zone ignored for strain, displacement, and settlement calculations.
Soil-Behavior Type
Very Stiff
Gravel & Sand
Silt & Clay
Organic & Sensitive
Peak Ground Acceleration, PGA = 0.62g
Earthquake Magnitude, M = 7.1
Ground Motion: 2,475-year Site Specific PSHA
Method: Boulanger, R. W., and Idriss, I. M. (2014). CPT and SPT Based Liquefaction Triggering Procedures (Report No. UCD/CGM-14/01)
PROJECT NO. 60664196
SALT LAKE CITY PUBLIC UTILITIES
SALT LAKE CITY, UTAH
SLC WATER RECLAMATION FACILITY
INFLUENT PIPELINE
CP20-IS-02
FIGURE 22 2
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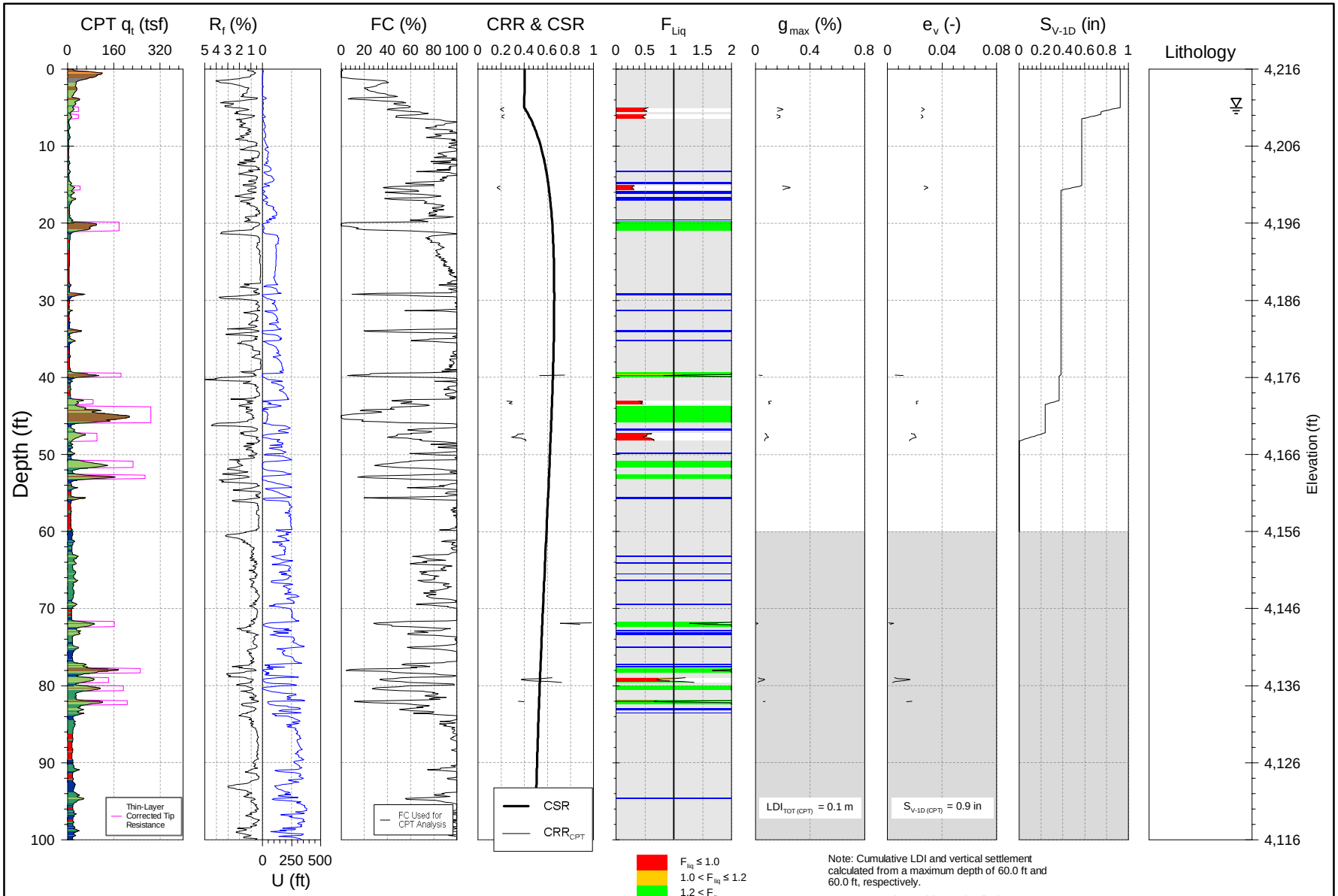

CPT q_t (tsf)
R_f (%)
FC (%)
CRR & CSR
F_{Liq}
g_{max} (%)
e_v (-)
S_{V-1D} (in)
Lithology
Depth (ft)
Elevation (ft)
Thin-Layer Corrected Tip Resistance
FC Used for CPT Analysis
CSR
CRR_{CPT}
$LDI_{TOT\ (CPT)}$ = 0.1 m
$S_{V-1D\ (CPT)}$ = 0.3 in
U (ft)
$F_{liq} \leq 1.0$
$1.0 < F_{liq} \leq 1.2$
$1.2 < F_{liq}$
Not Liquefiable
Excluded Thin Layer
Note: Cumulative LDI and vertical settlement calculated from a maximum depth of 60.0 ft and 60.0 ft, respectively.
Zone ignored for strain, displacement, and settlement calculations.
Soil-Behavior Type
Very Stiff
Gravel & Sand
Silt & Clay
Organic & Sensitive
Peak Ground Acceleration, PGA = 0.62g
Earthquake Magnitude, M = 7.1
Ground Motion: 2,475-year Site Specific PSHA
Method: Boulanger, R. W., and Idriss, I. M. (2014). CPT and SPT Based Liquefaction Triggering Procedures (Report No. UCD/CGM-14/01)
PROJECT NO. 60664196
AECOM
SALT LAKE CITY PUBLIC UTILITIES
SALT LAKE CITY, UTAH
SLC WATER RECLAMATION FACILITY
INFLUENT PIPELINE
CP20-IS-03
FIGURE 23 3
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Earthquake Magnitude, M = 7.1
Ground Motion: 2,475-year Site Specific PSHA
Method: Boulanger, R. W., and Idriss, I. M. (2014). *CPT and SPT Based Liquefaction Triggering Procedures* (Report No. UCD/CGM-14/01)

PROJECT NO. 60664196	SALT LAKE CITY PUBLIC UTILITIES	SLC WATER RECLAMATION FACILITY INFLUENT PIPELINE	FIGURE 24 4
AECOM	SALT LAKE CITY, UTAH	CP20-IS-04	

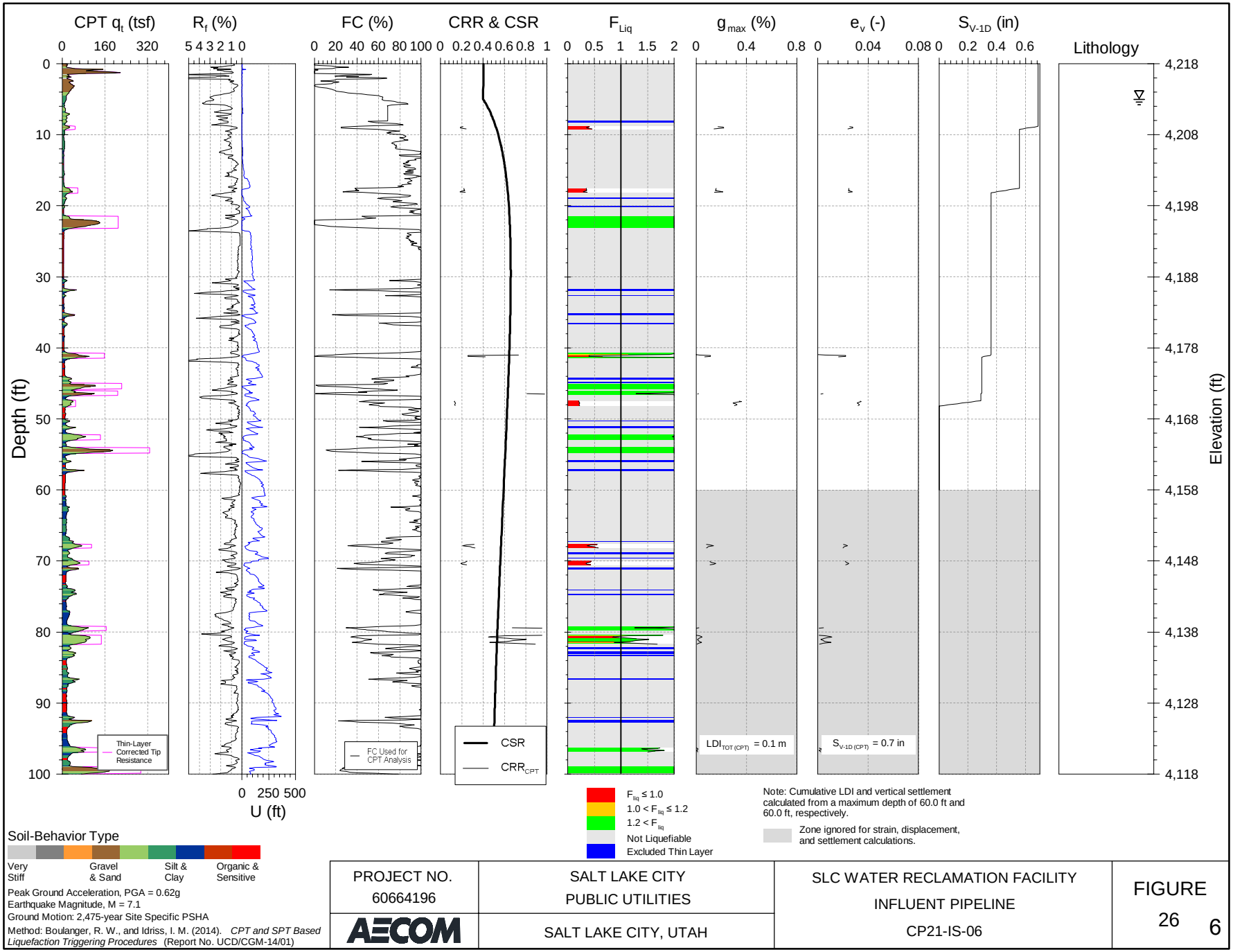
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Method: Boulanger, R. W., and Idriss, I. M. (2014). *CPT and SPT Based Liquefaction Triggering Procedures* (Report No. UCD/CGM-14/01)

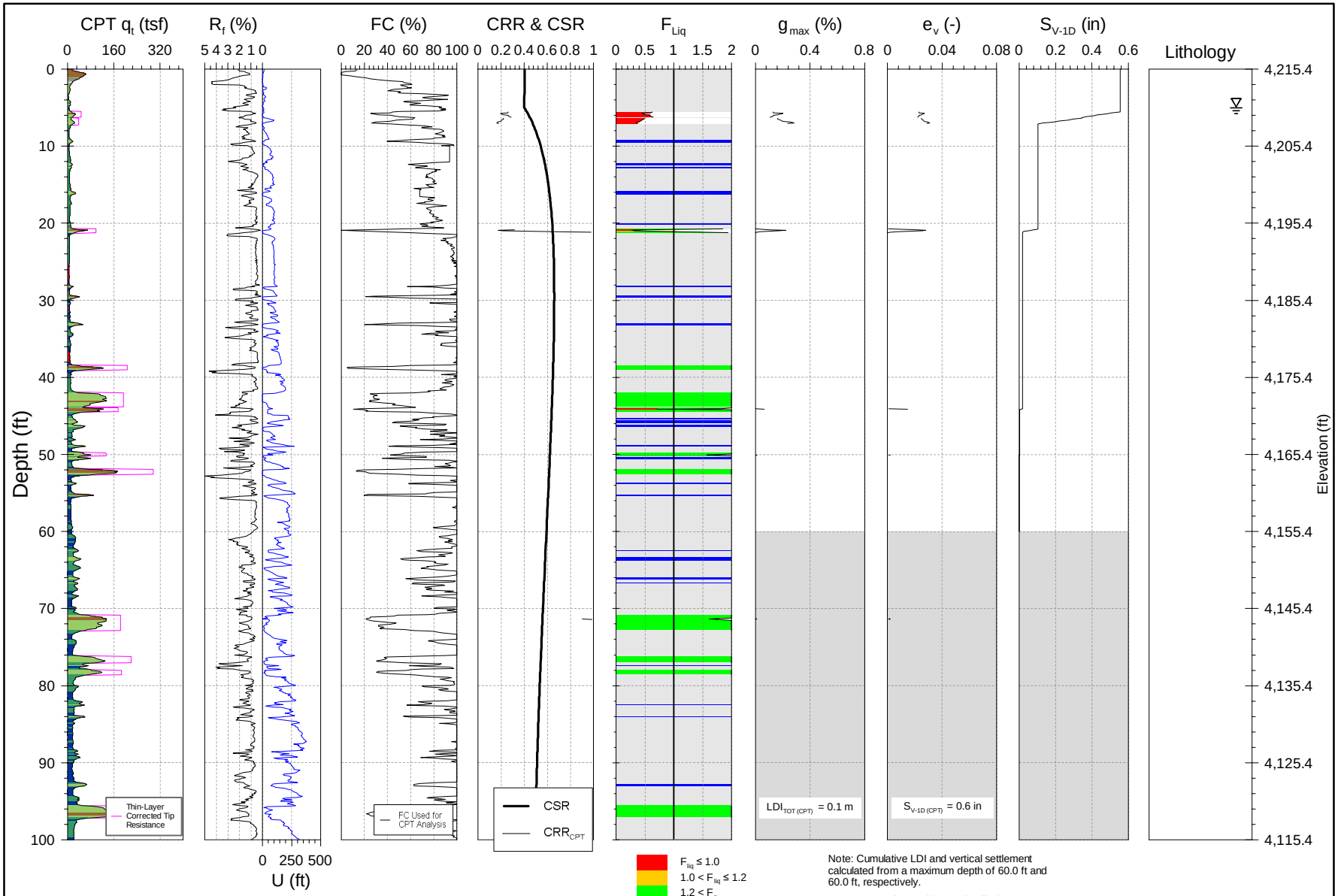
PROJECT NO. 60664196	SALT LAKE CITY PUBLIC UTILITIES	SLC WATER RECLAMATION FACILITY INFLUENT PIPELINE	FIGURE 25 5
AECOM	SALT LAKE CITY, UTAH	CP20-IS-05	

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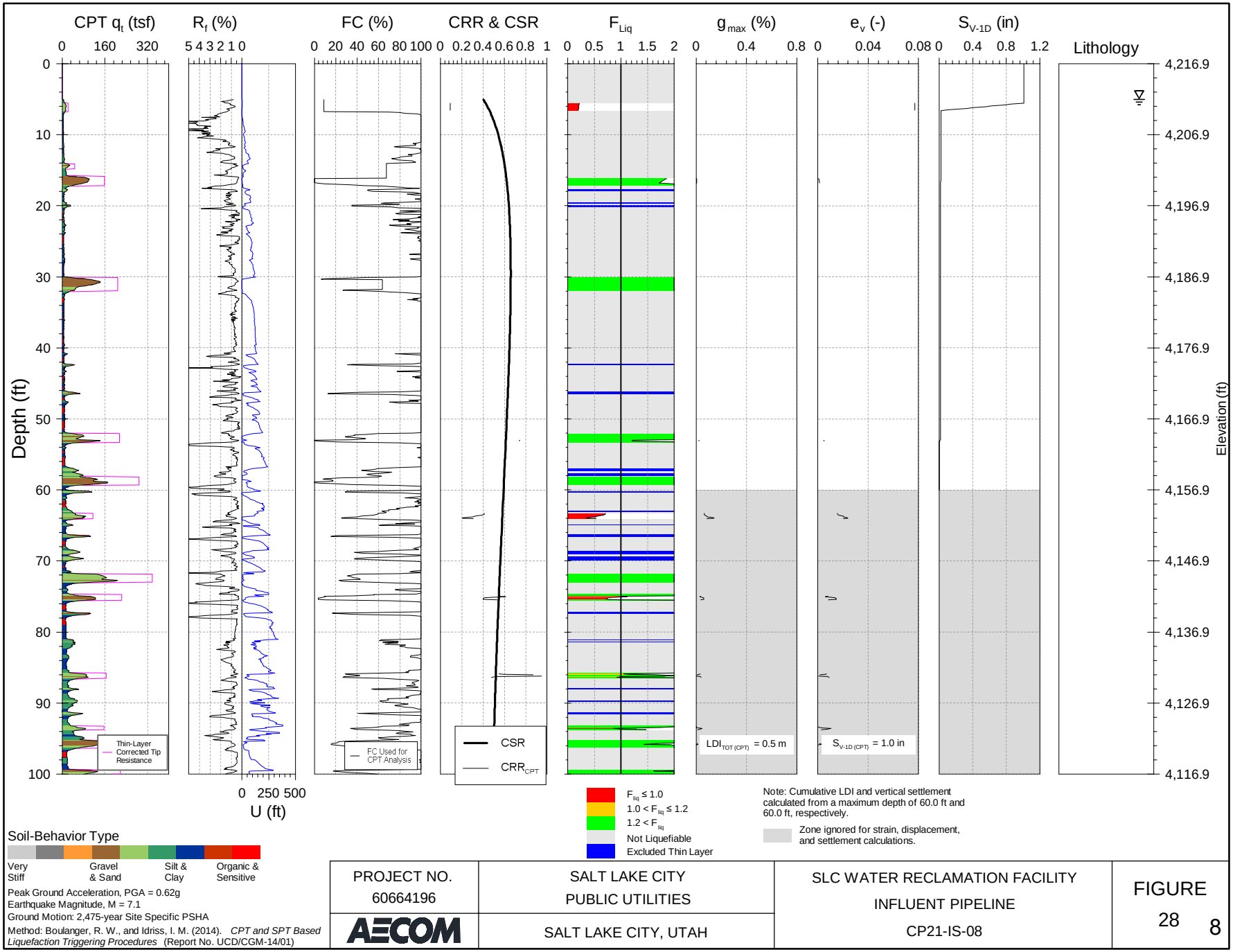
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PROJECT NO. 60664196	SALT LAKE CITY PUBLIC UTILITIES	SLC WATER RECLAMATION FACILITY INFLUENT PIPELINE	FIGURE 26 6
AECOM	SALT LAKE CITY, UTAH	CP21-IS-06	

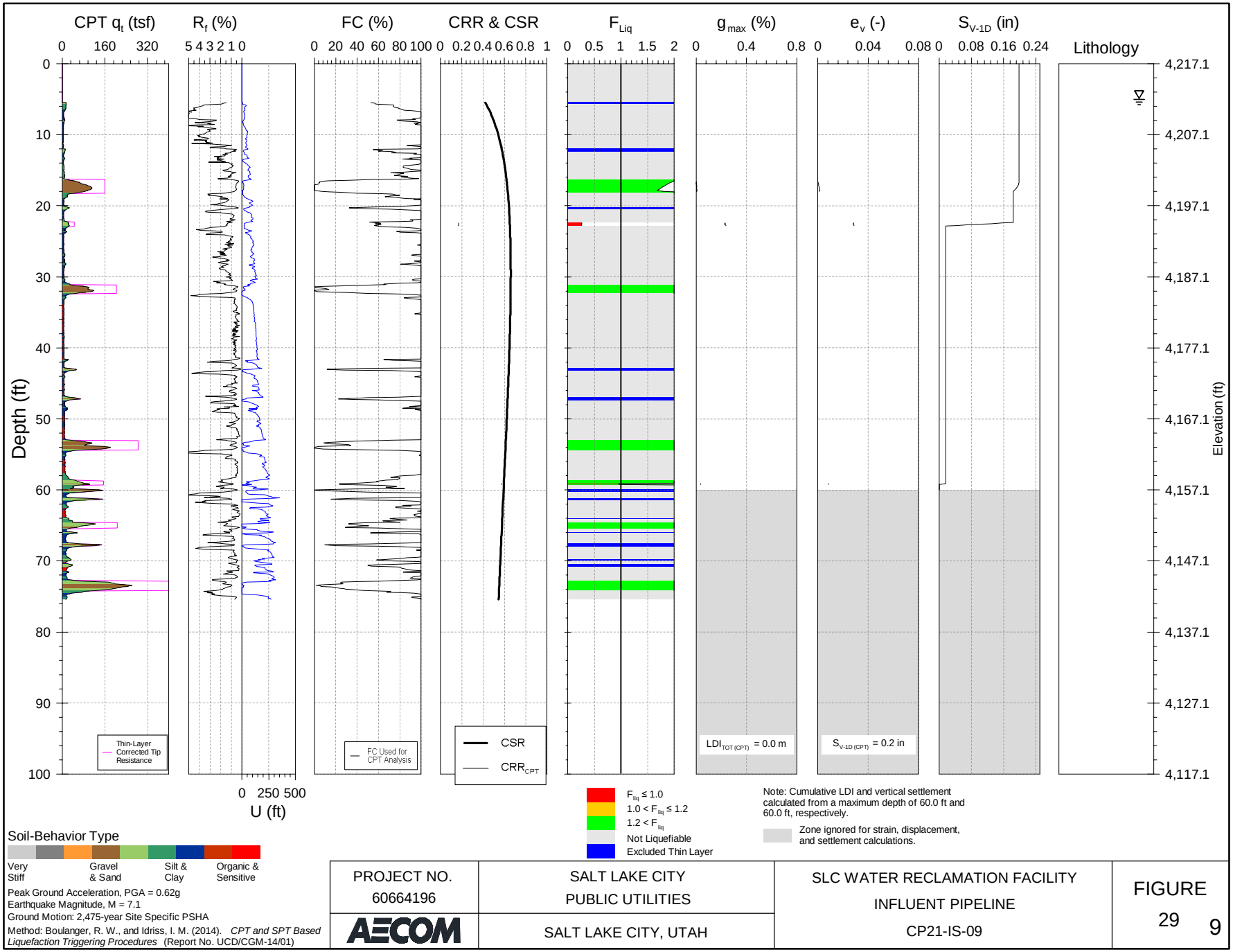


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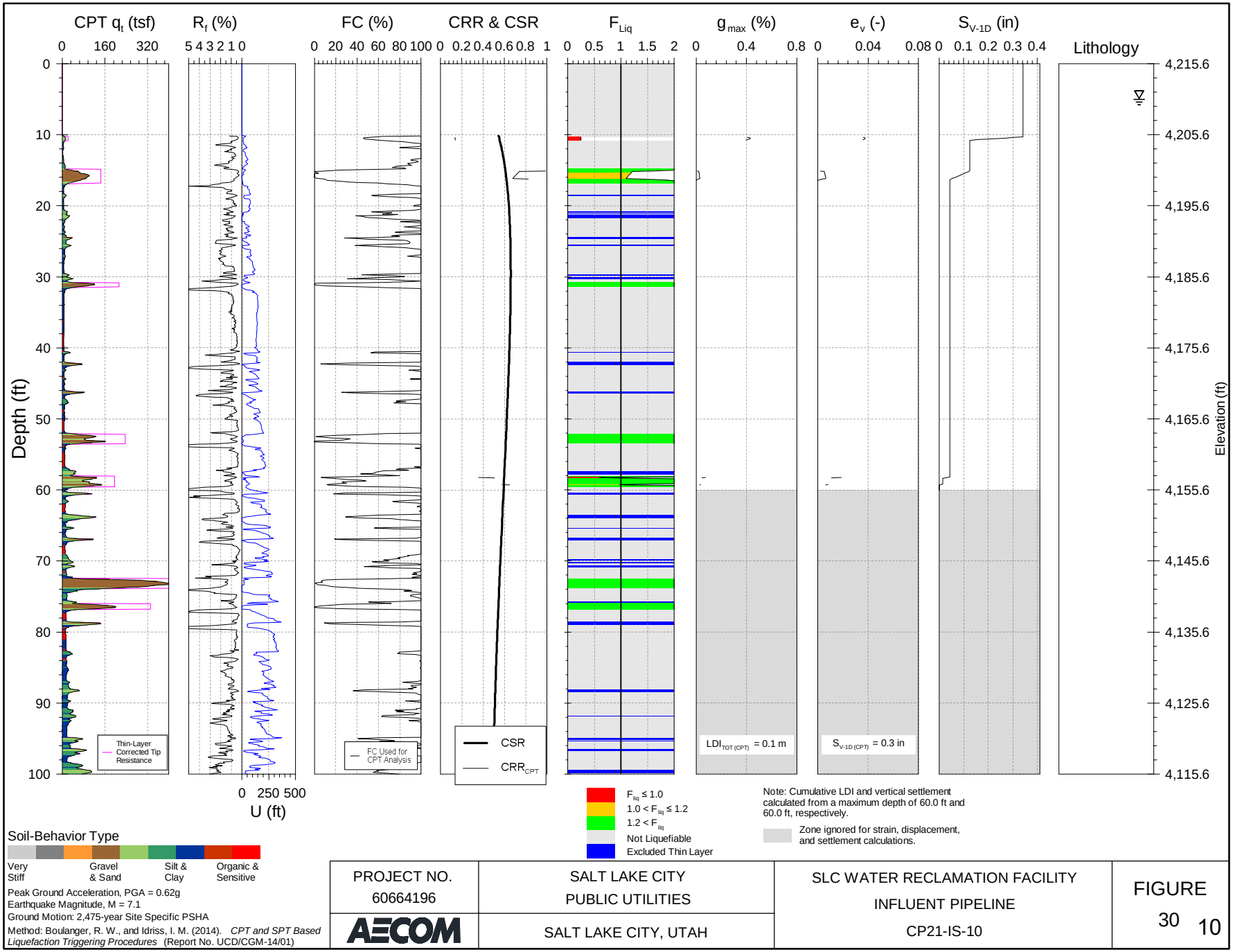
PROJECT NO. 60664196	SALT LAKE CITY PUBLIC UTILITIES	SLC WATER RECLAMATION FACILITY INFLUENT PIPELINE	FIGURE 27 7
AECOM	SALT LAKE CITY, UTAH	CP21-IS-07	



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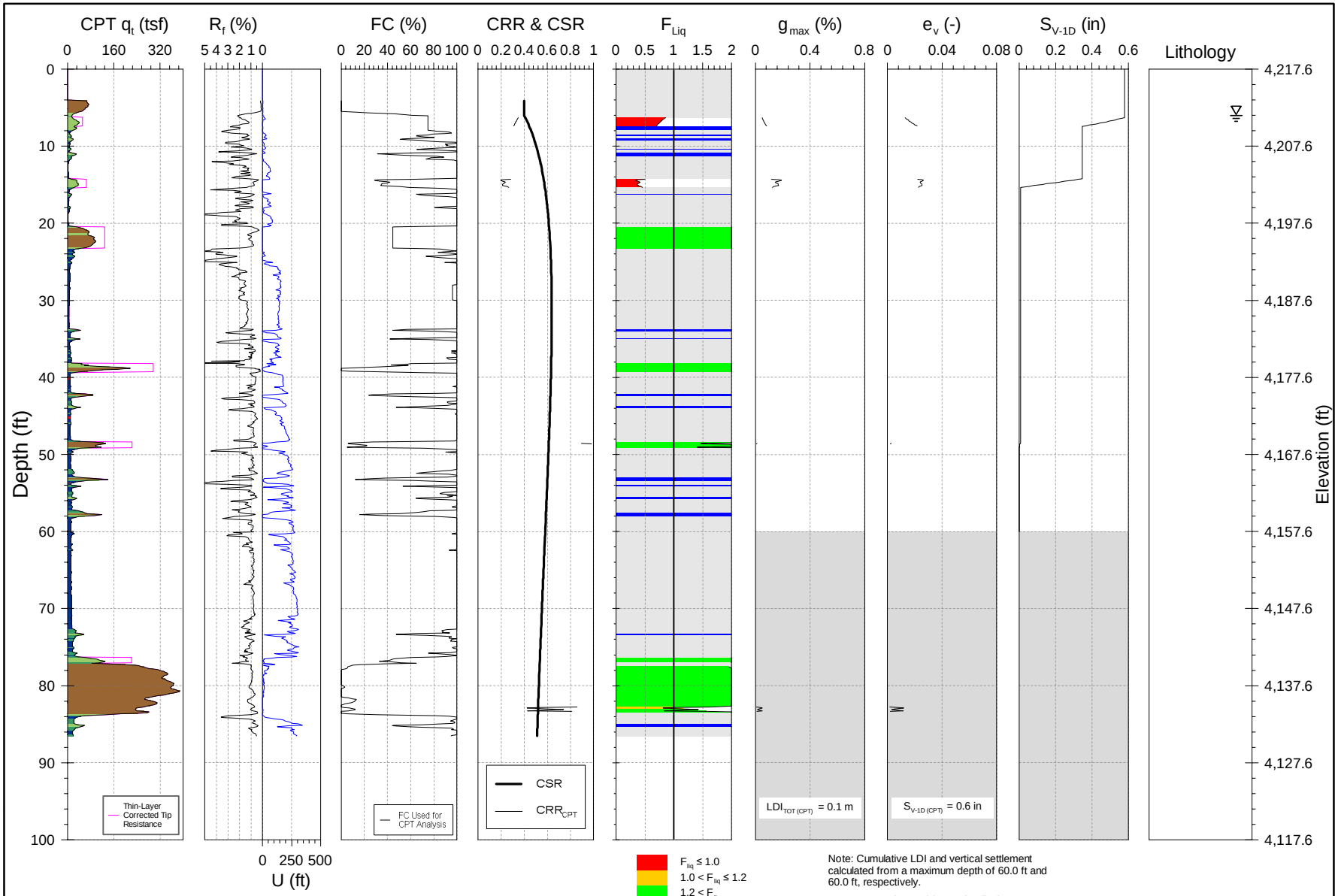
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Peak Ground Acceleration, PGA = 0.62g
Earthquake Magnitude, M = 7.1
Ground Motion: 2,475-year Site Specific PSHA
Method: Boulanger, R. W., and Idriss, I. M. (2014). *CPT and SPT Based Liquefaction Triggering Procedures* (Report No. UCD/CGM-14/01)

PROJECT NO. 60664196	SALT LAKE CITY PUBLIC UTILITIES	SLC WATER RECLAMATION FACILITY INFLUENT PIPELINE	FIGURE 30 10
AECOM	SALT LAKE CITY, UTAH	CP21-IS-10	

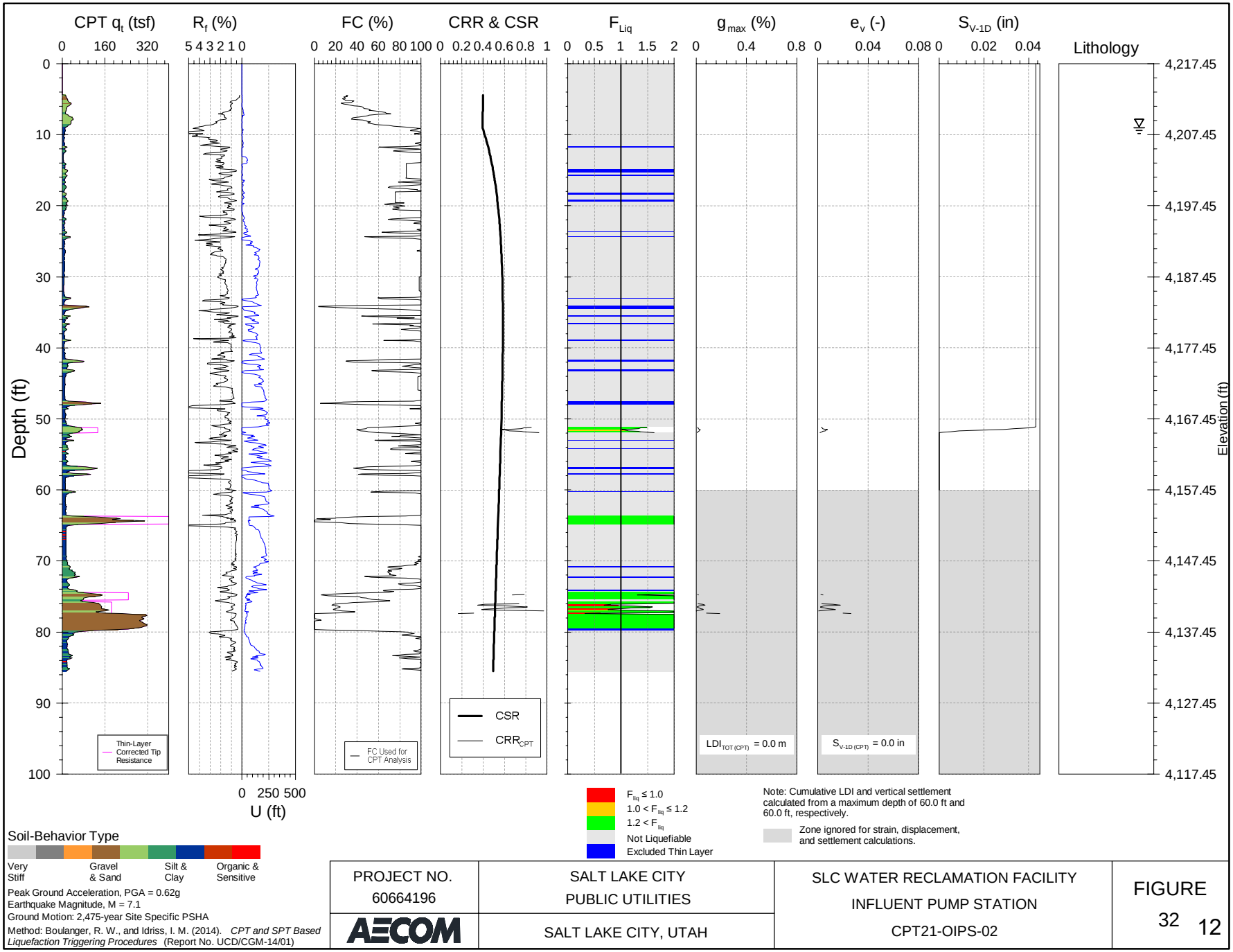
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Peak Ground Acceleration, PGA = 0.62g
Earthquake Magnitude, M = 7.1
Ground Motion: 2,475-year Site Specific PSHA
Method: Boulanger, R. W., and Idriss, I. M. (2014). *CPT and SPT Based Liquefaction Triggering Procedures* (Report No. UCD/CGM-14/01)

PROJECT NO. 60664196	SALT LAKE CITY PUBLIC UTILITIES	SLC WATER RECLAMATION FACILITY INFLUENT PUMP STATION CPT21-OIPS-01
AECOM	SALT LAKE CITY, UTAH	FIGURE 31 11

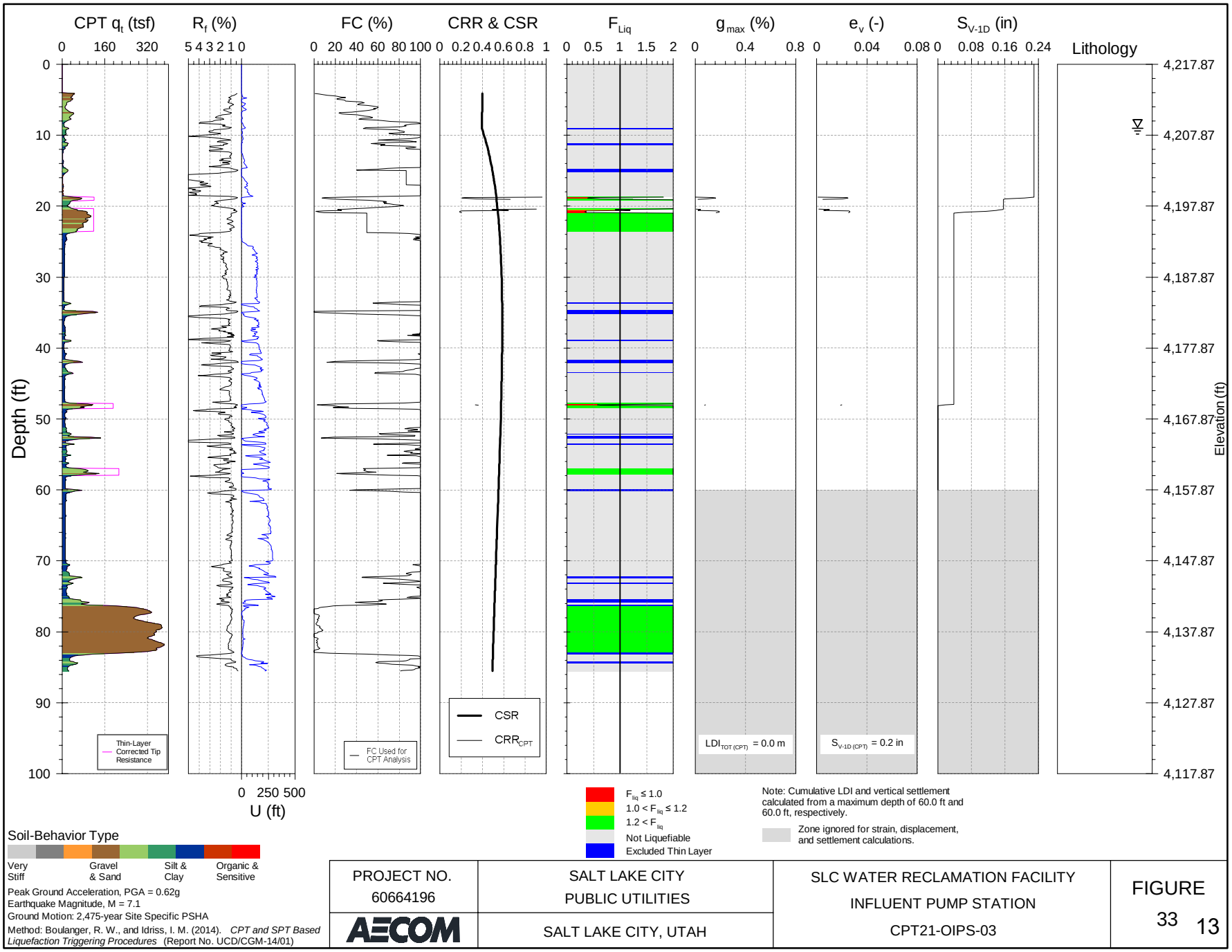
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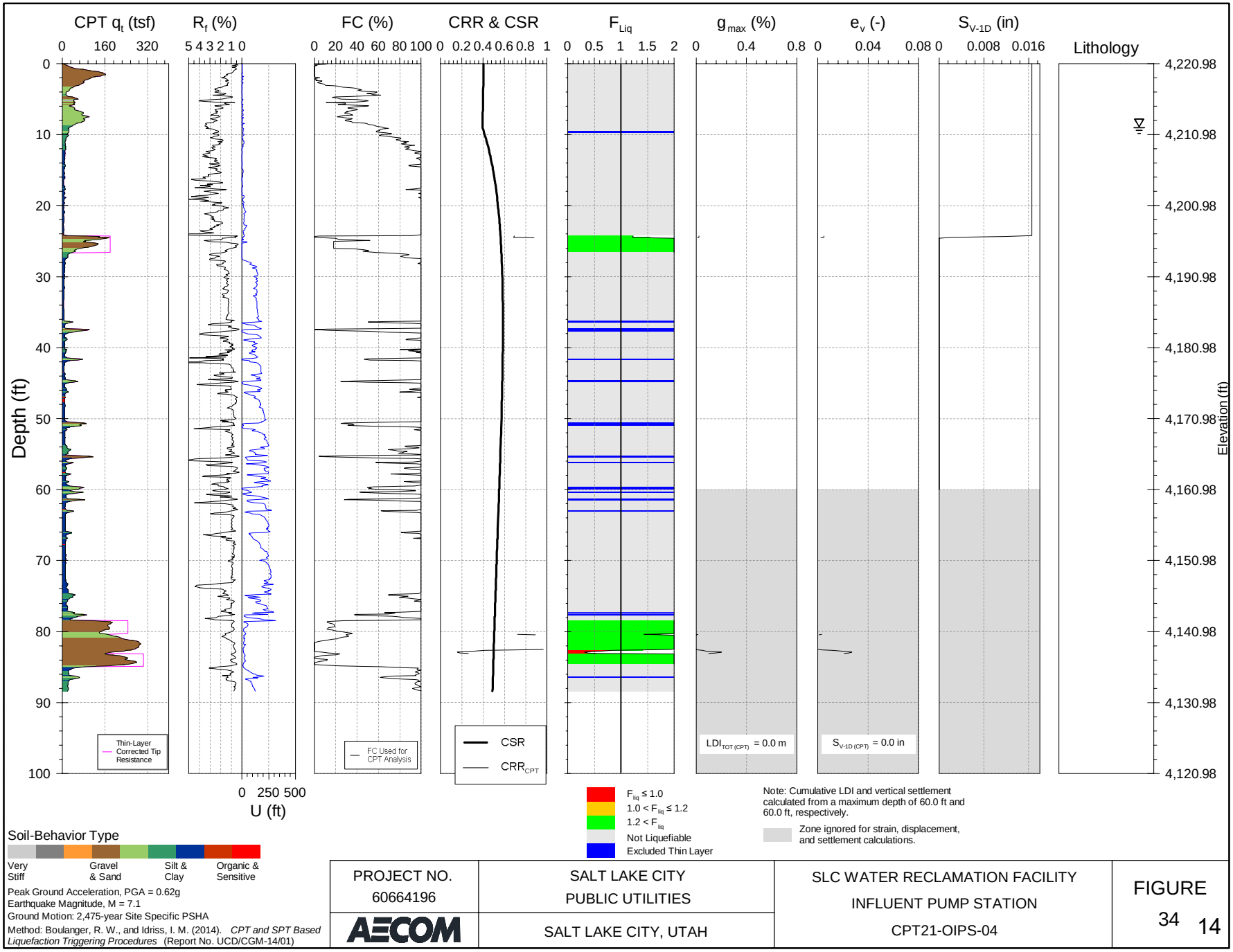


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Earthquake Magnitude, M = 7.1
Ground Motion: 2,475-year Site Specific PSHA
Method: Boulanger, R. W., and Idriss, I. M. (2014). *CPT and SPT Based Liquefaction Triggering Procedures* (Report No. UCD/CGM-14/01)

PROJECT NO. 60664196	SALT LAKE CITY PUBLIC UTILITIES	SLC WATER RECLAMATION FACILITY INFLUENT PUMP STATION	FIGURE 32 12
AECOM	SALT LAKE CITY, UTAH	CPT21-OIPS-02	

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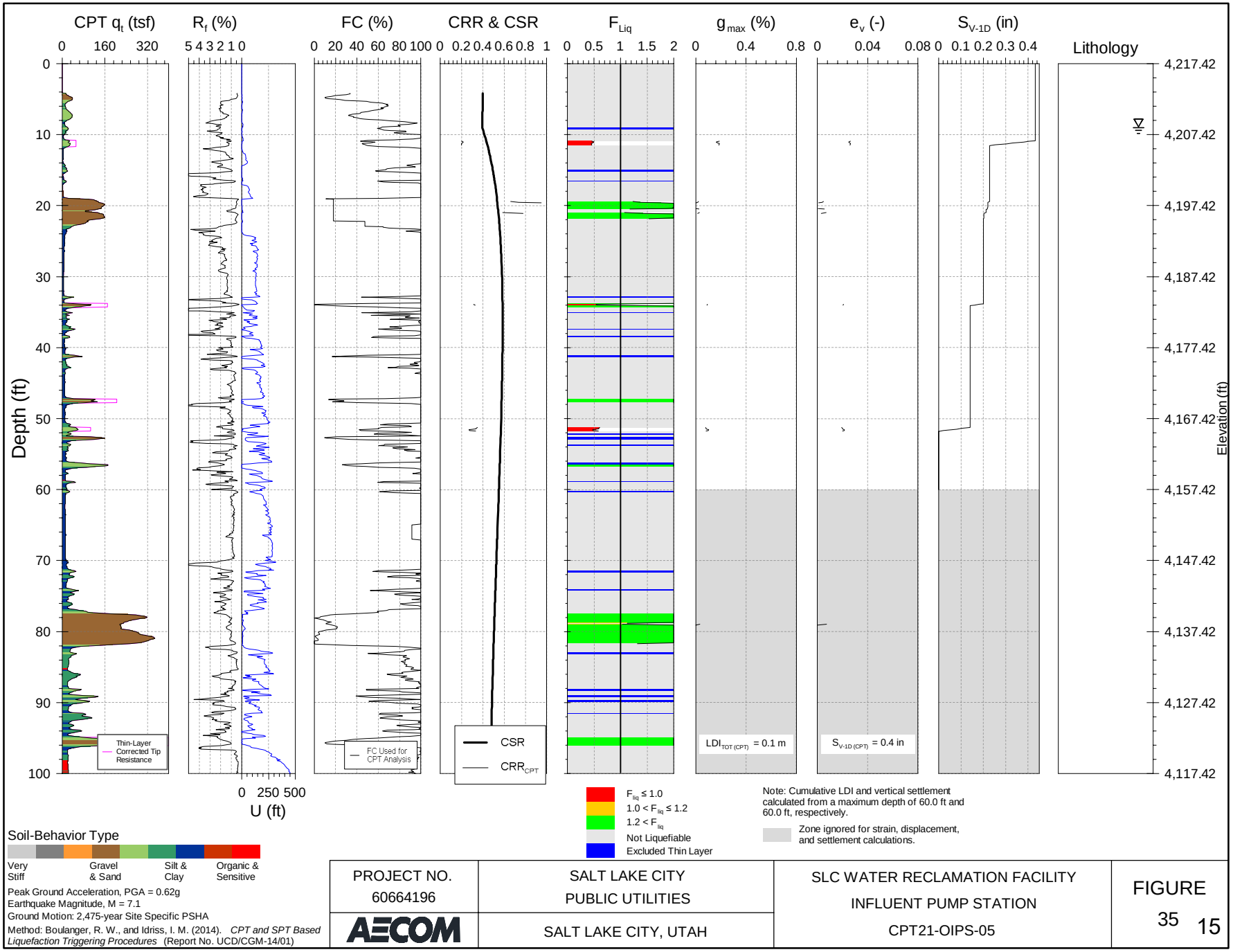

CPT q_t (tsf)
R_f (%)
FC (%)
CRR & CSR
F_{Liq}
g_{max} (%)
e_v (-)
S_{V-1D} (in)
Lithology
Depth (ft)
Elevation (ft)
Thin-Layer Corrected Tip Resistance
FC Used for CPT Analysis
CSR
CRR_{CPT}
$LDI_{TOT\ (CPT)}$ = 0.0 m
$S_{V-1D\ (CPT)}$ = 0.2 in
U (ft)
$F_{liq} \leq 1.0$
$1.0 < F_{liq} \leq 1.2$
$1.2 < F_{liq}$
Not Liquefiable
Excluded Thin Layer
Note: Cumulative LDI and vertical settlement calculated from a maximum depth of 60.0 ft and 60.0 ft, respectively.
Zone ignored for strain, displacement, and settlement calculations.
Soil-Behavior Type
Very Stiff
Gravel & Sand
Silt & Clay
Organic & Sensitive
Peak Ground Acceleration, PGA = 0.62g
Earthquake Magnitude, M = 7.1
Ground Motion: 2,475-year Site Specific PSHA
Method: Boulanger, R. W., and Idriss, I. M. (2014). CPT and SPT Based Liquefaction Triggering Procedures (Report No. UCD/CGM-14/01)
PROJECT NO. 60664196
AECOM
SALT LAKE CITY PUBLIC UTILITIES
SALT LAKE CITY, UTAH
SLC WATER RECLAMATION FACILITY
INFLUENT PUMP STATION
CPT21-OIPS-03
FIGURE 33 13
L:\DCS\Projects_WTR\60664196_SLCWRF_Offsite_IPS\400_Technical\431_TechnicalArea_Geotech\4 Calculations\2 Liquefaction Analysis\CPT21-OIPS-03 & B21-OIPS-03\CPT Liquefaction Figure.grf
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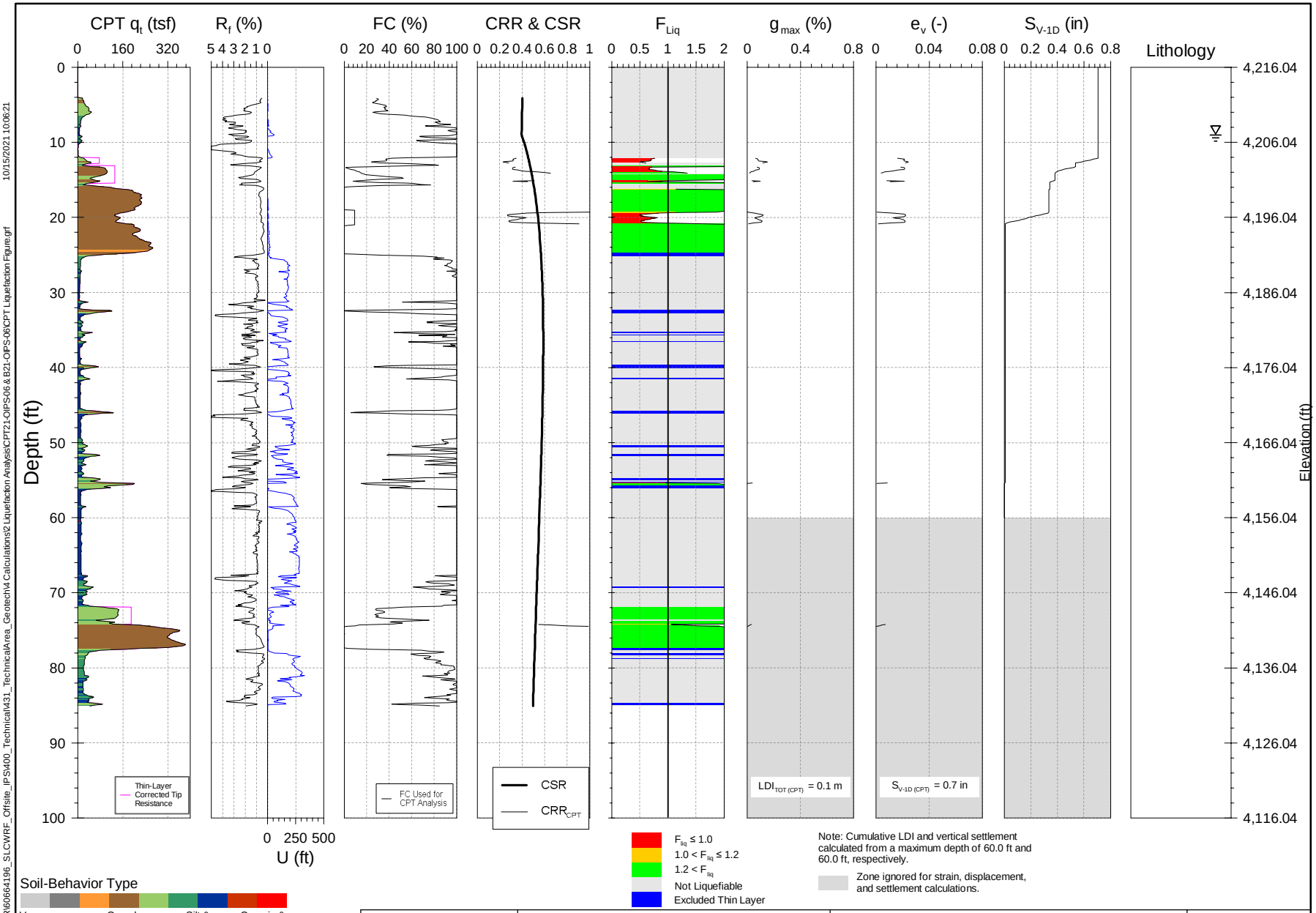
Peak Ground Acceleration, PGA = 0.62g
Earthquake Magnitude, M = 7.1
Ground Motion: 2,475-year Site Specific PSHA
Method: Boulanger, R. W., and Idriss, I. M. (2014). *CPT and SPT Based Liquefaction Triggering Procedures* (Report No. UCD/CGM-14/01)

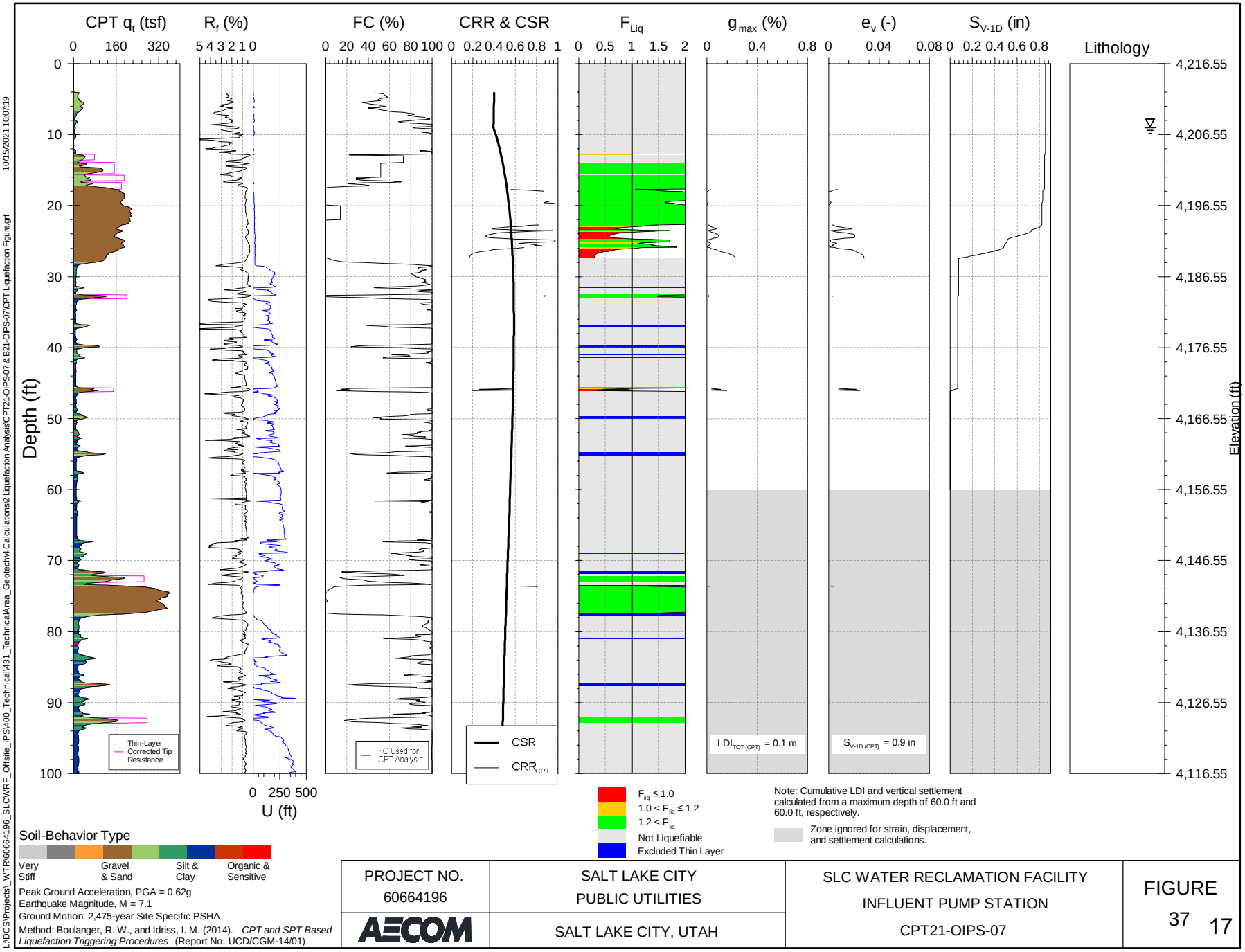
PROJECT NO. 60664196	SALT LAKE CITY PUBLIC UTILITIES	SLC WATER RECLAMATION FACILITY INFLUENT PUMP STATION CPT21-OIPS-04	FIGURE 34 14
AECOM	SALT LAKE CITY, UTAH		

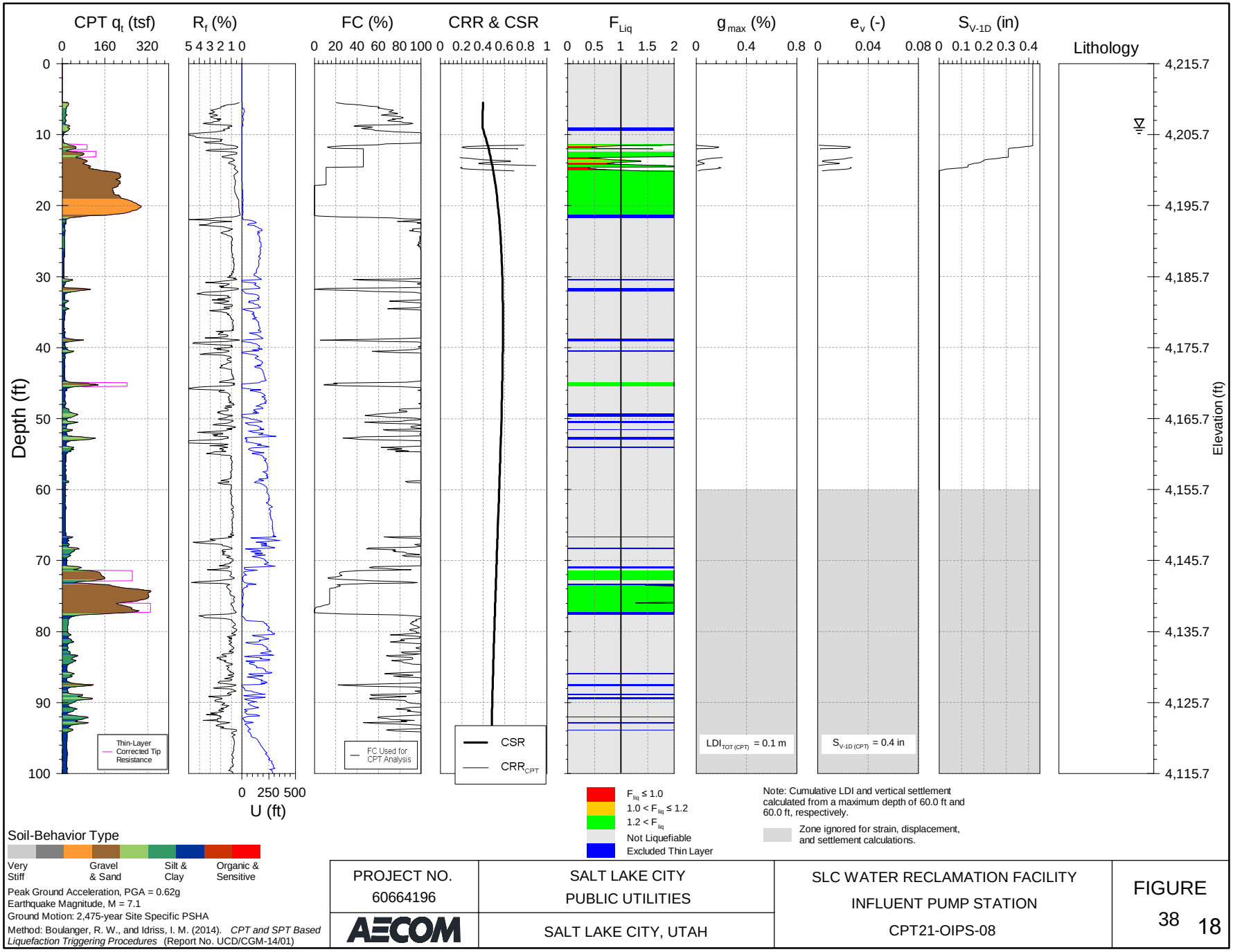
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PROJECT NO. 60664196	SALT LAKE CITY PUBLIC UTILITIES	SLC WATER RECLAMATION FACILITY INFLUENT PUMP STATION CPT21-OIPS-05	FIGURE 35 15
AECOM	SALT LAKE CITY, UTAH		


CPT q_t (tsf)
R_f (%)
FC (%)
CRR & CSR
F_{Liq}
g_{max} (%)
e_v (-)
S_{V-1D} (in)
Lithology
Depth (ft)
Elevation (ft)
U (ft)
Thin-Layer Corrected Tip Resistance
FC Used for CPT Analysis
CSR
CRR_{CPT}
$LDI_{TOT\ (CPT)}$ = 0.1 m
$S_{V-1D\ (CPT)}$ = 0.7 in
$F_{liq} \leq 1.0$
$1.0 < F_{liq} \leq 1.2$
$1.2 < F_{liq}$
Not Liquefiable
Excluded Thin Layer
Note: Cumulative LDI and vertical settlement calculated from a maximum depth of 60.0 ft and 60.0 ft, respectively.
Zone ignored for strain, displacement, and settlement calculations.
Soil-Behavior Type
Very Stiff
Gravel & Sand
Silt & Clay
Organic & Sensitive
Peak Ground Acceleration, PGA = 0.62g
Earthquake Magnitude, M = 7.1
Ground Motion: 2,475-year Site Specific PSHA
Method: Boulanger, R. W., and Idriss, I. M. (2014). CPT and SPT Based Liquefaction Triggering Procedures (Report No. UCD/CGM-14/01)
PROJECT NO. 60664196
SALT LAKE CITY PUBLIC UTILITIES
SALT LAKE CITY, UTAH
SLC WATER RECLAMATION FACILITY
INFLUENT PUMP STATION
CPT21-OIPS-06
FIGURE 36 16
L:\DCS\Projects_WTR\60664196_SLCWRF_Offsite_IPS\400_Technical\431_TechnicalArea_Geotech\4 Calculations\2 Liquefaction Analysis\CPT21-OIPS-06 & B21-OIPS-06\CPT Liquefaction Figure.grf
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CPT q_t (tsf)
R_f (%)
FC (%)
CRR & CSR
F_{Liq}
g_{max} (%)
e_v (-)
S_{V-1D} (in)
Lithology
Depth (ft)
Elevation (ft)
U (ft)
Thin-Layer Corrected Tip Resistance
FC Used for CPT Analysis
CSR
CRR_{CPT}
$LDI_{TOT\ (CPT)}$ = 0.1 m
$S_{V-1D\ (CPT)}$ = 0.9 in
$F_{liq} \leq 1.0$
$1.0 < F_{liq} \leq 1.2$
$1.2 < F_{liq}$
Not Liquefiable
Excluded Thin Layer
Note: Cumulative LDI and vertical settlement calculated from a maximum depth of 60.0 ft and 60.0 ft, respectively.
Zone ignored for strain, displacement, and settlement calculations.
Soil-Behavior Type
Very Stiff
Gravel & Sand
Silt & Clay
Organic & Sensitive
Peak Ground Acceleration, PGA = 0.62g
Earthquake Magnitude, M = 7.1
Ground Motion: 2,475-year Site Specific PSHA
Method: Boulanger, R. W., and Idriss, I. M. (2014). CPT and SPT Based Liquefaction Triggering Procedures (Report No. UCD/CGM-14/01)
PROJECT NO. 60664196
SALT LAKE CITY PUBLIC UTILITIES
SALT LAKE CITY, UTAH
SLC WATER RECLAMATION FACILITY
INFLUENT PUMP STATION
CPT21-OIPS-07
FIGURE 37 17
L:\DCS\Projects_WTR\60664196_SLCWRF_Offsite_IPS\400_Technical\431_TechnicalArea_Geotech\4 Calculations\2 Liquefaction Analysis\CPT21-OIPS-07 & B21-OIPS-07\CPT Liquefaction Figure.grf
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PROJECT NO. 60664196	SALT LAKE CITY PUBLIC UTILITIES	SLC WATER RECLAMATION FACILITY INFLUENT PUMP STATION CPT21-OIPS-08	FIGURE 38 18
AECOM	SALT LAKE CITY, UTAH		

Empirical Regression to Estimate Magnitude of Liquefaction Induced Lateral Spread
Ref. Youd., T.L., Hansen, C.M., and Bartlett, S.F.*

Wasatch Fault Rupture for Gently Sloping Area

		Date:	7/10/2020
Site:	**SLC WRF**	By:	EAR
Location:	Area Near Force Mains	Checked:	BWF
Engineer:	URS	Based on general site char. by CPT and SPT	
Owner:	SLCPU		

		Limits:
1.5%	S, Slope in ground (%):	>20% may ground rupture / landslide
	W, Free Face Ratio - Height of FF / Distance to Base of FF (H/L) :	>20% may ground rupture / landslide
2.5	R, Horizontal distance to seismic source (km):	see R limits table - >3km for M=7.5
7.1	M, Earthquate Moment Magnitude:	or equivalent scaling
2.474976	Z_T, depth to the top of the T15 layer (m)	
3.5	T15, Cum. Thickness of Liq Layers (N1(60)<15) (m):	<15m
0.3	DFifty15, Average mean grain size in T15 Liq Layer (mm):	0.08mm<DFifty15>1mm
20	F15, Average % fines (<#200) in T15 Liq Layer:	<50%

	(m)	(ft)
Dh, Free Face Lateral Spread Distance		
Dh, Slope Lateral Spread Distance	0.81	2.65

Free Face Equation:

$$\text{LogDh} = -16.713 + 1.532*M - 1.406*\text{Log}[R + 10^{(0.89M-5.64)}] - 0.012*R + 0.592*\text{LogW} + 0.540*\text{Log}T_{15} + 3.413*\text{Log}(100-F_{15}) - 0.795*\text{Log}(D50_{15} + 0.1\text{mm})$$

Gently Sloping Ground Equation:

$$\text{LogDh} = -16.213 + 1.532*M - 1.406*\text{Log}[R + 10^{(0.89M-5.64)}] - 0.012*R + 0.338*\text{LogS} + 0.540*\text{Log}T_{15} + 3.413*\text{Log}(100-F_{15}) - 0.795*\text{Log}(D50_{15} + 0.1\text{mm})$$

* Youd, T.L., Hansen, C.M., and Bartlett, S.F., 2002, Revised MLR Equations for Prediction of Lateral Spread Displacement, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, v. 128, no 12, p. 1007-1017.

Empirical Regression to Estimate Magnitude of Liquefaction Induced Lateral Spread
Ref. Youd., T.L., Hansen, C.M., and Bartlett, S.F.*

Wasatch Fault Rupture for Free Face

Date: 10/7/2021
Site: **SLC WRF**
By: NA
Location: IPS
Checked: BE
Engineer: AECOM
Based on general site char. by CPT and SPT
Owner: SLCPU

		Limits:
	S, Slope in ground (%):	>20% may ground rupture / landslide
0.1	W, Free Face Ratio - Height of FF / Distance to Base of FF (H/L) :	>20% may ground rupture / landslide
3	R, Horizontal distance to seismic source (km):	see R limits table - >3km for M=7.5
7.1	M, Earthquate Moment Magnitude:	or equivalent scaling
1.524	Z_T, depth to the top of the T15 layer (m)	
0.5	T15, Cum. Thickness of Liq Layers (N1(60)<15) (m):	<15m
0.34	DFifty15, Average mean grain size in T15 Liq Layer (mm):	0.08mm<DFifty15>1mm
9	F15, Average % fines (<#200) in T15 Liq Layer:	<50%

	(m)	(ft)	(in)
Dh, Free Face Lateral Spread Distance	0.10	0.34	4.07
Dh, Slope Lateral Spread Distance			

Note: W and T15 are outside (below) accepted range of regression model inputs. Predicted Dh may be less reliable.

Free Face Equation:

$$LogDh = -16.713 +1.532*M -1.406*Log[R +10^{(0.89M-5.64)}] -0.012*R +0.592*LogW +0.540*LogT_{15} +3.413*Log(100-F_{15}) -0.795*Log(D50_{15} +0.1mm)$$

Gently Sloping Ground Equation:

$$LogDh = -16.213 +1.532*M -1.406*Log[R +10^{(0.89M -5.64)}] -0.012*R +0.338*LogS +0.540*LogT_{15} + 3.413*Log(100-F_{15}) -0.795*Log(D50_{15} +0.1mm)$$

* Youd, T.L., Hansen, C.M., and Bartlett, S.F., 2002, Revised MLR Equations for Prediction of Lateral Spread Displacement, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, v. 128, no 12, p. 1007-1017.

Attachment 2

CPT	Surface Elevation	Depth at Top of Layer	Depth at Bottom of Layer	Elevation at Top of Layer	Elevation at Bottom of Layer	Adjustment	Justification	Additional Comments	Associated Structure	Associated Structure Bearing Elevation
HW-2	4221.052	52.08	52.17	4168.972	4168.882	Fines = 40	More consistent with field classification (SM) for #10 for BH18-PC-2		Collection Pad	4224.3
HW-2	4221.052	55.94	56.68	4165.112	4164.372		Field classification of sample (#10 for BH18-HW-1); no adjustment		Collection Pad	4225.3
HW-3	4221.1	8.12	13.04	4212.98	4208.06		No sample available at depth in nearby explorations; no photos to review		Collection Pad	4221.3
HW-3	4221.1	13.12	15.1	4207.98	4206.00		No sample available at depth in nearby explorations; no photos to review		Collection Pad	4221.3
HW-3	4221.1	15.1	16.6	4206.00	4204.50		No sample available at depth in nearby explorations; no photos to review	Layer different than shown in BH18-HW-1 or BH18-PC-2	Collection Pad	4221.3
HW-3	4221.1	16.5	18	4204.60	4203.10		No sample available at depth in nearby explorations; no photos to review	Layer different than shown in BH18-HW-1 or BH18-PC-2	Collection Pad	4221.3
HW-3	4221.1	19.5	20	4201.60	4201.10	PI > 7	Removing transition zone		Collection Pad	4221.3
HW-3	4221.1	24.28	24.61	4196.82	4196.49	Thin Layer	Slightly thicker than 6"; appears to be silt		Collection Pad	4221.3
HW-3	4221.1	29.45	30.02	4191.65	4191.08	Thin Layer	Slightly thicker than 6"; appears to be silt		Collection Pad	4221.3
PC-1	4221.6	12.385	13.369	4209.2	4208.2	PI > 7	Removing layer per discussion on 10/1.		Area South of Headworks	4161.2
PC-1	4221.6	39.21	39.37	4182.4	4182.2	Fines = 15	More consistent with field classication (SM) fo a thin layer in #7 for BH18-PC-4		Area South of Headworks	4161.2
PC-1	4221.6	68.323	69.717	4153.3	4151.9	Fines = 38.5	Sample #13A at 65' for PC-2 fines content (same elevation)		Area South of Headworks	4161.2
PC-2	4222.5	9.92	10.5	4212.6	4212.0	PI > 7	Removing transition zone		Headworks Odor Control Facility	4221.8
PC-2	4222.5	12.55	13.779	4210.0	4208.8	PI > 7	Removing layer per discussion on 10/1.		Headworks Odor Control Facility	4221.8
PC-2	4222.5	16.16	16.73	4206.4	4205.8		Sample #1 at 15' for BH18-HW-1 (42% fines); no adjustment bcs manually adding these fines reduces FOS		Headworks Odor Control Facility	4221.8
PC-2	4222.5	26.25	27.23	4196.3	4195.3		No sample available at depth in nearby explorations; no photos to review		Headworks Odor Control Facility	4221.8
PC-2	4222.5	30.84	31.25	4191.7	4191.3	PI > 7	Removing transition zone		Headworks Odor Control Facility	
PC-2	4222.5	31.742	32.152	4190.8	4190.4	PI > 7	Removing transition zone		Headworks Odor Control Facility	4221.8

CPT	Top of CPT Elevation (ft)	Top of Layer Depth (ft)	Bottom of Layer Depth (ft)	Top of Layer Elevation (ft)	Bottom of Layer Elevation (ft)	Adjustment	Justification	Additional Notes
CP20-IS-02	4215.87	5.91	5.99	4209.96	4209.88	PI > 7	Transition material	
CP20-IS-02	4215.87	8.53	9.27	4207.34	4206.60	PI > 7	Transition material	
CP20-IS-02	4215.87	8.53	9.27	4207.34	4206.60	Fines = 74.4 %	Fines for sample #3A for B21-IS-02 (same elevation)	
CP20-IS-02	4215.87	16.98	17.80	4198.89	4198.07	Fines = 76 %	Fines for sample #5 for B21-IS-02 (same elevation)	
CP20-IS-02	4215.87	18.29	19.77	4197.58	4196.10	Fines = 24 %	Fines for sample #6 for B21-IS-02 (same elevation)	
CP20-IS-04	4217.23	6.40	6.48	4210.83	4210.75	PI > 7	Transition material	
CP20-IS-04	4217.23	19.19	19.27	4198.04	4197.96	PI > 7	Transition material	
CP20-IS-05	4215.97	10.01	12.06	4205.96	4203.91	PI > 7	Transition material	
CP20-IS-05	4215.97	42.90	42.98	4173.07	4172.99	PI > 7	Transition material	
CP21-IS-06	4218.00	6.15	8.04	4211.85	4209.96	Fines = 68.8 %	Fines for sample #1 for B21-IS-04 (same elevation)	
CP21-IS-06	4218.00	6.15	8.04	4211.85	4209.96	PI > 7	Transition material	
CP21-IS-06	4218.00	8.69	8.78	4209.31	4209.22	PI > 7	Transition material	
CP21-IS-06	4218.00	9.19	9.27	4208.81	4208.73	PI > 7	Transition material	
CP21-IS-06	4218.00	15.01	17.06	4202.99	4200.94	PI > 7	Transition material	
CP21-IS-06	4218.00	17.39	17.47	4200.61	4200.53	PI > 7	Transition material	
CP21-IS-06	4218.00	18.13	18.21	4199.87	4199.79	PI > 7	Transition material	
CP21-IS-06	4218.00	47.33	47.41	4170.67	4170.59	PI > 7	Transition material	
CP21-IS-06	4218.00	48.15	48.23	4169.85	4169.77	PI > 7	Transition material	
CP21-IS-07	4215.39	5.41	5.50	4209.98	4209.89	PI > 7	Transition material	
CP21-IS-07	4215.39	7.14	7.22	4208.25	4208.17	PI > 7	Transition material	
CP21-IS-07	4215.39	10.01	12.06	4205.38	4203.33	Fines = 93.5 %	Fines for sample #2 for B21-IS-05 (same elevation)	
CP21-IS-07	4215.39	10.01	12.06	4205.38	4203.33	PI>7	Transition material	
CP21-IS-07	4215.39	15.91	16.24	4199.48	4199.15	Fines = 67.7 %	Fines for sample #4B for B21-IS-05 (same elevation)	
CP21-IS-08	4216.88	6.58	6.73	4210.30	4210.15	Fines = 8.9 %	Fines for sample #1A for B21-IS-06 (same elevation)	
CP21-IS-08	4216.88	6.64	6.73	4210.24	4210.15	PI > 7	Transition material	
CP21-IS-08	4216.88	14.11	16.07	4202.77	4200.81	Fines = 67.5 %	Fines for sample #4 for B21-IS-06 (same elevation)	
CP21-IS-08	4216.88	14.03	16.08	4202.85	4200.80	PI>7	Transition material	
CP21-IS-08	4216.88	30.43	31.74	4186.45	4185.14	Fines = 63.8 %	Fines for sample #8B for B21-IS-06 (same elevation)	
CP21-IS-09	4217.12	22.23	22.31	4194.89	4194.81	PI > 7	Transition material	
CP21-IS-09	4217.12	22.80	22.88	4194.32	4194.24	PI > 7	Transition material	
CP21-IS-10	4215.57	10.17	10.25	4205.40	4205.32	PI > 7	Transition material	
CP21-IS-10	4215.57	10.74	10.83	4204.83	4204.74	PI > 7	Transition material	
CP21-OIPS-01	4217.56	6.23	7.96	4211.33	4209.60	Fines = 75 %	Fines for sample #2 for B21-OIPS-01 (same elevation)	
CP21-OIPS-01	4217.56	6.15	6.23	4211.41	4211.33	PI > 7	Transition material	
CP21-OIPS-01	4217.56	20.50	23.20	4197.06	4194.36	Fines = 44.5 %	Fines for sample #4B for B21-OIPS-01 (same elevation)	
CP21-OIPS-01	4217.56	77.18	77.51	4140.38	4140.05	PI > 7	Transition material	
CP21-OIPS-01	4217.56	83.58	83.82	4133.98	4133.74	PI > 7	Transition material	
CP21-OIPS-02	4217.45	14.93	15.26	4202.52	4202.19	Fines = 86.2 %	Fines for sample #3 for B21-OIPS-02 (same elevation)	
CP21-OIPS-02	4217.45	18.04	19.44	4199.41	4198.01	Fines = 75.8 %	Fines for sample #4A for B21-OIPS-02 (same elevation)	
CP21-OIPS-03	4217.87	15.00	15.20	4202.87	4202.67	Fines = 86.6 %	Fines for sample #3 for B21-OIPS-03 (same elevation)	
CP21-OIPS-03	4217.87	20.18	20.26	4197.69	4197.61	PI>7	Transition material	
CP21-OIPS-03	4217.87	21.00	23.70	4196.87	4194.17	Fines = 49.7 %	Fines for sample #5 for B21-OIPS-03 (same elevation). Based on similarity of the sample 4B and 5, the fines content was applied to the elevation of sample #4B as well.	

CP21-OIPS-03	4217.87	23.62	23.70	4194.25	4194.17	PI>7	Transition material
CP21-OIPS-04	4220.98	25.00	26.00	4195.98	4194.98	Fines = 17.9 %	Fines for sample #6A for B21-OIPS-04 (Surface elevation of the CPT is approximately 1 ft higher than the nearby Boring)
CP21-OIPS-04	4220.98	84.64	84.89	4136.34	4136.09	PI>7	Transition material
CP21-OIPS-05	4217.42	10.74	10.83	4206.68	4206.59	PI>7	Transition material
CP21-OIPS-05	4217.42	11.56	11.65	4205.86	4205.77	PI>7	Transition material
CP21-OIPS-05	4217.42	18.95	19.36	4198.47	4198.06	PI>7	Transition material
CP21-OIPS-05	4217.42	19.10	22.14	4198.32	4195.28	Fines = 18.1 %	Fines for sample #4B for B21-OIPS-05 (same elevation). Based on similarity of the sample 4B and 5A, the fines content was applied to the elevation of sample #5A as well.
CP21-OIPS-05	4217.42	20.59	20.92	4196.83	4196.50	PI>7	Transition material
CP21-OIPS-05	4217.42	21.90	22.88	4195.52	4194.54	PI>7	Transition material
CP21-OIPS-05	4217.42	22.23	22.88	4195.19	4194.54	Fines = 47.7 %	Fines for sample #5B for B21-OIPS-05 (same elevation)
CP21-OIPS-05	4217.42	77.18	77.43	4140.24	4139.99	PI>7	Transition material
CP21-OIPS-05	4217.42	78.82	78.90	4138.60	4138.52	PI>7	Transition material
CP21-OIPS-05	4217.42	81.77	82.02	4135.65	4135.40	PI>7	Transition material
CP21-OIPS-06	4216.041	19.03	21.00	4197.01	4195.04	Fines = 9.3 %	Fines for sample #4 for B21-OIPS-06 (same elevation)
CP21-OIPS-06	4216.041	11.97	12.06	4204.07	4203.98	PI>7	Transition material
CP21-OIPS-06	4216.041	12.71	12.80	4203.33	4203.24	PI>7	Transition material
CP21-OIPS-06	4216.041	14.11	14.19	4201.93	4201.85	PI>7	Transition material
CP21-OIPS-06	4216.041	15.75	16.16	4200.29	4199.88	PI>7	Transition material
CP21-OIPS-07	4216.545	12.90	13.90	4203.65	4202.65	PI>7	Transition material
CP21-OIPS-07	4216.545	13.00	13.94	4203.55	4202.61	Fines = 72.9 %	Fines for sample #3B for B21-OIPS-07 (same elevation)
CP21-OIPS-07	4216.545	14.03	15.99	4202.52	4200.56	Fines = 51.8 %	Fines for sample #4 for B21-OIPS-07 (same elevation)
CP21-OIPS-07	4216.545	20.00	21.98	4196.55	4194.57	Fines = 14 %	Fines for sample #6 for B21-OIPS-07 (same elevation)
CP21-OIPS-07	4216.545	27.48	28.13	4189.07	4188.42	PI>7	Transition material
CP21-OIPS-08	4215.696	11.97	14.50	4203.73	4201.20	Fines = 45.9 %	Fines for sample #3 for B21-OIPS-08 (same elevation). Based on the photos, and sample #3 and #4 this fine content was applied to half way in between two samples
CP21-OIPS-08	4215.696	14.60	17.10	4201.10	4198.60	Fines = 11 %	Fines for sample #4 for B21-OIPS-08 (same elevation). Based on the photos, and sample #3 and #4 this fine content was applied to half way in between two samples
CP21-OIPS-08	4215.696	74.00	76.00	4141.70	4139.70	Fines = 14.2 %	Fines for sample #15 for B21-OIPS-08 (same elevation)

BH18-DW-1	4216.42	17A	4151.42	65		26.6								67							
BH18-DW-1	4216.42	18A	4146.42	70		41.6															
BH18-DW-1	4216.42	19A	4141.42	75										77							
BH18-DW-1	4216.42	19B	4141.42	75	CL			33	18	15											
BH18-DW-1	4216.42	20	4136.42	80		38.7															
BH18-DW-1	4216.42	21A	4131.42	85	CL	27.6		30	17	13											
BH18-DW-1	4216.42	22	4128.42	88		25.9								31							
BH18-DW-1	4216.42	23	4122.42	94		27.2								65							
BH18-DW-1	4216.42	24	4116.42	100	CL			30	21	9											
BH18-DW-1	4216.42	26	4106.42	110	CL	33.5		41	21	20											
BH18-DW-1	4216.42	28	4096.42	120										56							
BH18-HP-1	4221.78	3	4201.78	20		24.7								70							
BH18-HP-1	4221.78	4	4196.78	25	CL	37.8	81.7	33	20	13	0	13.7	86		x						
BH18-HP-1	4221.78	7	4186.78	35	CH	60.5	62.2	53	26	27	0	0.2	100				x				
BH18-HP-1	4221.78	8	4185.28	36.5																x	
BH18-HP-1	4221.78	10	4176.78	45	CL			38	20	18											
BH18-HP-1	4221.78	12A	4168.78	53										47							
BH18-HP-1	4221.78	12B	4168.78	53	CL			36	20	16											
BH18-HP-1	4221.78	14	4157.78	64	CL	32.8	91.4	26	18	8	0	0.8	99		x						
BH18-HP-1	4221.78	16	4152.78	69										59							
BH18-HP-1	4221.78	18B	4142.78	79	CL			39	17	22	0	11.3	89								
BH18-HP-1	4221.78	21	4126.78	95	CL	32.1	91.3	40	20	20	0	5.6	94		x						
BH18-HP-1	4221.78	22A	4123.78	98										40							
BH18-HP-1	4221.78	25	4106.78	115	CH	40.1	82.9	51	21	30	0	2.9	97		x						
BH18-TD-3	4221.159	2	4206.159	15		25.1	98.5							64							
BH18-TD-3	4221.159	6	4192.159	29	ML	27	100.6	NP	NP	NP	0	39.2	61				x				
BH18-TD-3	4221.159	7	4190.659	30.5																x	
BH18-TD-3	4221.159	10	4179.159	42	CL	36.8	89.1	35	19	16	0	2.7	97		x						
BH18-TD-3	4221.159	14A	4160.159	61										61							
BH18-TD-3	4221.159	15	4156.159	65	CL	32	95.7	30	19	11	0	0.9	99		x						
BH18-TD-3	4221.159	17	4146.159	75	CL			31	17	14											
BH18-TD-3	4221.159	18B	4139.159	82										16							
BH18-TD-3	4221.159	19B	4134.159	87										74							
BH18-TD-3	4221.159	22	4121.159	100	CL	31.6	87.8	35	19	16	0.6	5.9	94		x						
BH18-TD-3	4221.159	25	4106.159	115	CL	44.9	73.1	50	23	27	0	7.4	93		x						
BH18-TD-2	4217.46	2B and 2C	4207.96	9.5	SC-SM			22	16	6	0.1	51.1	49								
BH18-TD-2	4217.46	3A	4206.46	11	ML			23	20	3											
BH18-TD-2	4217.46	3B	4206.46	11	SM								39								
BH18-DW-5	4221.04	2B	4207.04	14	CL			28	17	11											
BH18-DW-5	4221.04	3	4205.54	15.5				26	15	11	0.1	51.2	49								
BH18-DW-5	4221.04	4A	4203.54	17.5	CL			32	20	12											
BH18-HW-1	4221.02	1	4206.02	15	SC						2.8	54.9	42								
BH18-HW-1	4221.02	2	4201.52	19.5																x	
BH18-HW-1	4221.02	5	4186.02	35	CH			50	24	26										x	
BH18-HW-1	4221.02	8	4172.02	49	CL			33	20	13	0	0.3	100								
BH18-HW-1	4221.02	13	4154.02	67	CL	42.4	77	49	22	27	0	5.2	95		x						
BH18-HW-1	4221.02	17	4136.02	85	CL	35.1	85.2	46	20	26	0	0.5	100		x						
BH18-HW-1	4221.02	24	4107.02	114	CL	40.7	82.1	49	21	28	0	7.3	93		x						
BH18-PC-1	4218.849	1	4202.849	16																x	
BH18-PC-1	4218.849	6	4179.849	39	CL			48	24	24	0	5	95					x			
BH18-PC-1	4218.849	8B	4173.849	45										91							
BH18-PC-1	4218.849	10A	4163.849	55	CL			42	21	21											
BH18-PC-1	4218.849	10B	4163.849	55										79							

BH18-PC-1	4218.849	15B	4138.849	80											63									
BH18-PC-1	4218.849	16B	4133.849	85	CL					46	20	26	0	0.8	99									
BH18-PC-1	4218.849	18A	4123.849	95											92									
BH18-PC-1	4218.849	21	4108.849	110	CL					30	18	12												
BH18-PC-1	4218.849	23	4098.849	120	CL					40	20	20												
BH18-PC-2	4218.562	1	4208.562	10																			x	
BH18-PC-2	4218.562	2	4204.562	14	CL	31.7	93.3			30	21	9	0	16.7	83.3									
BH18-PC-2	4218.562	5	4190.562	28	CL	59.5	66.2			42	23	19		1.3	98.7		x							
BH18-PC-2	4218.562	6	4189.062	29.5	CH					61	25	36												
BH18-PC-2	4218.562	8B	4177.562	41																			x	
BH18-PC-2	4218.562	11A	4163.562	55											64.4									
BH18-PC-2	4218.562	13A	4153.562	65											38.5									
BH18-PC-2	4218.562	15A	4143.562	75											83.6									
BH18-PC-2	4218.562	19	4123.562	95	CL					43	21	22												
BH18-PC-3	4219.114	1A	4208.114	11																			x	
BH18-PC-3	4219.114	2	4204.114	15	CH	55.2	68.4			52	26	26	0.2	5.3	94.5			x						
BH18-PC-3	4219.114	4B	4189.114	30		28.84									30.8									
BH18-PC-3	4219.114	6	4179.114	40		62.3	61.8			61	26	35					x							
BH18-PC-3	4219.114	11	4154.114	65		39.2	84.3			31	18	13					x							
BH18-PC-3	4219.114	16B	4129.114	90	CL					26	15	11												
BH18-PC-3	4219.114	19	4114.114	105		25.45									65.3									
BH18-PC-3	4219.114	21	4101.114	118		30	92.4						0	7.8	92.2		x							
BH18-PC-4	4218.851	3	4198.851	20	CH	47.7	75.8	2.712		50	23	27	0	0.7	99.3		x							
BH18-PC-4	4218.851	4	4197.351	21.5																			x	
BH18-PC-4	4218.851	5	4193.851	25	CL					49	24	25												
BH18-PC-4	4218.851	7	4181.851	37	CL					43	21	22	0.3	3.4	96.3									
BH18-PC-4	4218.851	12	4153.851	65	CL					44	21	23												
BH18-PC-4	4218.851	21	4108.851	110	CL					48	22	26												
BH18-PC-5	4219.102	1	4209.102	10																			x	
BH18-PC-5	4219.102	3	4199.102	20		33.7	88.2			42	20	22					x							
BH18-PC-5	4219.102	5	4189.102	30	CL	18.4	100			49	23	26	0	42.5	57.5		x	x						
BH18-PC-5	4219.102	6	4184.102	35	ML					24	21	3												
BH18-PC-5	4219.102	11	4159.102	60																			X	
BH18-PC-5	4219.102	19	4119.102	100		26.6	97.3										x							
BH18-PC-5	4219.102	22	4104.102	115		33.7	89.1			33	19	14			99.5		x							
BH18-BR-1	4218.586	3A	4208.586	10																			X	
BH18-BR-1	4218.586	5A	4198.586	20		46.04									73.5									
BH18-BR-1	4218.586	10B	4173.586	45		29.24									53.6									
BH18-BR-1	4218.586	12	4163.586	55	ML					NP	NP	NP												
BH18-BR-1	4218.586	13	4160.586	58	CL	40.7	82.3			37	20	17					X							
BH18-BR-1	4218.586	17	4143.586	75		19.29									75									
BH18-BR-1	4218.586	22	4118.586	100		27.59									45.3									
BH18-BR-1	4218.586	25	4103.586	115											96.1		x							
BH18-BR-2	4218.646	1	4213.646	5		9.67									11.4									
BH18-BR-2	4218.646	3B	4208.646	10																			x	
BH18-BR-2	4218.646	5	4200.646	18																			X	
BH18-BR-2	4218.646	6	4193.646	25		46.1	75.7			47	25	22			94		x							
BH18-BR-2	4218.646	11B	4166.646	52	ML	23.13				20	17	3			84									
BH18-BR-2	4218.646	17A	4138.646	80	CL	30.29				33	18	15			96.9									
BH18-BR-2	4218.646	21	4118.646	100		36.1	84.4										x							
BH18-BR-3	4219.048	2B	4211.548	7.5	CH					51	25	26												
BH18-BR-3	4219.048	3	4209.048	10		29.57									32.8									

BH18-BR-3	4219.048	4	4202.048	17		44.1	75.3				0	18.4	81.6		x		x			
BH18-BR-3	4219.048	5	4198.048	21		24.17							14.7							
BH18-BR-3	4219.048	8	4180.048	39	CH	61.6	64.7	57	26	31					x					x
BH18-BR-3	4219.048	11	4164.048	55		22.81							39.2							
BH18-BR-3	4219.048	14	4149.048	70	CL-ML			20	16	4	0	9.6	90.4							
BH18-BR-3	4219.048	19	4124.048	95		34.8	84.9	50	21	29			99		x					
BH18-BR-3	4219.048	21	4115.048	104		29.05							82.3							
BH18-BR-4	4219.829	2	4195.329	24.5				NP	NP	NP			38.7							
BH18-BR-4	4219.829	3B	4190.829	29				NP	NP	NP			58.4							
BH18-BR-4	4219.829	4A	4171.329	48.5				NP	NP	NP			68.5							
BH18-BR-4	4219.829	4B	4171.329	48.5									36.1							
BH18-BR-4	4219.829	5	4165.829	54				NP	NP	NP			29							
BH18-BR-4	4219.829	6A	4161.829	58				16	15	1			52.1							
BH18-BR-4	4219.829	7	4141.829	78		26.7	97.4								x					
BH18-BR-4	4219.829	8	4137.829	82		32.7	88.7	38	21	17			98.9		x					
BH18-BR-4	4219.829	9	4097.829	122		42.2	78.1	45	22	23			98.8		x					
BH18-BR-4	4219.829	10	4093.829	126		25	96.7	26	17	9			82.7		x					
BH19-BR-6	4218.813	1A	4208.813	10									48.9							
BH19-BR-6	4218.813	4A	4194.813	24									9.2							
BH19-BR-6	4218.813	5A	4189.813	29				NP	NP	NP										
BH19-BR-6	4218.813	7A	4184.813	34				44	23	21										
BH19-BR-6	4218.813	8	4176.813	42				25	22	3			85.2							
BH19-BR-6	4218.813	9B	4171.813	47									47.5							
BH19-BR-6	4218.813	10	4168.813	50		39.1	83.3	30	19	11					x					
BH19-BR-6	4218.813	11A	4165.813	53									32.6							
BH19-BR-6	4218.813	12B	4160.813	58				NP	NP	NP			61.7							
BH19-BR-6	4218.813	14	4146.813	72		36.5	85.2	35	20	15			95.4		x					
BH19-BR-6	4218.813	16	4133.813	85		30.7	89.4	36	18	18					x					
BH19-BR-6	4218.813	18	4114.813	104		45.3	76.4	46	23	23					x					
BH19-BR-6	4218.813	20	4097.813	121		46.9	73.5	56	24	32					x					
BH18-BR-7	4223.09	1	4206	17.5		29.4	95.2	NP	NP	NP			63.8				x			
BH18-BR-7	4223.09	2	4203	20.5				32	19	13			81.4							
BH18-BR-7	4223.09	3A	4199	24									18							
BH18-BR-7	4223.09	4A	4181	42				NP	NP	NP			19.2							
BH18-BR-7	4223.09	6	4165	58				17	15	2			63.2							
BH18-BR-7	4223.09	8	4116	107		28.8	91.1	33	18	15			72.7		x					
BH18-BR-7	4223.09	9	4102	121		45.4	74.7	48	25	23			97.7		x					
BH18-BR-7	4223.09	10	4098	125		25.8	99.4								x					
BH18-BR-7	4223.09	11	4083	140.5		24.3	98	23	21	2			67.5		x					
BH18-BR-7	4223.09	12	4075	148		25	97.1	40	18	22			81.1		x					
BH18-BR-7	4223.09	13	4070	153		23.1	99.2								x					
BH18-BR-7	4223.09	14	4068	155		32.1	89.7	41	21	20			97.5		x					
BH19-BR-9	4221.3	4B	4205	16	ML			NP	NP	NP			61.7							
BH19-BR-9	4221.3	7	4183	38	ML			NP	NP	NP			90.7							
BH19-BR-9	4221.3	9B	4173	48									62.2							
BH19-BR-9	4221.3	10	4167	54	CL			31	20	11										
BH19-BR-9	4221.3	13	4151	70	ML	27.2	93.9	NP	NP	NP					x					
BH19-BR-9	4221.3	17	4131	90	ML	27	95.2	NP	NP	NP					x					
BH19-BR-9	4221.3	21	4111	110	CH	48.7	71.8	64	24	40					x					
BH19-BR-9	4221.3	22	4106	115	CH			57	23	34										
BH19-ES-1	4221.4	3	4208	13	MH			51	33	18			77.4							x
BH19-ES-1	4221.4	5	4204	17	SM			NP	NP	NP			41.2							
BH19-ES-1	4221.4	7	4201	20	CL			34	19	15										
BH19-ES-1	4221.4	8B	4197	24	ML			NP	NP	NP			76.5							

BH19-ES-1	4221.4	10	4186	35	CH	57.1	67.5	55	26	29					x					
BH19-ES-1	4221.4	13B	4177	44									21.7							
BH19-ES-1	4221.4	14B	4169	52									52.6							
BH19-ES-1	4221.4	15	4166	55	CL			35	20	15										
BH19-ES-1	4221.4	18	4151	70	CL			28	19	9										
BH19-ES-1	4221.4	21	4136	85	CL	34.6	87.6	31	19	12					x					
BH19-ES-1	4221.4	24	4121	100	CH	39.4	81.7	51	21	30					x					
BH19-ES-2	4221.0	1	4212	9									33.9							
BH19-ES-2	4221.0	2B	4210	11	CH			53	32	21			84.6							
BH19-ES-2	4221.0	3B	4208	13	ML			NP	NP	NP			70.8							
BH19-ES-2	4221.0	6	4201	20		37	84.1						98.6		x		x			
BH19-ES-2	4221.0	6b	4201	20	CL			36	19	17										
BH19-ES-2	4221.0	7C	4198	23	CL			30	20	10										
BH19-ES-2	4221.0	8B	4195	26									37.9							
BH19-ES-2	4221.0	10	4186	35	CH	56.3	66.2	56	25	31					x					
BH19-ES-2	4221.0	13B	4170	51									46.1							
BH19-ES-2	4221.0	14	4166	55	CL	41	79	39	21	18					x					
BH19-ES-2	4221.0	23	4121	100	CH	36.4	81.8	51	20	31					x					
BH19-ES-2	4221.0	25A	4111	110	CL			32	20	12			90.8							
BH19-ES-2	4221.0	27	4101	120	CH			62	24	38										
BH19-HES-1	4220.2	1B	4209	11															x	
BH19-HES-1	4220.2	2A	4205	15									63.9							
BH19-HES-1	4220.2	3A	4201	19				24	22	2			74.7							
BH19-HES-1	4220.2	4B	4196	24									20.7							
BH19-HES-1	4220.2	5	4191	29		44.5	76.1	37	21	16					x					
BH19-HES-1	4220.2	7B	4180	40									39.2							
BH19-HES-1	4220.2	8	4176	44		35.4	84.2	34	19	15					x					
BH19-HES-1	4220.2	10	4164	56		36.9	86.7	34	19	15					x					
BH19-HES-1	4220.2	15	4139	81				50	22	28										
BH19-HES-1	4220.2	17	4127	93									31.2							
BH19-HES-1	4220.2	18	4121	99		32.3	89.2	42	21	21			98.3		x					
BH19-HES-1	4220.2	24	4102	118				44	22	22			97.8							
BH19-OM-2	4224.8	3	4205	19.5									50.9							
BH19-OM-2	4224.8	5B	4196	29									18							
BH19-OM-2	4224.8	8	4185	40		53.1	70.1	55	25	30					x					
BH19-OM-2	4224.8	12B	4168	57									52.9							
BH19-OM-2	4224.8	13	4165	60		32.8	91.1	23	17	6					x					
BH19-OM-5	4215.1	1	4206	9									56							
BH19-OM-5	4215.1	2	4203	12				41	21	20									x	
BH19-OM-5	4215.1	4	4192	23		73.6	56.6	66	28	38			99.9		x		x			
BH19-OM-5	4215.1	6	4184	31									50.7							
BH19-OM-5	4215.1	8	4176	39		45.5	76.5	40	21	19					x					
BH19-OM-5	4215.1	9A	4169	46				NP	NP	NP			64.5							
BH19-OM-5	4215.1	11B	4159	56				NP	NP	NP			88.1							
BH19-OM-5	4215.1	15	4134	81				49	21	28										
BH19-OM-5	4215.1	20	4113	102				44	20	24										
BH19-OM-5	4215.1	22	4102	113		45.1	76.9	57	23	34					x					
BH19-OM-5	4215.1	23	4096	119		35.1	87.3	45	22	23			98.2		x					
BH21-OF-1	4218.1	1	4211.6	6.5				40	24	16			67.2							
BH21-OF-1	4218.1	3	4207.6	10.5				NP	NP	NP			43.7							
BH21-OF-1	4218.1	5	4202.6	15.5		78.2	54.3	71	30	41	0	5.3	94.7		x					
BH21-OF-1	4218.1	6	4200.6	17.5		62.4													x	
BH21-OF-1	4218.1	7	4198.6	19.5				38	22	16			82.7							
BH21-OF-1	4218.1	10	4176.6	41.5				24	17	7			23.5							

Boring	Surface Elevation of Boring	Sample Number	Elevation of Top of Sample	Depth at Top of Sample	USCS Group Symbol	Water Content (%)	Dry Density of Soil (pcf)	Atterberg Limits			Grain-Size			Additional Testing								
											Gravel	Sand										
								LL	PL	PI	Total	Total	Fines	Consol Test	DS	UC	TXUU	TXCU	TXCD	TXCY	DSS	Corrosion Test
								-	-	-	(%)	(%)	(%)	-	-	-	-	-	-	-	-	-
B21-IS-01	4215.572	1	4210.572	5																		x
B21-IS-01	4215.572	2B	4205.072	10.5				30	25	5			78.7									
B21-IS-01	4215.572	3B	4199.572	16							0.0	84.4	15.6									
B21-IS-02	4215.882	3A	4207.882	8				29	15	14			74.4									
B21-IS-02	4215.882	5	4199.882	16				26	21	5			76.0									
B21-IS-02	4215.882	6	4197.882	18							0.0	76	24.0									
B21-IS-03	4216.036	2	4210.036	6																		x
B21-IS-03	4216.036	3	4206.036	10				40	21	19												
B21-IS-04	4218.054	1	4212.054	6				33	17	16			68.8									
B21-IS-04	4218.054	2	4210.054	8																		x
B21-IS-04	4218.054	4	4203.054	15				50	24	26												
B21-IS-05	4215.614	2	4205.614	10				38	21	17			93.5									
B21-IS-05	4215.614	4B	4199.914	15.7				23	20	3			67.7									
B21-IS-06	4216.881	1A	4211.881	5							1.1	89.9	8.9									
B21-IS-06	4216.881	4	4202.881	14				27	19	8			67.5									
B21-IS-06	4216.881	8B	4186.481	30.4				NP	NP	NP	0.0	36.2	63.8									
B21-OIPS-01	4217.548	2	4211.548	6				27	21	6			75.0									
B21-OIPS-01	4217.548	4B	4197.048	20.5				NP	NP	NP			44.5									
B21-OIPS-01	4217.548	6	4189.548	28		51.1	72	41	23	18	0.0	3.7	96.3	x								
B21-OIPS-02	4217.053	3	4203.053	14				30	23	7			86.2									
B21-OIPS-02	4217.053	4A	4199.053	18				NP	NP	NP			75.8									
B21-OIPS-02	4217.053	6	4187.053	30				47	25	22			98.3									
B21-OIPS-02	4217.053	9	4173.053	44		36.8	84.3	37	21	16	0.0	3	97.0	x								
B21-OIPS-03	4218.096	3	4203.096	15				37	20	17			86.6									
B21-OIPS-03	4218.096	5	4196.096	22							0.0	50.3	49.7									
B21-OIPS-04	4219.85	6A	4195.85	24				NP	NP	NP	2.6	79.5	17.9									
B21-OIPS-05	4217.197	4B	4198.197	19							0.1	81.9	18.1									
B21-OIPS-05	4217.197	5B	4195.197	22				NP	NP	NP			47.7									
B21-OIPS-05	4217.197	13	4152.197	65		51.5	73.8	40	19	21	1.2	7.1	91.7	x								
B21-OIPS-06	4216.489	4	4197.489	19							2.0	88.7	9.3									
B21-OIPS-06	4216.489	7	4188.489	28		53.3	70.1	48	26	22	0.0	0.3	99.7	x								
B21-OIPS-07	4216.518	2	4206.518	10		44.7	76.9	50	20	30	0.0	0.6	99.4	x								
B21-OIPS-07	4216.518	3B	4203.518	13				27	18	9			72.9									
B21-OIPS-07	4216.518	4	4202.518	14				NP	NP	NP			51.8									
B21-OIPS-07	4216.518	6	4196.518	20							0.7	85.3	14.0									
B21-OIPS-07	4216.518	19	4120.518	96		42.7	77.1	49	23	26	0.0	0.2	99.8	x								
B21-OIPS-08	4216.086	3	4204.086	12				NP	NP	NP			45.9									
B21-OIPS-08	4216.086	4	4201.086	15							0.0	88.9	11.0									
B21-OIPS-08	4216.086	12	4158.086	58																		x
B21-OIPS-08	4216.086	13	4152.086	64		44.4	76.7	45	22	23	0.0	0.3	99.7	x								
B21-OIPS-08	4216.086	15	4142.086	74							0.0	85.8	14.2									
B21-OIPS-09	4215.638	4	4197.638	18							0.0	88	12.0									
B21-OIPS-09	4215.638	8B	4170.638	45				21	19	2			71.0									
B21-OIPS-09	4215.638	10	4160.638	55				37	19	18			82.7									
B21-OIPS-09	4215.638	14	4140.638	75				NP	NP	NP	0.0	72.2	27.8									
B21-OIPS-09	4215.638	18	4120.638	95		34.8	87	39	21	18	0.0	1.3	98.7	x								

Salt Lake City Water Reclamation Facility
Influent Pump Station
Bearing Capacity Calculation

Purpose

This memorandum details the approach and methodology used to calculate the bearing capacity for several facilities proposed at the New Salt Lake City Water Reclamation Facility (New WRF). These facilities include the influent pump station (IPS) and associated facilities. The IPS and associated facilities are planned to be located near 1200 West and Reclamation Rd, immediately south of the existing Salt Lake City Department of Public Utilities (SLCDPU) Pump Station site and approximately 0.5 mile southeast of the main plant site.

Data Available

AECOM performed geotechnical explorations of subsurface conditions within, or in the vicinity of, the footprint of proposed IPS structures. A subsurface exploration program specifically for the IPS facilities and the influent pipeline was performed in December 2020 through January 2021, and August 2021. These explorations included 18 CPTs and 15 exploratory borings; additional explorations had been performed previously but are not part of this analysis. The explorations analyzed specifically for the IPS facilities and the Influent Pipeline facilities are included in Table 1. Laboratory testing was performed on selected samples collected from the borings in order to help select engineering properties of encountered subsurface materials. The IPS geotechnical report contains information relating to the explorations and laboratory testing performed.

Table 1. Summary of Subsurface Explorations

Field Investigation	Total Depth (feet)	Groundwater Depth (feet)
B21-IS-01	37.0	-- [1]
B21-IS-02	32.0	-- [1]
B21-IS-03	35.0	-- [1]
B21-IS-04	37.0	-- [1]
B21-IS-05	35.0	-- [1]
B21-IS-06	37.0	-- [1]
B21-OIPS-01	52.0	-- [1]
B21-OIPS-02	52.0	-- [1]
B21-OIPS-03	49.0	-- [1]
B21-OIPS-04	52.0	-- [1]
B21-OIPS-05	102.0	-- [1]
B21-OIPS-06	52.0	-- [1]
B21-OIPS-07	100.0	-- [1]
B21-OIPS-08	102.0	-- [1]
B21-OIPS-09	102.0	-- [1]
CP20-IS-01[2]	124.0	12.1
CP20-IS-02	75.1	8.5
CP20-IS-03	120.9	7.4
CP20-IS-04	75.1	9.4
CP20-IS-05	120.1	6.6
CP21-IS-06	123.9	7.4
CP21-IS-07	122.1	3.3
CP21-IS-08	120.1	4.4

Field Investigation	Total Depth (feet)	Groundwater Depth (feet)
CP21-IS-09	75.4	2.7
CP21-IS-10	120.3	2.9
CPT21-OIPS-01	86.5	0.6
CPT21-OIPS-02	85.5	9.4
CPT21-OIPS-03	85.5	12.5
CPT21-OIPS-04	88.4	10.8
CPT21-OIPS-05	137.5	10.0
CPT21-OIPS-06	85.1	9.1
CPT21-OIPS-07	160.8	7.6
CPT21-OIPS-08	131.4	11.2

Notes:
1. Boreholes were not left open to obtain groundwater measurements and encountered groundwater is not readily observed in boreholes excavated by mud rotary drilling methods. Groundwater depth is assumed to be similar to depths encountered in nearby explorations.
2. This CPT was used in analysis even though it is no longer located on the pipeline alignment.

Assumptions

The following assumptions were made regarding this calculation and supporting data:

- Laboratory tests were performed in accordance with the referenced American Association of State Highway and Transportation Officials (AASHTO) or American Society for Testing and Materials (ASTM) standards and are reported accurately by the subcontracted testing facility.
- Samples tested in the laboratory are representative of the soil unit from which they were obtained. Further, the results of the testing are indicative of material properties for the soil unit.
- Ground water elevation is at an elevation of approximately 4,212 feet near the IPS and associated facilities, or at the base of the foundation elevation, whichever is higher. Based on pore pressure dissipation (PPD) testing, the groundwater may be lower than 4,212 feet, with a greater than 100% of hydrostatic pressure increase with depth. A higher elevation of 4,212 feet was considered in the bearing capacity analysis for the IPS.
- The top of native ground surface in the area of the IPS and associated facilities ranges from 4,217 feet to 4,220 feet. The proposed finished grade in the area of the IPS and associated facilities ranges between approximately 4,221 to 4,222 feet.
- Excavation shoring is anticipated surrounding the IPS facility, and lightweight backfill was being considered at the time of preparation of this calculation. The bearing capacity analysis considered a staged construction sequence including surrounding backfill being brought up as the facility is constructed. Assumptions relating to incremented structure load application and backfilling are noted in the Methodology and Analysis Results Sections.

Methodology

Bearing resistance analysis includes development of an idealized soil profile based on encountered subsurface conditions, interpreted laboratory test results, construction of a bearing resistance model to represent the subsurface conditions at the project site, the dimensions of the proposed facilities, and surficial grade changes at the structure locations.

For the IPS and associated facilities, the shear strength parameters were selected based on review of the shear strength characterization for the Liquid Train area as well as in the immediate vicinity of the IPS facility.

The modulus of subgrade reaction is analyzed using formula 9-9 in Bowles, Foundation Analysis and Design (1997). The formula input parameters include the allowable bearing capacity and selected safety factor. The analysis and description are shown in Attachment 1.

Calculation Procedure

AECOM used an Excel spreadsheet to perform the bearing resistance analysis for this project. The spreadsheet requires inputs of soil strength, groundwater conditions, foundation dimensions, and foundation embedment depth to analyze the bearing resistance. The allowable bearing resistance was calculated by dividing the nominal bearing resistance by a factor of

safety of 2.5. A detailed description of the bearing resistance analyses methods and factors are presented in Attachment 1 and Attachment 2.

Bearing Layer Soil Parameters

AECOM selected the bearing soil layer parameters for the IPS facilities using available borehole, CPT, and laboratory test data. Selected soil parameters are presented in Table 2. In some cases for which the foundation size was relatively large, shallow surface fills were neglected, and strength parameters were selected based on the underlying clay material.

Groundwater Conditions

In the area of the IPS facility, located near 1200 West and Reclamation Rd, the monitoring well groundwater level for the screened interval was observed to be as high as approximately 4,212 feet based on periodic well measurements in BH19-ITW-6. As noted in the assumptions, for facilities bearing above the estimated groundwater elevation, the depth of groundwater was considered to be at the base of the foundation. Whereas dewatering conditions for the IPS excavation are not known, the groundwater was conservatively assumed to be at the base of the excavation or top of the backfill level for short-term construction analyses, but not higher than 4,212 feet.

Input parameters

Input parameters used in the bearing resistance analysis are summarized in Table 2.

Table 2. Bearing Resistance Analysis Input Parameters

Structure Name	Foundation Dimensions (B x L) or Diameter	Final Grade Elevation	Depth of Foundation Below Final Grade / Effective Embedment Depth	Groundwater Depth in Analysis	Unit Weight of Soil	Drained Parameters		Undrained Parameters	
	(feet)	(feet)	(feet)	(feet)	(pcf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)
IPS Facility									
Construction – No Backfill	43 x 82	4221.5	0[1]	0[2]	70[3]	--	--	0	1050 (700)[4]
Construction – 20 ft Backfill	43 x 82	4221.5	20[1]	0[2]	70[3]	--	--	0	1050 (700)[4]
Construction – 50 ft Backfill	43 x 82	4221.5	50[1]	9[2]	70[3]	--	--	0	1050 (700)[4]
Long-Term Drained	43 x 82	4221.5	50.5	9.5	70[3]	26 (18)[4]	0	--	--
IPS Electrical (Spot Footings)	7 x 7	4221.5	3.5	3.5	112	26	0	0	750
IPS Odor Control	30 x 72	4221.5	2.5	2.5	112	26	0	0	750
IPS Generator Pad	44 x 80	4221.5	2.5	2.5	112	26	0	0	750
Fuel Tanks	12 x 35	4221.5	2.5	2.5	112	26	0	0	750

Notes: '--' denotes blank entry

1. Effective embedment depth selected based on relative depth of adjacent ground within the IPS excavation.
2. Water level conservatively assumed to be at the base of the excavation or the level of the backfill within the IPS excavation, but not higher than 4,212 feet.
3. Calculations conservatively assume the use of lightweight backfill within the IPS excavation, which was being considered at the time this calculation was prepared.
4. Parameters reduced for punching or local shear calculations in accordance with AASHTO (2017) Section 10.6.3.1.2b.

Analysis Results

A summary of the allowable drained and undrained bearing resistance results is presented in Table 3. The permanent dead loads are compared to the allowable bearing resistances. For the IPS facility, which has a significant planned excavation, the effective stress reduction associated with the excavation was subtracted from the applied load for the long-term drained condition and for the short-term undrained condition to the level of the adjacent backfill (i.e. for no backfill, no excavation load

reduction was used; for 20 feet of backfill, 20 feet of excavation load reduction was used, and for 50 feet of backfill, the full 50 feet of excavation load reduction was used). This was done in part because limited confinement of bearing soil would be available when backfilling around the structure has not yet been completed. A staged analysis was performed for undrained loading conditions for the IPS to consider the incremental loading and backfilling of the structure. The incremental load assumptions (limits) associated with the analyzed backfill levels are noted in Table 3.

Table 3. Bearing Resistance Analysis Results

Structure Name	Allowable Drained Bearing Resistance (ksf)	Allowable Undrained Bearing Resistance (ksf)	Applied Permanent Dead Load (Effective Net Load) (ksf)	Is Allowable Bearing Resistance ≥ Permanent Dead Load or Effective Net Load (Y/N)
IPS Facility				
Construction – No Backfill	--[1]	1.6	1.5 (1.5)[2]	Y
Construction – 20 ft Backfill	--[1]	1.9	2.9 (1.9)[3]	Y
Construction – 50 ft Backfill	--[1]	2.6	5.2 (2.6)[4]	Y
Long-Term Drained	7.3	--[1]	5.8 (3.2)[5]	Y
IPS Electrical	3.4	2.0	1.5	Y
IPS Odor Control	5.1	1.8	0.5	Y
IPS Generator Pad	6.5	1.8	0.3	Y
Fuel Tanks	3.0	1.8	0.3	Y

Notes:

1. Bearing Resistance not applicable for the given analysis condition.
2. Assumes that up to 25 percent of the total structure dead load (5.8 ksf) may be applied before any backfill is placed around the IPS structure.
3. Assumes that up to 50 percent of the total structure dead load (5.8 ksf) may be applied once backfill has been completed up to an elevation 20 feet above the IPS structure bearing elevation. Effective net load considers that portion of the soil excavation for the IPS facility which is below the backfill level of 20 feet above the structure bearing elevation.
4. Assumes that up to 90 percent of the total structure dead load (5.8 ksf) may be applied once backfill has been completed up to an elevation 50 feet above the IPS structure bearing elevation. Effective net load considers that portion of the soil excavation for the IPS facility which is below the backfill level of 50 feet above the structure bearing elevation. It is anticipated that the construction schedule will be slow enough to allow drainage under initial loads such that adequate strength gain will have occurred by the time the final portion of the permanent load is applied.
5. Considers long-term total structure dead load (5.8 ksf) under drained conditions. Effective net load considers the effect of the soil excavation for the IPS facility.

A summary of the Modulus of subgrade reaction analysis presented in Table 4. These moduli of subgrade reaction are appropriate for the foundation design parameters and soil properties shown in Table 2. If there are changes in the foundation location, dimensions, bearing elevation, or other design parameters, the bearing capacity or modulus of subgrade reaction may also change, and the geotechnical engineer should be contacted to assess the impact of the changes on the recommendations provided herein.

Table 4. Modulus of Subgrade Reaction

Structure Name	Modulus of Subgrade Reaction, k_s (pci)
IPS Facility	45
IPS Electrical	35
IPS Odor Control	31
IPS Generator Pad	31
Fuel Tanks	31

References

American Association of State Highway and Transportation Officials [AASHTO]. (2017). AASHTO LRFD Bridge Design Specifications, U.S. Customary Units. Washington, D.C.

Joseph E. Bowles, P.E., S.E. (1997). *Foundation Analysis and Design, Fifth Edition*, ISBN 0-07-118844-4.

Attachments

Attachment 1: Modulus of Subgrade Reaction Analysis Results

Attachment 2: Bearing Resistance Analysis Results

Attachment 1: Modulus of Subgrade Reaction Analysis Results

Subgrade reaction modulus

Reference: Bowles (1997), Formula 9-9

$k_s = 12 * S.F. * q_a$

k_s Subgrade reaction modulus (pcf)
S.F. Safety factor
q_a Allowable bearing resistance (psf)

Structure Name	S.F.	q_{all} (psf)	k_s (pcf)	k_s (pci)
IPS Facility	2.5	2,600	78,000	45
IPS Electrical	2.5	2,000	60,000	35
IPS Odor Control	2.5	1,800	54,000	31
IPS Generator Pad	2.5	1,800	54,000	31
IPS GP Fuel Tanks	2.5	1,800	54,000	31

Attachment 2: Bearing Resistance Analysis Results

AECOM

IPS Facility

Drained and Undrained

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	IPS - Undrained (General Shear; During Construction; No Backfill)
Date:	9/30/2021

ϕ_f	0.0	deg
c	1,050	psf
γ	70.0	pcf
D_w	0.0	ft
B	43.00	ft
L	82.00	ft
D_f	0.00	ft
θ		deg
V		kip
H		kip

q_n	**6**	**ksf**
N_{cm}	**5.679073**	
N_c	5.14	
s_c	1.104878	
i_c	1	
N_{qm}	**1**	
N_q	1	
s_q	1	
d_q	1	
i_q	1	
$N_{\gamma m}$	**0**	
N_γ	0	
s_γ	1	
i_γ	1	
q_n	**5.963027 ksf**	
C_{wq}	0.5	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

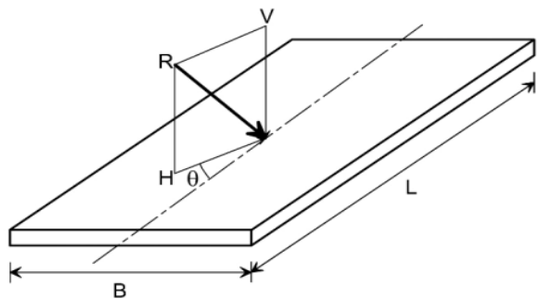


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

10.6.3.1.2b—Considerations for Punching Shear

If local or punching shear failure is possible, the nominal bearing resistance shall be estimated using reduced shear strength parameters c^* and ϕ^* in Eqs. 10.6.3.1.2b-1 and 10.6.3.1.2b-2. The reduced shear parameters may be taken as:

$$c^* = 0.67c \qquad (10.6.3.1.2b\text{-}1)$$

$$\phi^* = \tan^{-1}(0.67\tan\phi_f) \qquad (10.6.3.1.2b\text{-}2)$$

where:

c^* = reduced effective stress soil cohesion for punching shear (ksf)
ϕ^* = reduced effective stress soil friction angle for punching shear (degrees)

C10.6.3.1.2b

Local shear failure is characterized by a failure surface that is similar to that of a general shear failure but that does not extend to the ground surface, ending somewhere in the soil below the footing. Local shear failure is accompanied by vertical compression of soil below the footing and visible bulging of soil adjacent to the footing but not by sudden rotation or tilting of the footing. Local shear failure is a transitional condition between general and punching shear failure. Punching shear failure is characterized by vertical shear around the perimeter of the footing and is accompanied by a vertical movement of the footing and compression of the soil immediately below the footing but does not affect the soil outside the loaded area. Punching shear failure occurs in loose or compressible soils, in weak soils under slow (drained) loading, and in dense sands for deep footings subjected to high loads.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	IPS - Undrained (Punching or Local Shear; During Construction; No Backfill)
Date:	9/30/2021

ϕ_f	0.0	deg
c	700	psf
γ	70.0	pcf
D_w	0.0	ft
B	43.00	ft
L	82.00	ft
D_f	0.00	ft
θ		deg
V		kip
H		kip

q_n	**4**	**ksf**
N_{cm}	**5.679073**	
N_c	5.14	
s_c	1.104878	
i_c	1	
N_{qm}	**1**	
N_q	1	
s_q	1	
d_q	1	
i_q	1	
$N_{\gamma m}$	**0**	
N_γ	0	
s_γ	1	
i_γ	1	
q_n	**3.975351 ksf**	
C_{wq}	0.5	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

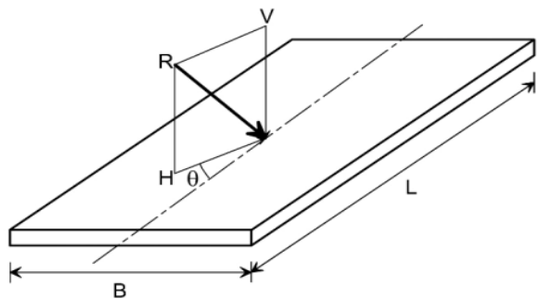


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

10.6.3.1.2b—Considerations for Punching Shear

If local or punching shear failure is possible, the nominal bearing resistance shall be estimated using reduced shear strength parameters c^* and ϕ^* in Eqs. 10.6.3.1.2b-1 and 10.6.3.1.2b-2. The reduced shear parameters may be taken as:

$$c^* = 0.67c \qquad (10.6.3.1.2b\text{-}1)$$

$$\phi^* = \tan^{-1}(0.67\tan\phi_f) \qquad (10.6.3.1.2b\text{-}2)$$

where:

c^* = reduced effective stress soil cohesion for punching shear (ksf)
ϕ^* = reduced effective stress soil friction angle for punching shear (degrees)

C10.6.3.1.2b

Local shear failure is characterized by a failure surface that is similar to that of a general shear failure but that does not extend to the ground surface, ending somewhere in the soil below the footing. Local shear failure is accompanied by vertical compression of soil below the footing and visible bulging of soil adjacent to the footing but not by sudden rotation or tilting of the footing. Local shear failure is a transitional condition between general and punching shear failure. Punching shear failure is characterized by vertical shear around the perimeter of the footing and is accompanied by a vertical movement of the footing and compression of the soil immediately below the footing but does not affect the soil outside the loaded area. Punching shear failure occurs in loose or compressible soils, in weak soils under slow (drained) loading, and in dense sands for deep footings subjected to high loads.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	IPS - Undrained (General Shear; During Construction; 20 ft Backfill)
Date:	9/30/2021

ϕ_f	0.0	deg
c	1,050	psf
γ	70.0	pcf
D_w	0.0	ft
B	43.00	ft
L	82.00	ft
D_f	20.00	ft
θ		deg
V		kip
H		kip

q_n	**6.7**	**ksf**
N_{cm}	**5.679073**	
N_c	5.14	
s_c	1.104878	
i_c	1	
N_{qm}	**1**	
N_q	1	
s_q	1	
d_q	1	
i_q	1	
$N_{\gamma m}$	**0**	
N_γ	0	
s_γ	1	
i_γ	1	
q_n	**6.663027 ksf**	
C_{wq}	0.5	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \; q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

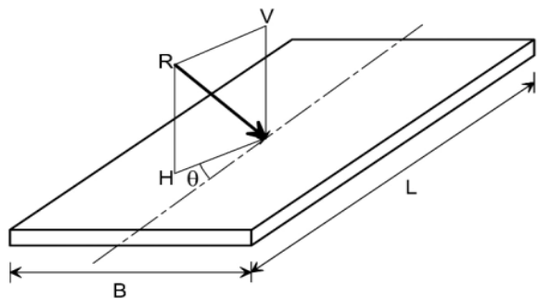


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

10.6.3.1.2b—Considerations for Punching Shear

If local or punching shear failure is possible, the nominal bearing resistance shall be estimated using reduced shear strength parameters c^* and ϕ^* in Eqs. 10.6.3.1.2b-1 and 10.6.3.1.2b-2. The reduced shear parameters may be taken as:

$$c^* = 0.67c \qquad (10.6.3.1.2b\text{-}1)$$

$$\phi^* = \tan^{-1}(0.67\tan\phi_f) \qquad (10.6.3.1.2b\text{-}2)$$

where:

c^* = reduced effective stress soil cohesion for punching shear (ksf)
ϕ^* = reduced effective stress soil friction angle for punching shear (degrees)

C10.6.3.1.2b

Local shear failure is characterized by a failure surface that is similar to that of a general shear failure but that does not extend to the ground surface, ending somewhere in the soil below the footing. Local shear failure is accompanied by vertical compression of soil below the footing and visible bulging of soil adjacent to the footing but not by sudden rotation or tilting of the footing. Local shear failure is a transitional condition between general and punching shear failure. Punching shear failure is characterized by vertical shear around the perimeter of the footing and is accompanied by a vertical movement of the footing and compression of the soil immediately below the footing but does not affect the soil outside the loaded area. Punching shear failure occurs in loose or compressible soils, in weak soils under slow (drained) loading, and in dense sands for deep footings subjected to high loads.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	IPS - Undrained (Punching or Local Shear; During Construction; 20 ft Backfill)
Date:	9/30/2021

ϕ_f	0.0	deg
c	700	psf
γ	70.0	pcf
D_w	0.0	ft
B	43.00	ft
L	82.00	ft
D_f	20.00	ft
θ		deg
V		kip
H		kip

q_n	**4.7**	**ksf**
N_{cm}	**5.679073**	
N_c	5.14	
s_c	1.104878	
i_c	1	
N_{qm}	**1**	
N_q	1	
s_q	1	
d_q	1	
i_q	1	
$N_{\gamma m}$	**0**	
N_γ	0	
s_γ	1	
i_γ	1	
q_n	**4.675351 ksf**	
C_{wq}	0.5	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

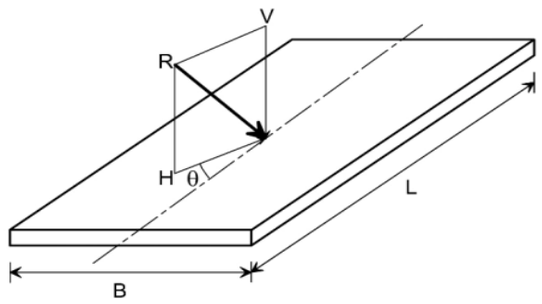


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

10.6.3.1.2b—Considerations for Punching Shear

If local or punching shear failure is possible, the nominal bearing resistance shall be estimated using reduced shear strength parameters c^* and ϕ^* in Eqs. 10.6.3.1.2b-1 and 10.6.3.1.2b-2. The reduced shear parameters may be taken as:

$$c^* = 0.67c \qquad (10.6.3.1.2b\text{-}1)$$

$$\phi^* = \tan^{-1}(0.67\tan\phi_f) \qquad (10.6.3.1.2b\text{-}2)$$

where:

c^* = reduced effective stress soil cohesion for punching shear (ksf)
ϕ^* = reduced effective stress soil friction angle for punching shear (degrees)

C10.6.3.1.2b

Local shear failure is characterized by a failure surface that is similar to that of a general shear failure but that does not extend to the ground surface, ending somewhere in the soil below the footing. Local shear failure is accompanied by vertical compression of soil below the footing and visible bulging of soil adjacent to the footing but not by sudden rotation or tilting of the footing. Local shear failure is a transitional condition between general and punching shear failure. Punching shear failure is characterized by vertical shear around the perimeter of the footing and is accompanied by a vertical movement of the footing and compression of the soil immediately below the footing but does not affect the soil outside the loaded area. Punching shear failure occurs in loose or compressible soils, in weak soils under slow (drained) loading, and in dense sands for deep footings subjected to high loads.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	IPS - Undrained (General Shear; During Construction; 50 ft Backfill)
Date:	11/19/2021

ϕ_f	0.0	deg
c	1,050	psf
γ	70.0	pcf
D_w	9.0	ft
B	43.00	ft
L	82.00	ft
D_f	50.00	ft
θ		deg
V		kip
H		kip

q_n	**8.5**	**ksf**
N_{cm}	**5.679073**	
N_c	5.14	
s_c	1.104878	
i_c	1	
N_{qm}	**1.216279**	
N_q	1	
s_q	1	
d_q	1.216279	
i_q	1	
$N_{\gamma m}$	**0**	
N_γ	0	
s_γ	1	
i_γ	1	
q_n	**8.474643 ksf**	
C_{wq}	0.59	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

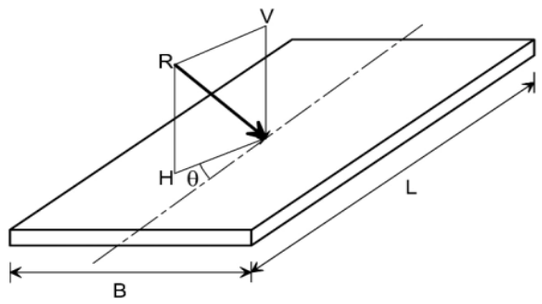


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

10.6.3.1.2b—Considerations for Punching Shear

If local or punching shear failure is possible, the nominal bearing resistance shall be estimated using reduced shear strength parameters c^* and ϕ^* in Eqs. 10.6.3.1.2b-1 and 10.6.3.1.2b-2. The reduced shear parameters may be taken as:

$$c^* = 0.67c \qquad (10.6.3.1.2b\text{-}1)$$

$$\phi^* = \tan^{-1}(0.67\tan\phi_f) \qquad (10.6.3.1.2b\text{-}2)$$

where:

c^* = reduced effective stress soil cohesion for punching shear (ksf)
ϕ^* = reduced effective stress soil friction angle for punching shear (degrees)

C10.6.3.1.2b

Local shear failure is characterized by a failure surface that is similar to that of a general shear failure but that does not extend to the ground surface, ending somewhere in the soil below the footing. Local shear failure is accompanied by vertical compression of soil below the footing and visible bulging of soil adjacent to the footing but not by sudden rotation or tilting of the footing. Local shear failure is a transitional condition between general and punching shear failure. Punching shear failure is characterized by vertical shear around the perimeter of the footing and is accompanied by a vertical movement of the footing and compression of the soil immediately below the footing but does not affect the soil outside the loaded area. Punching shear failure occurs in loose or compressible soils, in weak soils under slow (drained) loading, and in dense sands for deep footings subjected to high loads.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	IPS - Undrained (Punching or Local Shear; During Construction; 50 ft Backfill)
Date:	11/19/2021

ϕ_f	0.0	deg
c	700	psf
γ	70.0	pcf
D_w	9.0	ft
B	43.00	ft
L	82.00	ft
D_f	50.00	ft
θ		deg
V		kip
H		kip

q_n	**6.5**	**ksf**
N_{cm}	**5.679073**	
N_c	5.14	
s_c	1.104878	
i_c	1	
N_{qm}	**1.216279**	
N_q	1	
s_q	1	
d_q	1.216279	
i_q	1	
$N_{\gamma m}$	**0**	
N_γ	0	
s_γ	1	
i_γ	1	
q_n	**6.486967**	**ksf**
C_{wq}	0.59	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

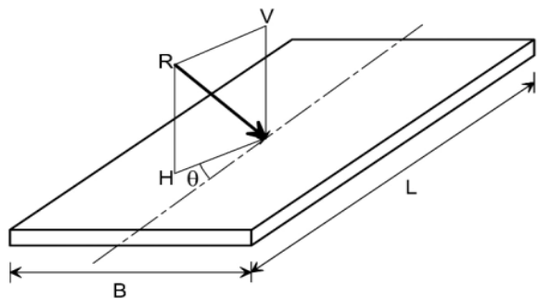


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

10.6.3.1.2b—Considerations for Punching Shear

If local or punching shear failure is possible, the nominal bearing resistance shall be estimated using reduced shear strength parameters c^* and ϕ^* in Eqs. 10.6.3.1.2b-1 and 10.6.3.1.2b-2. The reduced shear parameters may be taken as:

$$c^* = 0.67c \qquad (10.6.3.1.2b\text{-}1)$$

$$\phi^* = \tan^{-1}(0.67\tan\phi_f) \qquad (10.6.3.1.2b\text{-}2)$$

where:

c^* = reduced effective stress soil cohesion for punching shear (ksf)
ϕ^* = reduced effective stress soil friction angle for punching shear (degrees)

C10.6.3.1.2b

Local shear failure is characterized by a failure surface that is similar to that of a general shear failure but that does not extend to the ground surface, ending somewhere in the soil below the footing. Local shear failure is accompanied by vertical compression of soil below the footing and visible bulging of soil adjacent to the footing but not by sudden rotation or tilting of the footing. Local shear failure is a transitional condition between general and punching shear failure. Punching shear failure is characterized by vertical shear around the perimeter of the footing and is accompanied by a vertical movement of the footing and compression of the soil immediately below the footing but does not affect the soil outside the loaded area. Punching shear failure occurs in loose or compressible soils, in weak soils under slow (drained) loading, and in dense sands for deep footings subjected to high loads.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	IPS - Long-Term Drained (General Shear; 50.5 ft Backfill)
Date:	11/19/2021

ϕ_f	26.0	deg
c	0	psf
γ	70.0	pcf
D_w	9.5	ft
B	43.00	ft
L	82.00	ft
D_f	50.50	ft
θ		deg
V		kip
H		kip

q_n	**45.6**	**ksf**
N_{cm}	**28.54024**	
N_c	22.3	
s_c	1.279832	
i_c	1	
N_{qm}	**18.19293**	
N_q	11.9	
s_q	1.255762	
d_q	1.217442	
i_q	1	
$N_{\gamma m}$	**9.878049**	
N_γ	12.5	
s_γ	0.790244	
i_γ	1	
q_n	**45.63838**	**ksf**
C_{wq}	0.594059	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

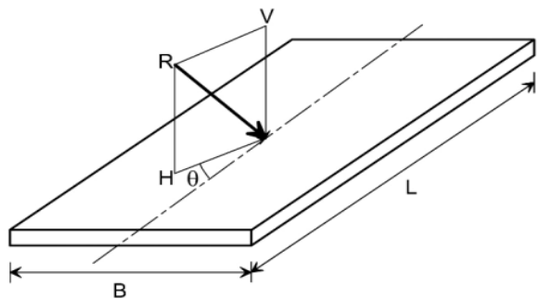


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

10.6.3.1.2b—Considerations for Punching Shear

If local or punching shear failure is possible, the nominal bearing resistance shall be estimated using reduced shear strength parameters c^* and ϕ^* in Eqs. 10.6.3.1.2b-1 and 10.6.3.1.2b-2. The reduced shear parameters may be taken as:

$$c^* = 0.67c \qquad (10.6.3.1.2b\text{-}1)$$

$$\phi^* = \tan^{-1}(0.67\tan\phi_f) \qquad (10.6.3.1.2b\text{-}2)$$

where:

c^* = reduced effective stress soil cohesion for punching shear (ksf)
ϕ^* = reduced effective stress soil friction angle for punching shear (degrees)

C10.6.3.1.2b

Local shear failure is characterized by a failure surface that is similar to that of a general shear failure but that does not extend to the ground surface, ending somewhere in the soil below the footing. Local shear failure is accompanied by vertical compression of soil below the footing and visible bulging of soil adjacent to the footing but not by sudden rotation or tilting of the footing. Local shear failure is a transitional condition between general and punching shear failure. Punching shear failure is characterized by vertical shear around the perimeter of the footing and is accompanied by a vertical movement of the footing and compression of the soil immediately below the footing but does not affect the soil outside the loaded area. Punching shear failure occurs in loose or compressible soils, in weak soils under slow (drained) loading, and in dense sands for deep footings subjected to high loads.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	IPS - Long-Term Drained (Punching or Local Shear; 50.5 ft Backfill)
Date:	11/19/2021

ϕ_f	18.0	deg
c	0	psf
γ	70.0	pcf
D_w	9.5	ft
B	43.00	ft
L	82.00	ft
D_f	50.50	ft
θ		deg
V		kip
H		kip

q_n **18.3** **ksf**

N_{cm} **15.87927**

N_c	13.1
s_c	1.212158
i_c	1

N_{qm} **7.551839**

N_q	5.3
s_q	1.170385
d_q	1.217442
i_q	1

$N_{\gamma m}$ **3.24**

N_γ	4.1
s_γ	0.790244
i_γ	1

q_n **18.29696** **ksf**

C_{wq}	0.594059
$C_{w\gamma}$	0.5

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

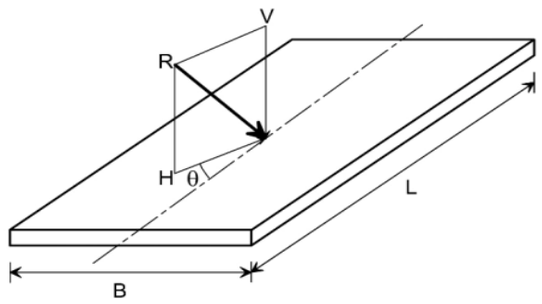


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

10.6.3.1.2b—Considerations for Punching Shear

If local or punching shear failure is possible, the nominal bearing resistance shall be estimated using reduced shear strength parameters c^* and ϕ^* in Eqs. 10.6.3.1.2b-1 and 10.6.3.1.2b-2. The reduced shear parameters may be taken as:

$$c^* = 0.67c \qquad (10.6.3.1.2b\text{-}1)$$

$$\phi^* = \tan^{-1}(0.67\tan\phi_f) \qquad (10.6.3.1.2b\text{-}2)$$

where:

c^* = reduced effective stress soil cohesion for punching shear (ksf)
ϕ^* = reduced effective stress soil friction angle for punching shear (degrees)

C10.6.3.1.2b

Local shear failure is characterized by a failure surface that is similar to that of a general shear failure but that does not extend to the ground surface, ending somewhere in the soil below the footing. Local shear failure is accompanied by vertical compression of soil below the footing and visible bulging of soil adjacent to the footing but not by sudden rotation or tilting of the footing. Local shear failure is a transitional condition between general and punching shear failure. Punching shear failure is characterized by vertical shear around the perimeter of the footing and is accompanied by a vertical movement of the footing and compression of the soil immediately below the footing but does not affect the soil outside the loaded area. Punching shear failure occurs in loose or compressible soils, in weak soils under slow (drained) loading, and in dense sands for deep footings subjected to high loads.

AECOM

IPS Electrical – Spot Footings

Drained and Undrained

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	IPS Electrical - Undrained
Date:	11/19/2021

ϕ_f	0.0	deg
c	750	psf
γ	112.0	pcf
D_w	3.5	ft
B	7.00	ft
L	7.00	ft
D_f	3.50	ft
θ		deg
V		kip
H		kip

q_n	**5**	**ksf**
N_{cm}	**6.168**	
N_c	5.14	
s_c	1.2	
i_c	1	
N_{qm}	**1**	
N_q	1	
s_q	1	
d_q	1	
i_q	1	
$N_{\gamma m}$	**0**	
N_γ	0	
s_γ	1	
i_γ	1	
q_n	**5.018**	**ksf**
C_{wq}	1	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

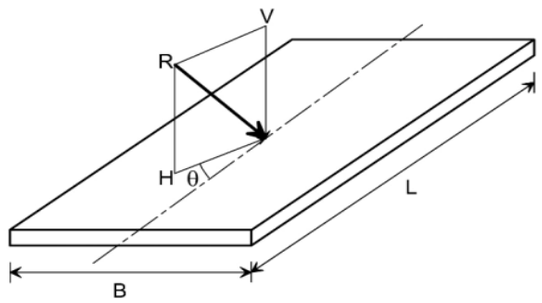


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	IPS Electrical - Drained
Date:	11/19/2021

ϕ_f	26.0	deg
c	0	psf
γ	112.0	pcf
D_w	3.5	ft
B	7.00	ft
L	7.00	ft
D_f	3.50	ft
θ		deg
V		kip
H		kip

q_n	**8.4**	**ksf**
N_{cm}	**34.2**	
N_c	22.3	
s_c	1.533632	
i_c	1	
N_{qm}	**17.70402**	
N_q	11.9	
s_q	1.487733	
d_q	1	
i_q	1	
$N_{\gamma m}$	**7.5**	
N_γ	12.5	
s_γ	0.6	
i_γ	1	
q_n	**8.409975 ksf**	
C_{wq}	1	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

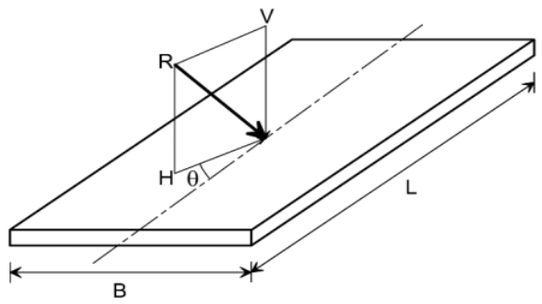


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

AECOM

IPS Odor Control

Drained and Undrained

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	Odor Control near IPS - Undrained
Date:	11/19/2021

ϕ_f	0.0	deg
c	750	psf
γ	112.0	pcf
D_w	2.5	ft
B	30.00	ft
L	72.00	ft
D_f	2.50	ft
θ		deg
V		kip
H		kip

q_n	**4.5**	**ksf**
N_{cm}	**5.568333**	
N_c	5.14	
s_c	1.083333	
i_c	1	
N_{qm}	**1**	
N_q	1	
s_q	1	
d_q	1	
i_q	1	
$N_{\gamma m}$	**0**	
N_γ	0	
s_γ	1	
i_γ	1	
q_n	**4.45625**	**ksf**
C_{wq}	1	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)

N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)

D_f = footing embedment depth (ft)

B = footing width (ft)

C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)

s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)

d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)

i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

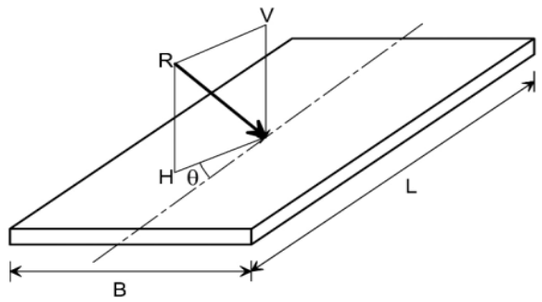


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	Odor Control near IPS - Drained
Date:	11/19/2021

ϕ_f	26.0	deg
c	0	psf
γ	112.0	pcf
D_w	2.5	ft
B	30.00	ft
L	72.00	ft
D_f	2.50	ft
θ		deg
V		kip
H		kip

q_n	**12.8**	**ksf**
N_{cm}	**27.25833**	
N_c	22.3	
s_c	1.222347	
i_c	1	
N_{qm}	**14.31834**	
N_q	11.9	
s_q	1.203222	
d_q	1	
i_q	1	
$N_{\gamma m}$	**10.41667**	
N_γ	12.5	
s_γ	0.833333	
i_γ	1	
q_n	**12.75914**	**ksf**
C_{wq}	1	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

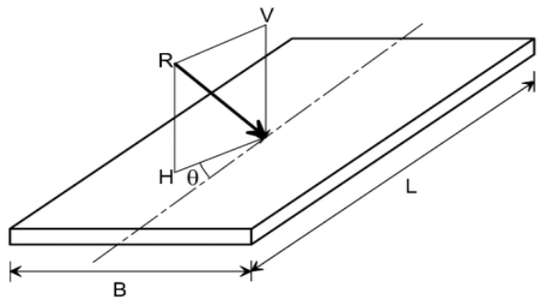


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

AECOM

IPS Generator Pad and Fuel Tanks

Drained and Undrained

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	Generator Pad near IPS - Undrained
Date:	11/19/2021

ϕ_f	0.0	deg
c	750	psf
γ	112.0	pcf
D_w	2.5	ft
B	44.00	ft
L	80.00	ft
D_f	2.50	ft
θ		deg
V		kip
H		kip

q_n	**4.6**	**ksf**
N_{cm}	**5.7054**	
N_c	5.14	
s_c	1.11	
i_c	1	
N_{qm}	**1**	
N_q	1	
s_q	1	
d_q	1	
i_q	1	
$N_{\gamma m}$	**0**	
N_γ	0	
s_γ	1	
i_γ	1	
q_n	**4.55905**	**ksf**
C_{wq}	1	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \; q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

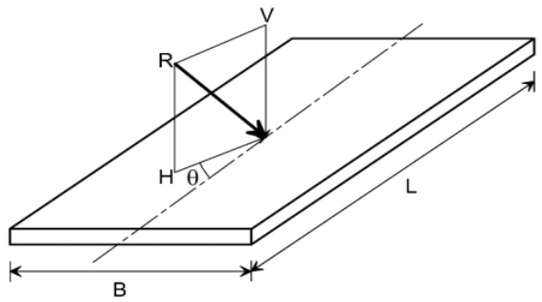


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	Generator Pad near IPS - Drained
Date:	11/19/2021

ϕ_f	26.0	deg
c	0	psf
γ	112.0	pcf
D_w	2.5	ft
B	44.00	ft
L	80.00	ft
D_f	2.50	ft
θ		deg
V		kip
H		kip

q_n	**16.2**	**ksf**
N_{cm}	**28.845**	
N_c	22.3	
s_c	1.293498	
i_c	1	
N_{qm}	**15.09221**	
N_q	11.9	
s_q	1.268253	
d_q	1	
i_q	1	
$N_{\gamma m}$	**9.75**	
N_γ	12.5	
s_γ	0.78	
i_γ	1	
q_n	**16.23782**	**ksf**
C_{wq}	1	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)
N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)
γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)
s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)
d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)
i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

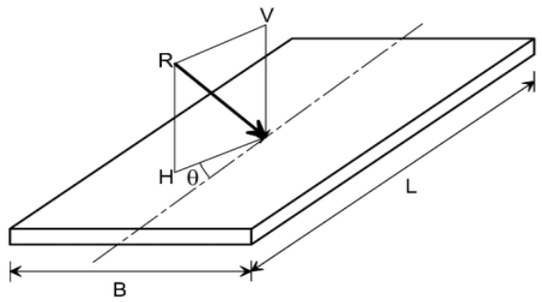


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	Fuel Tank near Generator Pad near IPS - Undrained
Date:	11/19/2021

ϕ_f	0.0	deg
c	750	psf
γ	112.0	pcf
D_w	2.5	ft
B	12.00	ft
L	35.00	ft
D_f	2.50	ft
θ		deg
V		kip
H		kip

q_n	**4.4**	**ksf**
N_{cm}	**5.492457**	
N_c	5.14	
s_c	1.068571	
i_c	1	
N_{qm}	**1**	
N_q	1	
s_q	1	
d_q	1	
i_q	1	
$N_{\gamma m}$	**0**	
N_γ	0	
s_γ	1	
i_γ	1	
q_n	**4.399343 ksf**	
C_{wq}	1	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)

N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)

D_f = footing embedment depth (ft)

B = footing width (ft)

C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)

s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)

d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)

i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

φ_b = resistance factor specified in Article 10.5.5.2.2
q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

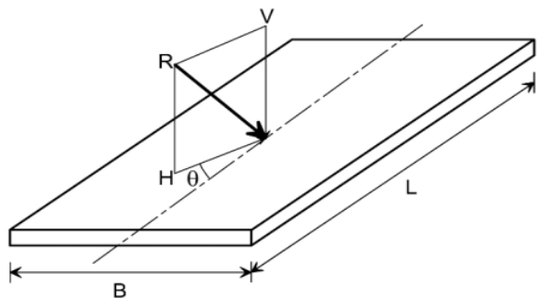


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

AASHTO (2017) Bearing Resistance of Soil

Client:	SLC Department of Public Utilities
Project:	SLC WRF IPS (near 1200 W)
Project No.:	60664196
Analysis:	Fuel Tank near Generator Pad near IPS - Drained
Date:	11/19/2021

ϕ_f	26.0	deg
c	0	psf
γ	112.0	pcf
D_w	2.5	ft
B	12.00	ft
L	35.00	ft
D_f	2.50	ft
θ		deg
V		kip
H		kip

q_n	**7.5**	**ksf**
N_{cm}	**26.38**	
N_c	22.3	
s_c	1.18296	
i_c	1	
N_{qm}	**13.88995**	
N_q	11.9	
s_q	1.167223	
d_q	1	
i_q	1	
$N_{\gamma m}$	**10.78571**	
N_γ	12.5	
s_γ	0.862857	
i_γ	1	
q_n	**7.513186 ksf**	
C_{wq}	1	
$C_{w\gamma}$	0.5	

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma} \qquad (10.6.3.1.2a\text{-}1)$$

in which:

$$N_{cm} = N_c s_c i_c \qquad (10.6.3.1.2a\text{-}2)$$

$$N_{qm} = N_q s_q d_q i_q \qquad (10.6.3.1.2a\text{-}3)$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma \qquad (10.6.3.1.2a\text{-}4)$$

where:

c = cohesion, taken as undrained shear strength (ksf)

N_c = cohesion term (undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

N_q = surcharge (embedment) term (drained or undrained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

N_γ = unit weight (footing width) term (drained loading) bearing capacity factor as specified in Table 10.6.3.1.2a-1 (dim)

γ = total (moist) unit weight of soil above or below the bearing depth of the footing (kcf)

D_f = footing embedment depth (ft)

B = footing width (ft)

C_{wq},$C_{w\gamma}$ = correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2 (dim)

s_c, s_γ,s_q = footing shape correction factors as specified in Table 10.6.3.1.2a-3 (dim)

d_q = correction factor to account for the shearing resistance along the failure surface passing through cohesionless material above the bearing elevation as specified in Table 10.6.3.1.2a-4 (dim)

i_c, i_γ, i_q = load inclination factors determined from Eqs. 10.6.3.1.2a-5 or 10.6.3.1.2a-6, and 10.6.3.1.2a-7 and 10.6.3.1.2a-8 (dim)

$$q_R = \varphi_b \, q_n \qquad (10.6.3.1.1\text{-}1)$$

where:

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q_n = nominal bearing resistance (ksf)

For $\phi_f = 0$:

$$i_c = 1 - (nH/cBLN_c) \qquad (10.6.3.1.2a\text{-}5)$$

For $\phi_f > 0$:

$$i_c = i_q - [(1 - i_q)/(N_q - 1)] \qquad (10.6.3.1.2a\text{-}6)$$

in which:

$$i_q = \left[1 - \frac{H}{(V + cBL\cot\phi_f)}\right]^n \qquad (10.6.3.1.2a\text{-}7)$$

$$i_\gamma = \left[1 - \frac{H}{V + cBL\cot\phi_f)}\right]^{(n+1)} \qquad (10.6.3.1.2a\text{-}8)$$

$$n = [(2 + L/B)/(1 + L/B)]\cos^2\theta + [(2 + B/L)/(1 + B/L)]\sin^2\theta \qquad (10.6.3.1.2a\text{-}9)$$

where:

B = footing width (ft)
L = footing length (ft)
H = unfactored horizontal load (kips)
V = unfactored vertical load (kips)
θ = projected direction of load in the plane of the footing, measured from the side of length L (degrees)

In practice, therefore, for footings with modest embedment, consideration may be given to omission of the load inclination factors.

Figure C10.6.3.1.2a-1 shows the convention for determining the θ angle in Eq. 10.6.3.1.2a-9.

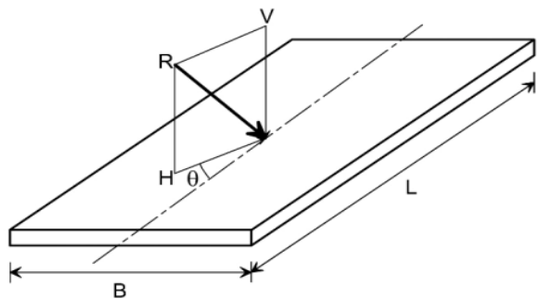


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

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Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
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	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

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Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The parent information from which Table 10.6.3.1.2a-4 was developed covered the indicated range of friction angle, ϕ_f. Information beyond the range indicated is not available at this time.

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

Salt Lake City Water Reclamation Facility Influent Pump Station Settlement Calculation

Purpose

This memorandum details the approach and methodology used to calculate estimates of settlement for several facilities in the area of the proposed Influent Pump Station (IPS) at the New Salt Lake City Water Reclamation Facility (New WRF). The IPS facilities include the IPS Electrical Building, IPS generator pad, IPS odor control, and Influent Force Main Sewer. IPS facilities are planned to be supported on mat foundations and/or other shallow foundations This document summarizes the data, assumptions, and methodology used in the settlement calculation, as well as the resulting settlement estimates.

AECOM performed geotechnical explorations of subsurface conditions within, or in the vicinity of, the footprint of proposed IPS facilities. The subsurface exploration program for the new IPS facilities was performed between July 2018 and August 2021. The explorations performed by AECOM included 22 CPTs and 20 exploratory borings. Additionally, two (2) CPTs and eight (8) exploratory borings were performed by Intermountain GeoEnvironmental Services, Inc. (IGES) of South Salt Lake, a subconsultant to AECOM, within the footprint of the proposed IPS facilities. The summary of exploration information is provided in Table 1. Spectral Analysis of Surface Waves (SASW) and Multichannel Analysis of Surface Waves (MASW) were also performed between September 10, 2018, and September 15, 2018, to help assess seismic site class in the project area. Laboratory testing was performed on selected samples collected from the borings in order to help select engineering properties of encountered subsurface materials.

Table 1. Summary of IPS Explorations

Field Investigation	Ground Surface Elevation [1] (feet)	Total Depth (feet)	Groundwater Depth [2] (feet)
CP18-PC-1	4221.6	120.1	9.8
CP20-IPSEL-01	4222.6	60.2	9.2
BH19-ES-1	4221.4	120.0	-
BH19-ES-2	4221.0	122.0	-
BH19-IT-1	4221.4	120.1	-
BH19-IT-5	4215.6	60.0	-
BH19-IT-6	4217.8	58.0	-
CP19-ES-1	4221.4	120.1	10.0
CP19-ES-2	4221.0	120.1	9.8
CP21-OIPS-01	4217.6	86.5	0.6
CP21-OIPS-02	4217.5	85.5	9.4
CP21-OIPS-03	4217.9	85.5	12.5
CP21-OIPS-04	4221.0	88.4	10.8
CP21-OIPS-05	4217.4	137.5	10.0
CP21-OIPS-06	4216.0	85.1	9.1
CP21-OIPS-07	4216.5	160.8	7.6
CP21-OIPS-08	4215.7	131.4	11.2
B21-OIPS-01	4217.5	52.0	-
B21-OIPS-02	4217.1	52.0	-
B21-OIPS-03	4218.1	49.0	-
B21-OIPS-04	4219.9	52.0	-
B21-OIPS-05	4217.2	102.0	-
B21-OIPS-06	4216.5	52.0	-

Field Investigation	Ground Surface Elevation [1] (feet)	Total Depth (feet)	Groundwater Depth [2] (feet)
B21-OIPS-07	4216.5	100.0	-
B21-OIPS-08	4216.1	102.0	-
B21-OIPS-09	4215.6	102.0	-
CP19-ITW-3[3]	4217.5	50.0	3.3
CP19-ITW-4[3]	4214.1	50.0	5.4
BH19-ITW-0[3]	4219.0	52.0	-
BH19-ITW-1[3]	4216.8	52.0	-
BH19-ITW-2[3]	4217.0	42.0	-
BH19-ITW-3N[3]	4218.0	52.0	-
BH19-ITW-3S[3]	4214.8	52.0	-
BH19-ITW-4[3]	4216.1	52.0	-
BH19-ITW-5[3]	4215.1	52.0	-
BH19-ITW-6[3]	4216.5	52.0	-
CP20-IS-01	4218.9	124.0	12.1
CP20-IS-02	4215.9	75.1	8.5
CP20-IS-03	4214.8	120.9	7.4
CP20-IS-04	4217.2	75.1	9.4
CP20-IS-05	4216.0	120.1	6.6
CP21-IS-06	4218.0	123.9	7.4
CP21-IS-07	4215.4	122.1	3.3
CP21-IS-08	4216.9	120.1	4.4
CP21-IS-09	4217.1	75.4	2.7
CP21-IS-10	4215.6	120.3	2.9
B21-IS-01	4215.6	37.0	-
B21-IS-02	4215.9	32.0	-
B21-IS-03	4216.0	35.0	-
B21-IS-04	4218.1	37.0	-
B21-IS-05	4215.6	35.0	-
B21-IS-06	4216.9	37.0	-

Notes: ft = feet; '-' denotes a blank entry

1. Surveyed elevation is based on North American Vertical Datum of 1988. Northing and Easting coordinates are provided on the boring logs in North American Datum of 1983 based on the Utah Central State Plane Projection
2. Because of the selected mud-rotary drilling method for borings, the groundwater depth was neither readily observed nor measured in the field. For CPT explorations, the groundwater depth is inferred, based on the results of the shallowest pore pressure dissipation test performed within each sounding, assuming 100 percent hydrostatic conditions.
3. Exploration was overseen by Intermountain GeoEnvironmental Services, Inc. of South Salt Lake, a subconsultant to AECOM.

CPT soundings were completed using a piezocone penetrometer with a 15-square-centimeter (cm^2) tip and net area ratio of 0.8. Pore pressure dissipation (PPD) tests were performed at select depths in the cone penetration soundings. Groundwater depths reported in Table 1 are generally calculated from the equilibrium pore pressure measured in the shallowest PPD test for each CPT sounding.

Exploratory borings were completed with a CME-75 truck-mounted drill, equipped with a 4-7/8-inch drag bit, or a CME-55 track-mounted drill rig equipped with a 3-3/4-inch outer diameter drag bit. Penetration resistances were obtained from the number of hammer blows observed to drive a split-spoon standard penetration test (SPT) sampler using a 140-pound automatic hammer dropped from a height of 30 inches. The resistance to sampler penetration into a subsurface layer is noted as blow counts (N) on the logs and refers to the number of hammer blows to advance the sampler a distance of 12 inches, beginning after 6-inches of penetration into the subsurface materials (i.e. the number of hammer blows for 18 inches of sampler penetration minus the number of hammer blows for the first 6 inches of penetration). Based on recent calibration testing, the calibrated energy transfer ratio may be assumed to be 87 percent for the hammer equipped on the CME-75 drilling equipment. Calibration for energy transfer was not available for the hammer equipped on the CME-55 drill used by Inberg-Miller Engineers until after this study was essentially complete; consequently, an energy transfer ratio of 85 percent was assumed based on experience with similar equipment. Laboratory testing (including consolidation, moisture content, and unit weight testing) was performed on selected soil samples collected from exploratory borings; laboratory test results are

summarized in the remarks column of the corresponding boring log, near the depth where the tested sample was obtained, and laboratory test reports will be provided with the geotechnical report.

Assumptions

The following assumptions were made regarding this calculation and supporting data:

- Laboratory tests were performed in accordance with the referenced American Association of State Highway and Transportation Officials (AASHTO) or American Society for Testing and Materials (ASTM) standards and are reported accurately by the subcontracted testing facility.
- Samples tested in the laboratory are representative of the soil unit from which they were obtained. Further, the results of the testing are indicative of material properties for the soil unit.
- Casagrande's method for estimating pre-consolidation stress (maximum past pressure) is adequate for estimating the level of over-consolidation for plastic soils. For soil samples having an apparent variable virgin compression slope, the virgin compression slope within the anticipated stress range of the soil is appropriate for use in Casagrande's method for estimating pre-consolidation stress.
- Modeling of the pre-consolidation stress (maximum past pressure) using an over-consolidation ratio (OCR) adequately captures the over consolidation within a plastic soil layer.
- Immediate settlement is not affected by maximum past pressure, i.e., the nonplastic soils are normally consolidated and linear elastic.
- The estimated induced vertical stress (Boussinesq 1883) adequately predicts the vertical stress condition as it would be in the field.
- Elastic (immediate) settlement occurs as quickly as loads are placed and is completed by end of construction.
- Settlement estimates are based on preliminary structural foundation information for proposed IPS facilities, including structure dimensions, foundation type, bearing pressure, and bearing elevation. The results presented herein are considered valid for the preliminary structural foundation information received to date.
- Small amounts of immediate settlement that occur during facility construction are accommodated in the construction process and are not of consequence for post-construction settlement consideration.
- The effect of subsurface drains will be localized near the structure and will not significantly influence the pore pressure regime of the entire profile.
- If subsurface drains near hydraulic structures are used, drawdown of the water table in the immediate vicinity of the structure will be temporary (short duration), such as for draining and maintenance of facilities.

Methodology

Settlement estimation included development of an idealized soil profile based on encountered subsurface conditions and interpreted laboratory test results, construction of a settlement model to represent the stress history of the subsurface at the project site and construction of proposed facilities and surficial fills along an estimated project timeline, and interpretation of model and calculation results. Foundation settlement is based on applicable loads and considers elastic, consolidation, and secondary settlement components. Settlement estimation considers both total magnitude (immediate as well as primary and secondary consolidation) and time-rate of settlement.

Calculation Procedure

AECOM used Settle3 version 5.006 (Rocscience Inc. 2020) to perform immediate and primary consolidation settlement calculations for this project. This software package allows the user to estimate settlement using a one-dimensional (1-D) analysis under the irregular fill and structure loads anticipated at the project site.

One of the strengths of using Settle3 over other similar packages is that it uses Terzaghi's one-dimensional consolidation equation solved implicitly to calculate excess pore water pressure at any point in time. This method allows a user to model time-dependent settlement in single layer and multilayer clay soils. The software also allows the user to select the methods used to estimate the induced vertical stress within the soil profile. These methods include Boussinesq (1883), Westergaard (1938), a model for multilayer profiles with layers of varying stiffness using the method of images (Curran and Hammah

2006), and simple load spreading techniques. This versatility allows the user to characterize induced vertical stress and, consequently, characterize total and differential settlement. Induced vertical stresses were estimated using Boussinesq's solution (Boussinesq 1883) for vertical induced stresses in this analysis.

Settle3 requires the input of soil lithology and groundwater conditions to characterize the subsurface in addition to soil properties for each of the soil layers. Moist and saturated unit weights are required for all soil models. For granular, freely-draining soils, settlement is considered elastic and is estimated using a 1-D Young's modulus (constrained modulus). The constrained (1-D) Young's modulus can be obtained from the three-dimensional (3-D) Young's modulus using the following expression (Fellenius 2018):

$$E_s = \frac{E(1-v)}{(1+v)(1-2v)}$$

where, E_s = Constrained (1-D) Young's Modulus
E = 3-D Young's Modulus
v = Poisson's Ratio of the Soil

For clayey, slowly-draining soils, settlement is estimated using traditional consolidation parameters including C_c (virgin compression index), C_r (recompression index), C_v (coefficient of consolidation), C_α (secondary compression index), and $C_{\alpha r}$ (secondary recompression index), in conjunction with σ'_c (pre-consolidation stress), OCR, or OCM (over-consolidation margin). For simplicity, Settle3 allows the use of strain-based consolidation parameters, which are typically referred to as compression ratio (CR), recompression ratio (RR), secondary compression ratio (C_α'), and secondary recompression ratio ($C_{\alpha r}'$), rather than the traditional parameters based on void ratio (Fellenius 2018).

Settle3 allows the user to input soil units as a layer of uniform thickness and depth extending infinitely in all horizontal directions or to define lateral variation in lithology. However, in either case, the initial stress (total and effective) is calculated the same way; each is calculated vertically using only the stress due to gravity. Such a calculation is appropriate for analyses which consider construction of a new fill area or which use free-field soil properties (soil properties developed prior to fill placement). This is because the initial stress state is properly characterized by the calculation implemented in Settle3. Settle3 also accommodates redefining soil parameters with each time step to allow parameter adjustments, if needed, for various stages of the settlement analysis. This feature was utilized in the analysis, as discussed in the sections below.

A spreadsheet issued by Bartlett et al. (2017) for secondary compression evaluation was modified and used to perform estimates of secondary compression settlement for the IPS facilities. The spreadsheet was originally created to include a stress calculation for embankment loading. However, the spreadsheet was modified by AECOM to accommodate importation of stresses from Settle3 to apply the general secondary compression calculation procedure to the more complex loading conditions present at IPS facilities. Three parameters are imported from Settle3 for each facility: pre-consolidation pressure with depth prior to early fill placement activities, effective stress with depth at the end of early fill placement activities, and effective stress with depth under the final loading condition. In addition, the spreadsheet was modified to accommodate use of multiple correlations and/or secondary compression coefficients through the depth profile. Additional detail is provided in the Subsurface Material Characterization Section. Secondary compression calculations are included in Attachments 2 and 3.

Soil Profile

AECOM developed a generalized soil profile for the IPS facilities using available borehole and CPT data from the current work, shown in Table 2. Material characterization for the various soil models selected for idealized profile, as shown in Table 2, will be described in subsequent sections.

Subsurface explorations don't generally indicate the presence of fill materials in the area of the proposed IPS facilities. Primarily fine-grained deposits were encountered, with a few thin (about 4 feet in thickness, or less) coarse-grained sand layers dispersed throughout the soil profile. Based on the tested samples, fine-grained deposits appear to be composed primarily of very soft to stiff, medium- to high-plasticity fat clays; very soft to very stiff, low- to medium-plasticity lean clays; and nonplastic to low-plasticity silts with varying amounts of sand. Coarse-grained layers, which are dispersed through the subsurface profile, generally are composed of very loose to dense sands.

Table 2. Summary of Generalized Soil Profile for the IPS Facilities

Layer No.	Soil Model	Layer Thickness	Depth at Top of Layer (ft)	Depth at Bottom of Layer (ft)	Elevation at Top of Layer (ft)	Elevation at Bottom of Layer (ft)
-	Existing Fill Load	0	-	-	-	4217
1	Unsaturated Sand/Clay	8	0	8	4217	4209
2	Clay 1	11	8	19	4209	4198
3	Sand 1	4	19	23	4198	4194
4	Clay 2	10	23	33	4194	4184
5	Clay 3	27	33	60	4184	4157
6	Clay 4	15	60	75	4157	4142
7	Sand 2	7	75	82	4142	4135
8	Clay 5	29	82	111	4135	4106
9	Sand 2	2	111	113	4106	4104
10	Clay 5	7	113	120	4104	4097
11	Sand 2	2	120	122	4097	4095
12	Clay 5	4	122	126	4095	4091
13	Sand 2	8	126	134	4091	4083
14	Clay 5	2	134	136	4083	4081
15	Sand 2	2	136	138	4081	4079
16	Clay 5	20	138	158	4079	4059
17	Sand 2	10	158	168	4059	4049
18	Clay 5	32	168	200	4049	4017

Groundwater Conditions

Groundwater was encountered in the explorations at depths of approximately 2 to 14 feet below the ground surface (groundwater encountered at elevations ranging from 4,208 to 4,216 feet), near the proposed IPS facilities. It was assumed that the groundwater was defined by a constant elevation at the time of drilling for this site. Based on the subsurface explorations identified in Table 1, the groundwater was inferred to be at an approximate elevation of 4,207 feet, which corresponds to a depth of roughly 10 feet or so, relative to existing ground, depending on the ground surface elevation. PPD tests performed at the project site were plotted with elevation, and a pore pressure trend line was selected to represent existing pore water pressure conditions. The pore pressure trend line suggests that there is a slight artesian condition at the IPS site, corresponding to approximately 118% of hydrostatic pressure.

Subsurface Material Characterization

AECOM developed soil properties for each of the layers shown in Table 2. These soil parameters included unit weight, Young's modulus (nonplastic soils), and traditional consolidation theory parameters (plastic soils). The following subsections establish the basis for selecting each parameter used in this analysis.

Unit Weight

More than 100 unit weight test results were available from laboratory testing performed for the New WRF, and soil unit weight for generalized soil layers was selected based on a review of average unit weight for the depth ranges in which the various soil layers are applied in the settlement analysis for the IPS facilities. The selected soil unit weights for each generalized soil layer for the IPS facilities are shown in Table 3 (see Table 2 for generalized soil layers).

Table 3. Summary of Estimated Unit Weights for the IPS Facilities

Soil Layer Description	Soil Unit Weight (pcf)
Clay 1	113
Clay 2	113
Clay 3	113
Clay 4	113
Clay 5	113
Sand 1	113
Sand 2	115

Elastic Modulus

AECOM estimated immediate soil settlement using the linear stress-strain behavior of Young's modulus in conjunction with the induced vertical stress for each layer.

For this analysis, nonplastic soils (e.g. fine- and coarse-grained soils which have plasticity index equal to 0) were considered susceptible to immediate elastic settlement. A Young's modulus was developed for each nonplastic soil layer based on soil type and relative density. Each modulus was estimated based on the typical range of Young's modulus values presented in Table C10.4.6.3-1 of AASHTO (2017). Relative densities for soil units were based on corrected blow counts, (N1)60, for each soil unit and by comparing CPT tip resistance for layers without available blow counts.

Primary Consolidation Parameters

AECOM estimated primary consolidation settlement using log-linear stress-strain behavior and conventional methods in conjunction with the induced vertical stress for each layer.

For this analysis, only plastic soils (fine-grained soils, which were tested with a plasticity index equal to 1, or more) were considered susceptible to consolidation settlement. Strain-based consolidation parameters were interpreted from laboratory test data completed on plastic soil samples. The compression ratio, CR, was interpreted as the steepest slope between two points on the virgin compression portion of the log-linear consolidation curve. Some samples showed flattening of the virgin compression slope for higher load stages. The steeper portion (higher compression ratio) was selected for these samples in part because the lower stress range of virgin compression is more representative of the stress range to which the soil layers will be subjected. The recompression ratio, RR, was interpreted as the steepest slope between two points on the unloading portion of the log-linear consolidation curve. The coefficient of consolidation, C_v, was conservatively selected from values reported by the testing laboratory for an appropriate range of stresses. Consolidation test results were plotted with elevation and developed parameters for the generalized soil layers used in the analysis. The Casagrande (1936) method was used for evaluating the pre-consolidation pressure for a given sample. For soil samples having an apparent variable virgin compression slope, the virgin compression slope within the anticipated stress range of the soil was used in Casagrande's method for estimating pre-consolidation stress. Parameters were selected to investigate settlement that could occur for the IPS facilities. Settlement parameters used in the analysis are presented in Table 4 and are influenced by test results obtained from explorations at the New WRF main plant site and by encountered materials in explorations at the IPS site. Examples of the interpretations of laboratory consolidation tests are provided in Attachment 4.

AECOM used the OCR as a measure of the level of over-consolidation in a soil layer. The selected primary consolidation parameters are presented in Table 4.

The recompression coefficient for each clay layer was reduced for all stages following early fill activities. Based on experience, engineering judgment, and review of case histories (Lee et al., 2013; Asadi & Sokhango, 2018; Dong, 2014; Ou et al., 1998; Tan et al., 2018; Tan & Wang, 2013a; Tan & Wang, 2013b), it is our opinion that actual rebound is often less than rebound estimated using the full recompression coefficients, on the order of one-third to one-half of the rebound estimated using full coefficients. Two abandoned clarifiers located in the existing WRF were taken out of service in the early 2000's. Staining on the tank base next to adjacent pavement suggests that rebound occurred after unloading the fluid weight from the tanks when they were taken out of service. Field measurements taken at three locations on each of the two tanks had an average estimated rebound of 1.7 inches from an estimated unloaded fluid weight of 0.67 ksf. This corresponds to

approximately 2.6 inches of rebound per 1 ksf. This unit rebound from field measurements was compared with recompression estimates in Settle3 using reduction factors of one-third and one-half. The estimated recompression settlement using a recompression coefficient of one-third of the initial interpreted laboratory coefficient was close to the relationship developed from field measurements of tank rebound. Accordingly, for settlement modeling of the IPS, a factor of one-third was applied to the recompression coefficients interpreted from laboratory data for each generalized soil layer in all model stages following early fill activities; this factor influences both rebound and recompression estimates. Table 9 presents a summary of our best estimate of primary consolidation parameters for the IPS. Figure 1 shows the nearby CPTs, the interpreted vertical effective stress, OCR values, and our best-estimated OCRs based on the available AECOM and IGES consolidation tests. In addition, Figure 2 shows interpreted compression ratio, CR, and re-compression ratio, RR, for the laboratory test data, and the nearby CPTs. The selected best estimate trend for each of these parameters is also plotted on the graphs in each figure.

We observed a significant portion of interbedded silt in some of the clay layers and to take its effect into account in our model we reduced compression and recompression ratios proportional to the silt content of the clay layer. For example, clay layer 1 had 40% silt content, so we reduced its RR and CR by 40%. In some of the layers, where percentage of interbedded silt varied significantly (such as clay layer 3) we broke them into sublayers and separately assigned a reduction factor to RR and CR of each sublayer proportional to its silt content rather than uniformly reducing RR/CR of the entire layer.

Table 4. Summary of Primary Consolidation Parameters for the IPS Facilities

Soil Layer Description	Compression Ratio, CR	Recompression Ratio, RR	Over-Consolidation Ratio, OCR	Coefficient of Consolidation, Cv (ft^2/day)
Clay 1	0.2	0.045	1.6	0.4
Clay 2	0.24	0.025	1.6	1.1
Clay 3	0.14	0.03	1.15	1.3
Clay 4	0.25	0.05	1.3	0.8
Clay 5	0.27	0.045	1.9	1.1

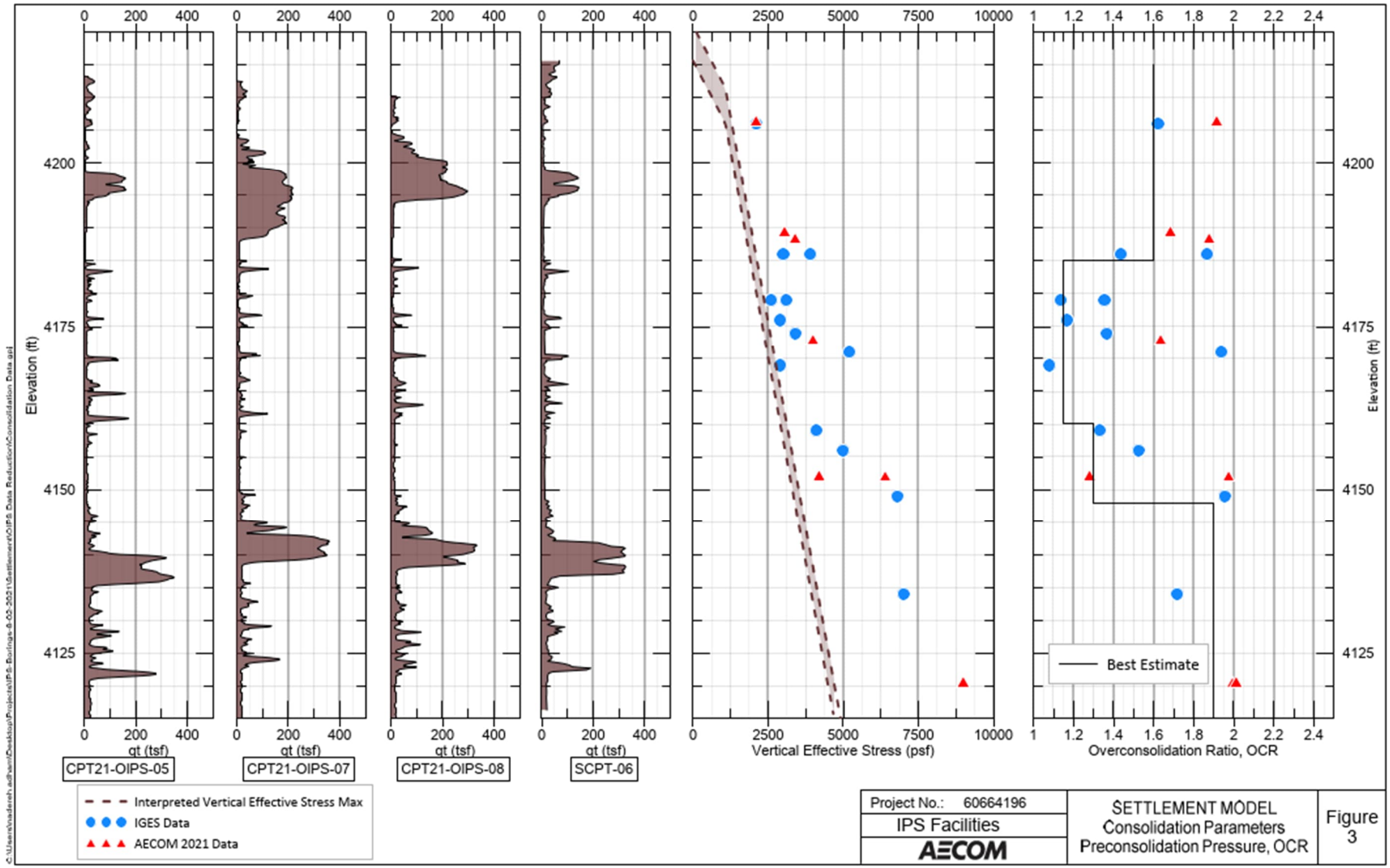


Figure 1. Interpreted vertical effective stress, and over-consolidation ratio for the IPS Facilities.

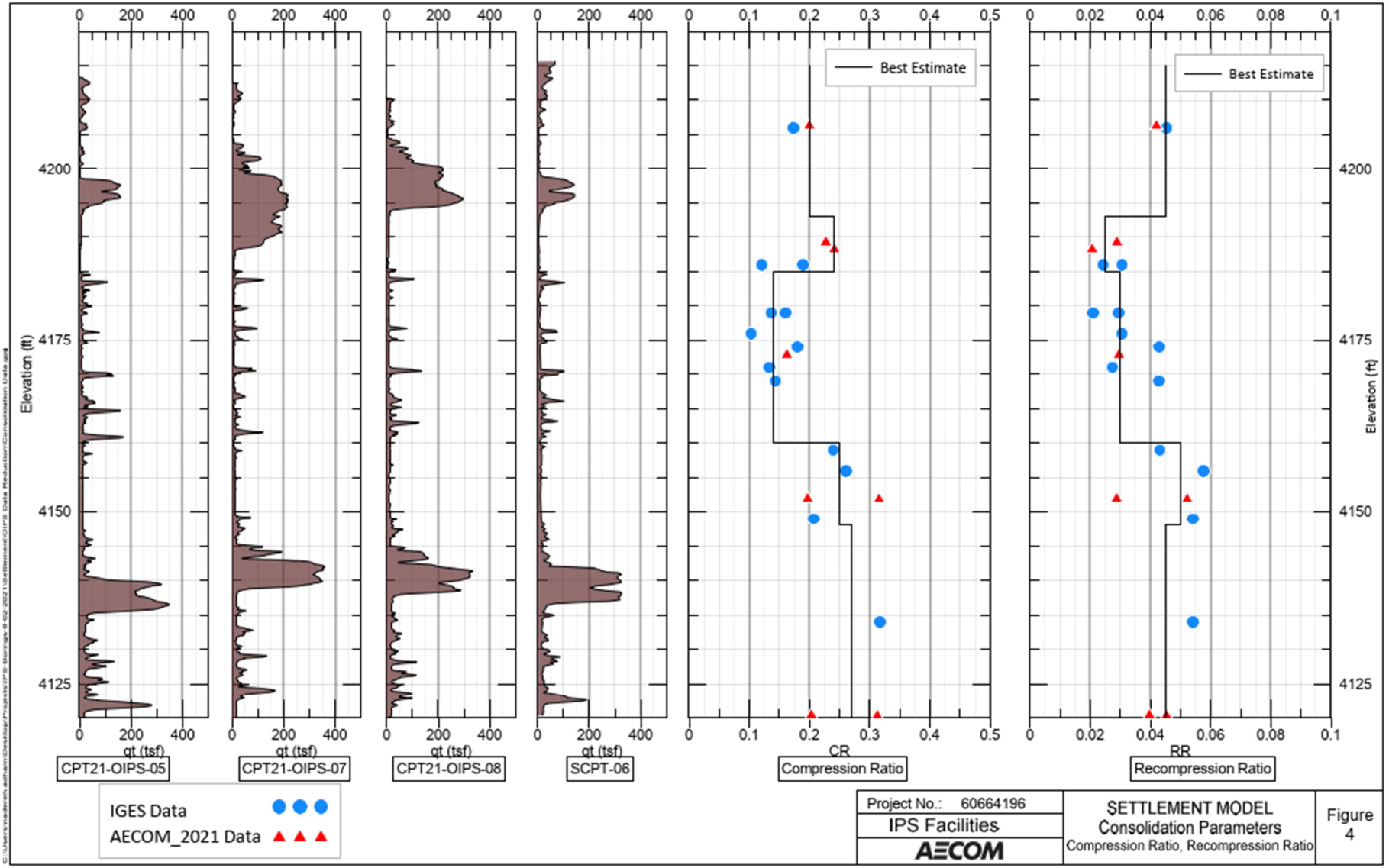


Figure 2. Interpreted compression ratio and re-compression ratio for the IPS Facilities.

Secondary Compression Parameters

AECOM considered secondary soil volume reduction associated with plastic adjustment of the soil fabric (Das 2006) using the secondary compression ratio, C_α'. For this analysis, only plastic soils were considered susceptible to secondary compression settlement. AECOM reviewed a secondary compression study conducted by Bartlett et al. (2017) for data along the Wasatch Front in addition to site-specific data, which included available time-rate of consolidation test results. Though secondary compression tests were not included in the laboratory testing program, secondary compression coefficients were estimated from logarithm of time consolidation plots for some samples for which the load increment appeared to have been kept in place beyond the end of primary consolidation. Bartlett et al. recommend relationships between C_α' and CR based on data tested along the Wasatch Front included in the 2017 study. An average C_α'/CR ratio of 0.0442 is recommended in the study, though one of the study sites, 400 South in Salt Lake City, showed a higher average ratio of 0.0591. The 400 South site is located within a couple of miles of the New WRF, and a similar higher trend was observed in the laboratory test data in the depth range of 20 to 45 feet. The remainder of laboratory test data agreed relatively well with the general ratio recommended. Accordingly, the 400 South relationships from the 2017 study were used in the current analysis for the depth range of 20 to 45 feet, and the general relationships from the 2017 study were used in the current analysis for the clays above and below the depth range of 20 to 45 feet. The selected parameters for the IPS Facilities are summarized in . Interpretations of laboratory consolidation tests for IPS facilities are provided in Attachment 4.

A spreadsheet developed by AECOM based on conventional secondary settlement theory with subdivision of clay layers was used to perform estimates of secondary compression of the IPS structures. Secondary compression calculations are included in Attachments 2 and 3. Refer to the Calculation Procedure Section for additional information.

Table 5. Summary of Secondary Compression Parameters for the IPS Facilities

Soil Layer Description	Secondary Compression Ratio, C_α'
Clay 1	0.008
Clay 2	0.014
Clay 3 (outside the depth range of 20-45 feet)	0.006
Clay 3 (within the depth range of 20-45 feet)	0.008
Clay 4	0.012
Clay 5	0.012

Fill Loads

To represent finished grade in the vicinity of the IPS facilities, fill loads were applied up to finished grade elevation, which is anticipated to be at 4,221.5 feet.

Excavation

Excavation is anticipated prior to facility construction to depths at or below the bearing elevation of the respective facilities. To represent excavation of material, negative loads were applied within the footprint of the structure at the excavation stage. Whereas the site fill load to finished grade is modeled as a single load across the area of the IPS facilities, correction loads were applied at the same bearing contact of the fill/native transition to negate all or a portion of the finished grade fill load, where necessary, within the footprint of structures. For facilities having additional excavation below the estimated native ground surface, additional negative loads were applied at the bearing elevation of the structures. Where excavations extended below the estimated groundwater elevation, effective soil weights were removed, leaving pore pressures in place for the settlement calculation.

Foundations

Spread, strip, and mat foundations for proposed IPS facilities were modeled as polygonal flexible loads placed at design structure elevations according to preliminary site plans and bearing pressures provided by the design team. Bearing pressures and elevations for shallow foundations are summarized in Table 6. Where structures bear below the estimated groundwater elevation, bearing pressures were reduced by the buoyant force of the displaced water.

Table 6. Summary of IPS Foundation Loads in Settle3

Facility	Foundation Type	Permanent Bearing Pressure (psf)	Estimated Percentage of Bearing Pressure Applied During Construction[1] (%)	Bearing Elevation[2] (ft)	Bearing Depth in Settlement Model / Neutral Plane Depth in Model (ft)
Influent Pump Station	Mat	5000 to 5800 [3]	85[4]	4168-4171	52
IPS Electrical Building	Strip/Spread Footings	1500[5]	100	4217.5 - 4218.5	0
IPS Odor Control	Mat	500	100	4218.5-4219.5	0
IPS Generator Pad	Mat	300	100	4218.5-4219.5	0

Notes:

1. A percentage of the total permanent bearing pressure was applied at the Construction stage for time-dependent analysis; the remainder of the permanent bearing pressure was applied at the Commissioning stage (see Table 7). Estimates for several major structures (see note 4) were provided by structure designers, and these were used to inform other estimates.
2. For some structures, bearing elevation and structure dimensions were still under revision at the time these calculations were performed.
3. Proposed foundation has eccentric loading.
4. Estimated percentage of bearing pressure applied at construction stage was provided by the structural team and rounded down to the nearest 5%. See note 1.
5. IPS Electrical building is going to be supported on 10 7'x7' spread footings with permanent bearing pressure of each being 1500 psf.

Load Staging

To model settlement with time and estimate settlement that will occur throughout construction stages, AECOM prepared Settle3 models with time stages. Settle3 reports the settlement at the beginning of each time stage. A preliminary construction schedule for the IPS Facilities was considered in selection of the simplified time stages. The time stages created in Settle3 and a description of loads at each time stage for the IPS Facilities are displayed in Table 7.

Table 7. Summary of Time Stages in Settlement Model for the IPS Facilities

Time Stage Name	Model Time (days)	Duration	Description of Loading/Model
Existing Conditions	0	1 day	Soil representative of existing conditions; no loads placed
Place New Fill	1	~8 months	Fill placed to estimated finished grade elevation (4221.5 feet)
Excavation	250	5 days	Corrections to finished grade fill are made, as needed; Additional material excavated down to bearing elevation of respective structure
Under-slab Backfill	255	5 days	Load placed at bearing elevation of IPS structure to represent 2 feet of structural backfill underneath IPS mat.
IPS Construction	260	1 day	Construction loads applied (percentages of loads ranging from 85-100% depending on nature of structure – see Table 6) Backfill added in IPS excavation surrounding IPS facility.
Day after lower construction	261	~1 month	No change to model
Connect Inlet	290	5 days	Load placed to represent weight of inlet wye.
Backfill Inlet	295	5 days	Load placed to represent backfill placed over the inlet wye.
Finish IPS Structure	300	~10 months	Additional load placed for IPS mat to represent construction of above-grade portion of IPS structure.
Commissioning	600	7 days	All the IPS Facilities receive 100% of total permanent load bearing pressure
1 Week PC	607	7 days	1 week Post-Construction (post commissioning); no loads placed
6 Months PC	782	~6 months	6 Months Post-Construction (post commissioning); no loads placed
50 Years PC	18850	~50 years	50 Years Post-Construction (post commissioning); no loads placed

Results

Estimated Surcharge (Early Grading) Settlement

The estimated settlement in the area of the IPS facilities that is induced by early grading activities to raise the existing grade to be near the final ground surface elevation, as measured at the ground surface, is summarized in Table 8. Figures showing the settlement due to early placement of fill material for IPS facilities are included in Attachment 1.

Table 8. Summary of Estimated Settlement induced by Fill Placement in the Area of the IPS Facilities

Facility	Fill-Induced Settlement (inches)
Influent Pump Station	3.1[1]
IPS Electrical Building	1.5[1]
IPS Odor Control	2.5[1]
IPS Generator Pad	1.7[1]

Notes:
1. IPS facilities are not being surcharged. The settlement values here are due to placement of early grading fill.

Rebound

It is anticipated that rebound will occur as a result of excavations and plant operations. Deep excavations prior to facility construction may induce rebound. A summary of estimated rebound for the relatively large, deep IPS facility is provided in Table 9, primarily based on bearing elevation and associated depth of excavation. There are numerous factors that could influence rebound in excavations; the magnitudes reported in the table are only estimates. Actual rebound magnitude could be more or less than that reported in the table. Much of the rebound resulting from excavation may occur during and shortly after excavation, but it should be expected that a portion of the rebound may need to be accommodated in construction of the facilities. During plant operations after commissioning of the new facilities, filling and emptying will result in recompression and rebound, respectively. The magnitude and duration of recompression and rebound depend on the amount of fluid weight removed or added and the rate at which the changes occur. Generally, in part based on field observations made for suspected rebound associated with decommissioned clarifiers in the existing WRF (see the discussion in the Primary Consolidation Parameters Section), it is anticipated that magnitude of rebound or recompression could be on the order of 1 to 3 inches.

Table 9. Estimated Excavation Rebound For the IPS

Facility	Bearing Elevation (ft)	Estimated Excavation Rebound[1] (in)
Influent Pump Station	4168-4171	1 to 3

Notes:
1. Estimated Excavation Rebound is affected by numerous factors and should be considered approximate. Actual excavation rebound may be more or less than the estimates provided.

Estimated Long-Term Settlement of Structures

Estimates of long-term settlement for the IPS facilities are summarized in Table 10. Long-term settlement is anticipated to be composed of recompression, a small amount of immediate settlement occurring during commissioning of the structures, and secondary compression settlement. The former two are reported together as Post-Construction Immediate and Recompression Settlement in the table. Figures showing Post-Construction Immediate, and Recompression Settlement approximated at the ground surface are included in Attachment 1. In addition, settlement approximated at the ground surface for the IPS facilities and at the bearing elevation for the IPS building are included in Attachment 1. Secondary settlement calculations are included in Attachments 2 and 3. Although settlement estimates have been reported to the nearest tenth of an inch, this level of precision is unrealistic for settlement estimates, and actual settlements may be more or less than those, which are reported.

Table 10. Summary of Estimated Long-Term Settlement for the IPS Facilities

Facility	Post-Construction Immediate and Recompression Settlement[1] (inches)	Secondary Compression Settlement[2] (inches)	Total Long-Term Settlement (inches)
Influent Pump Station	2.3	0.0	2.3
IPS Electrical Building	0.5	0.0	0.5
IPS Odor Control	1.0	0.4	1.4
IPS Generator Pad	0.8	0.0	0.8

Notes:

1. Settlement reported here is our estimate, based on field and laboratory data.
2. Secondary settlement is estimated for the design life of the proposed facility, which is assumed to be 50 years.

Estimated Differential Settlement

In addition to total settlement, differential settlement should be considered in design of the structures and appurtenant features. Settlement estimates suggest that significant long-term differential settlement could occur between structures. Differential settlement could also occur across structure footprints. Differential settlement across facilities and between facilities should be considered for its effect on the structures, connections, appurtenant facilities, and the hydraulic grade line for gravity flow systems. While some amount of settlement will occur at the ground surface immediately adjacent to the structures, as induced by the application of foundation and fill loads, differential settlements should be expected from the building footprint outward into the adjacent ground. Accordingly, utilities or features connecting into a structure from the outside could be adversely affected. Both immediate and long-term differential settlement (post construction immediate, recompression, and secondary settlement) need to be considered, and accommodations such as flexible connections at the Table 11. Summary of Secondary Compression Parameters for the IPS Facilities in the figures provided in Attachment 1, and differential Secondary Settlement calculations are provided in Attachment 3.

Estimates of differential settlement for the best estimate model of IPS facilities are summarized in Table 12. Differential settlement is estimated as the difference in settlement estimated at the center of the facility and a corner point located at approximately 1/8 of the facility's length and width or diameter in from the corner or outer extent of the facility. The differential settlement values are composed of secondary settlement and post-construction settlement. Table 12 includes estimated differential settlement of the IPS facilities, the distance between the center and outer point of the facility, and the associated angular distortion in radians.

To help limit the amount of differential settlement between the IPS structure and the bifurcating inlet wye, our analysis assumes the following construction items:

- Constructing the below grade portion of the IPS and backfilling the excavation up to finish grade where possible *before* connecting the bifurcating wye inlet to the IPS structure.
- For backfill material above the bifurcating wye, a material with an average saturated unit weight of 100 pcf or less is needed.
    - This could include an appropriate combination of geofoam, scoria, conventional backfill, or other suitable material, provided buoyancy is considered for materials susceptible to floating.

Although settlement estimates have been reported to the nearest tenth of an inch, this level of precision is unrealistic for settlement estimates, and actual settlements may be more or less than those, which are reported.

Table 12. Summary of Estimated Largest Differential Settlement of IPS Facilities

Facility Quadrant Point	Differential Settlement (in)	Distance from Center Point of Facility (ft)	Absolute Angular Distortion (radians)
IPS Building NW	0.3	33.7	0.001
IPS Electrical NW	0.1[1]	17.7	0.000
IPS Odor Control NW	0.6	29.2	0.002

Facility Quadrant Point	Differential Settlement (in)	Distance from Center Point of Facility (ft)	Absolute Angular Distortion (radians)
IPS Generator Pad NW	0.3	34.2	0.001

Notes: SW = Southwest; SE = Southeast; NW = Northwest; NE = Northeast.

1. Differential settlement for IPS Electrical building is calculated based on the difference between settlement of the inner spread footings and their adjacent corner footings.

Estimated Post-Earthquake Settlement

In addition to total settlement and differential settlement under permanent loads, post-earthquake liquefaction-induced settlement could occur during a seismic event. Estimated post-liquefaction settlement is discussed in detail and presented for specific facilities in the Liquefaction Calculation Package. For general reference, post-liquefaction settlement estimated to occur at the ground surface for the IPS facilities is less than about 2 inches, with post-liquefaction differential settlement estimated to occur at the bearing elevations of IPS facilities being less than 1 inch for most facilities. Post-liquefaction settlement may be non-uniform, and differential settlement could occur. Accordingly, the IPS Facilities, as well as adjacent sidewalks, flatwork, connections, and other appurtenant facilities may require maintenance and repairs following a seismic event.

Settlement estimation often is imprecise, and soil conditions are assessed based on limited points of investigation, limited soil samples, and limited laboratory testing. AECOM's estimates of settlement that are presented in this calculation package may be more or less than actual settlements, and the locations of maximum settlement may vary.

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Attachments

Attachment 1: Settlement Results Figures

Attachment 2: Secondary Settlement Calculations

Attachment 3: Differential Secondary Settlement Calculations

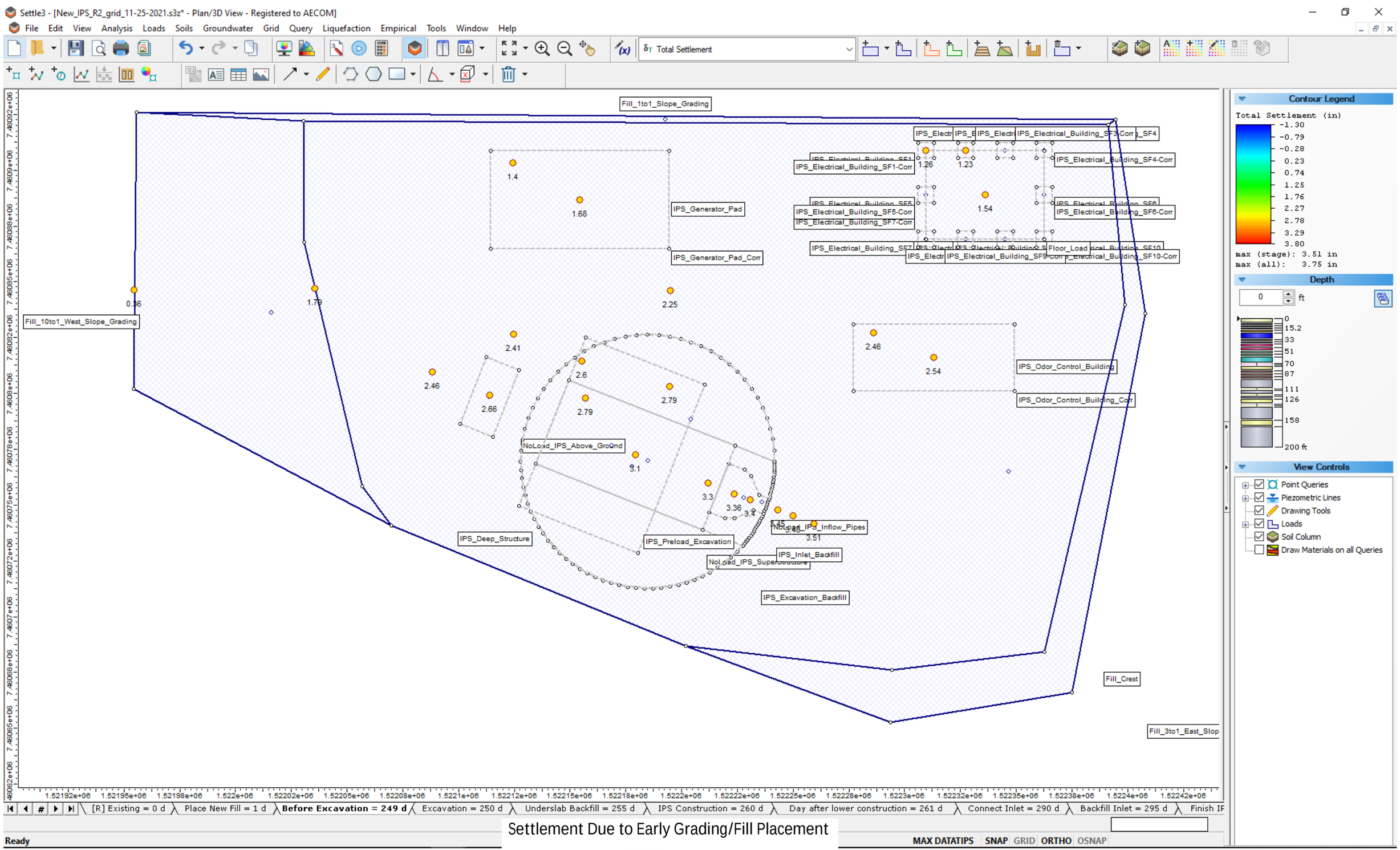
Attachment 4: Interpretations of Laboratory Consolidation Tests

Attachment 1

Settlement
Result Figures

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Settlement During Early Fill Placement at Ground Surface



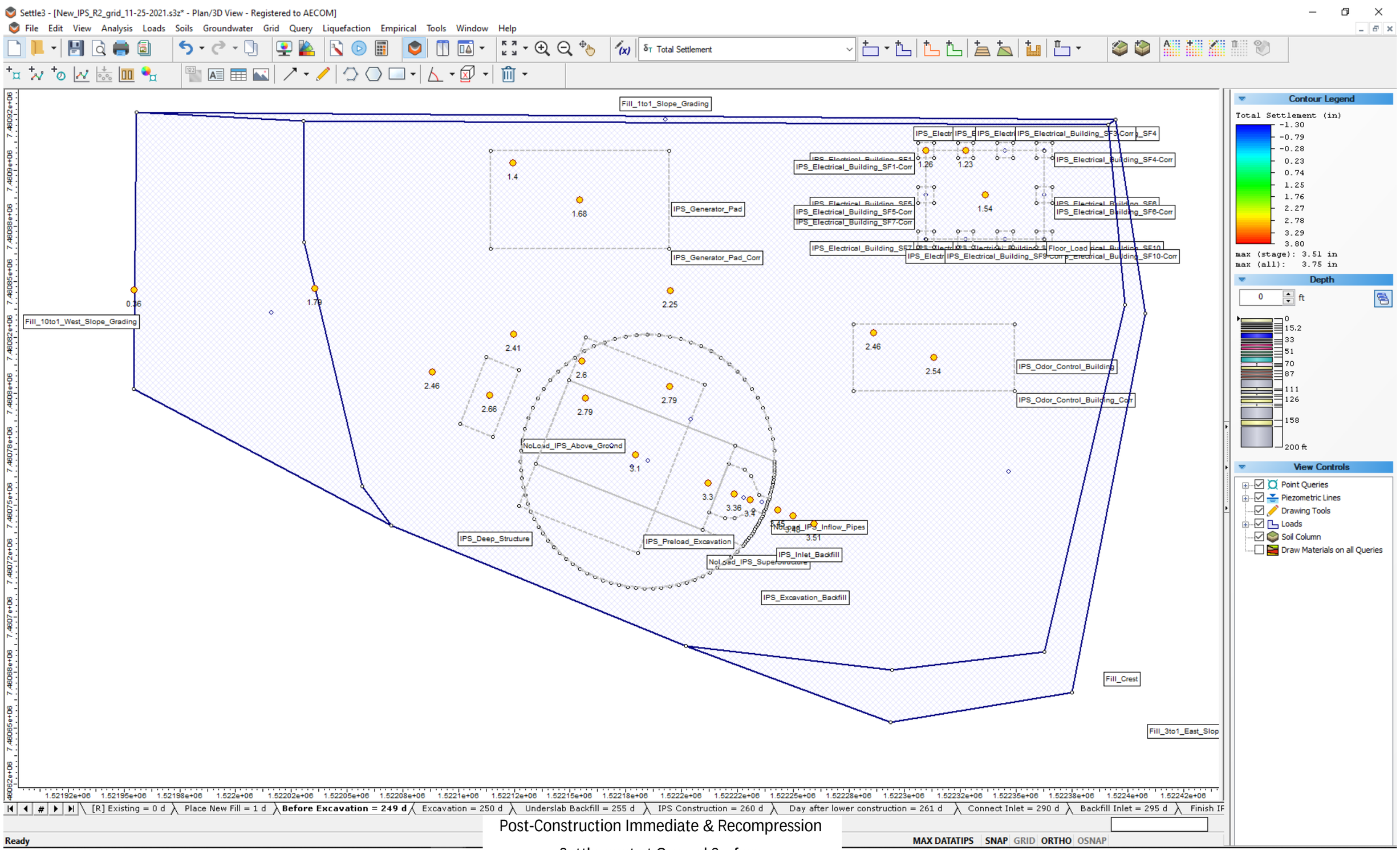
Settlement Due to Early Grading/Fill Placement

IPS Facilities

at Ground Surface

Best Estimate Parameters

Post-Construction Immediate & Recompression Settlement

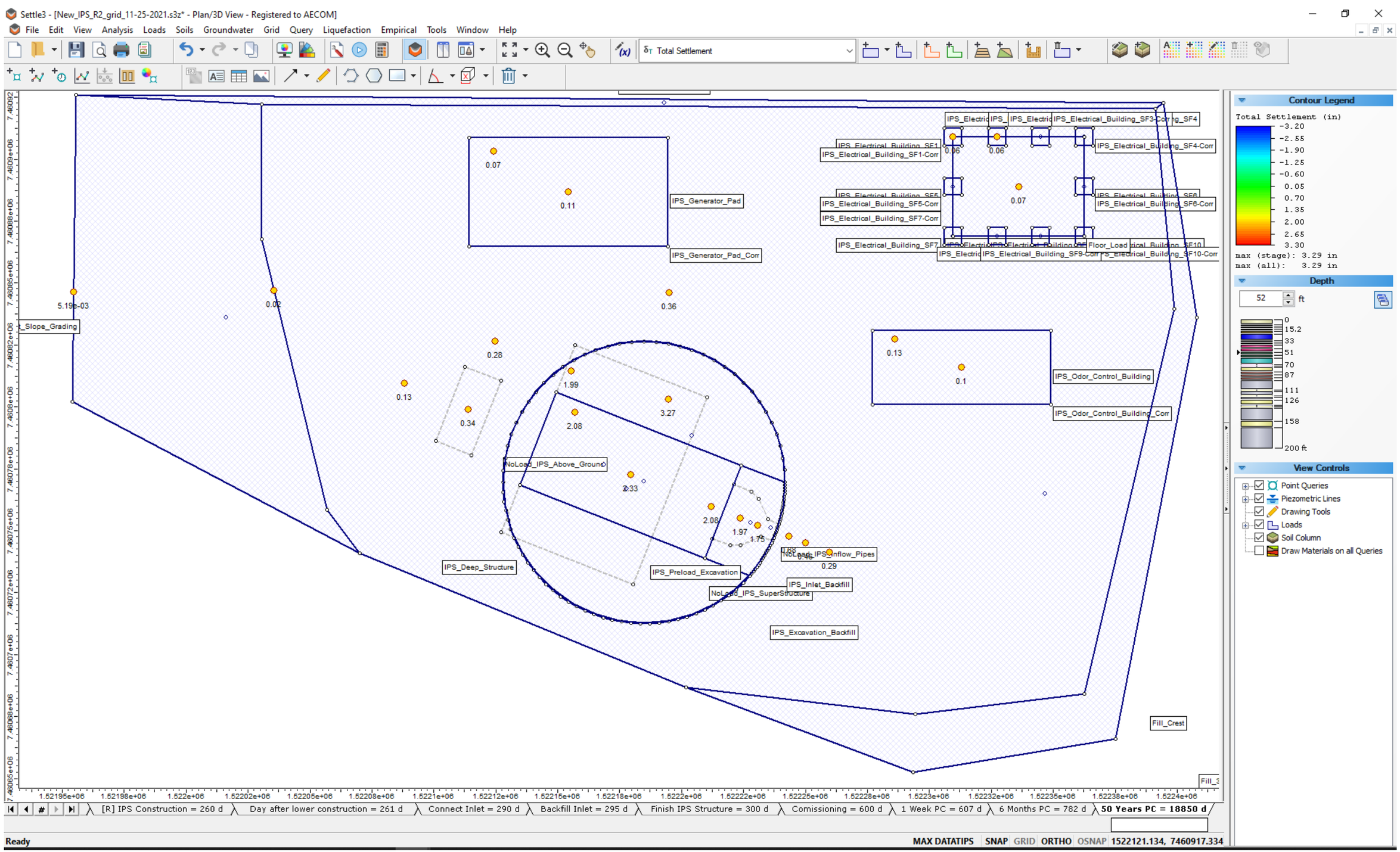


Post-Construction Immediate & Recompression

Settlement at Ground Surface

IPS Structures

Best Estimate Parameters



Post-Construction Immediate & Recompression

Settlement at Bearing Elevation

IPS Building

Best Estimate Parameters

Attachment 2: Secondary Settlement Calculations

Attachment 2

Secondary Settlement Calculations

Secondary Settlement

IPS Building

Secondary Settlement Calculation

Project: SLC WRF
Project No.: 60664196
Analysis: IPS_Center (QP 27)
Date: 11/29/2021

Depth of the base of the foundation (ft): 52

Final σ'v to existing σ'p ratio for triggering secondary: 1.05

Time from preloading to construction (months): 0

Average Degree of consolidation at the end of primary consolidation (%): 98

Using Terzaghi equations the required Tv is: 1.500

Depth of the profile in which secondary consolidation is considered (ft): 200

Dividing each layer into at least 3 sublayer(s) with a maximum sublayer thickness of 1 ft

Soil layer	H (ft)	Depth of bot. of layer (ft)	$H_{modified}$ (ft)	double drainage	C_v (ft^2/day)	T_v check	U_{avg} check	$C_{\alpha r}$	t_{EOP} (days)	$t_{const.}$ (days)	t (days)	Mid. Layer existing σ'_p (psf)	Mid. Layer final σ'_v (psf)	No. of Sublayers	layer contribution to settlement (%)	ΔH (in)
60% Clay 1; 40% Silt 1	3.6	11.6	0.0	Yes	0.40	#N/A	#N/A	0.005	#N/A	0	18262.5	1938	1720	3	0%	#N/A
60% Clay 1; 40% Silt 1	3.6	15.2	0.0	Yes	0.40	#N/A	#N/A	0.005	#N/A	0	18262.5	2230	1902	3	0%	#N/A
60% Clay 1; 40% Silt 1	3.8	19	0.0	Yes	0.40	#N/A	#N/A	0.005	#N/A	260	18522.5	2056	2093	3	0%	#N/A
Clay 2	10	33	0.0	Yes	2.00	#N/A	#N/A	0.014	#N/A	260	18522.5	3151	2791	3	0%	#N/A
50% Clay 3; 50% Silt	3	36	0.0	Yes	1.30	#N/A	#N/A	0.004	#N/A	260	18522.5	2812	2939	3	0%	#N/A
50% Clay 3; 50% Silt	3	39	0.0	Yes	1.30	#N/A	#N/A	0.004	#N/A	260	18522.5	2987	3087	3	0%	#N/A
85% Clay 3; 15% Silt	6	45	0.0	Yes	1.30	#N/A	#N/A	0.005	#N/A	260	18522.5	3336	3383	3	0%	#N/A
85% Clay 3; 15% Silt	6	51	0.0	Yes	1.30	#N/A	#N/A	0.005	#N/A	260	18522.5	3685	3677	3	0%	#N/A
50% Clay 3; 50% Silt	4.5	55.5	3.5	Yes	1.30	1.5	98.00	0.004	3.5	260	18522.5	3845	3811	4	0%	0.00
50% Clay 3; 50% Silt	4.5	60	4.5	Yes	1.30	1.5	98.00	0.004	5.8	260	18522.5	4078	4007	5	0%	0.00
Clay 4	10	70	10.0	Yes	0.80	1.5	98.00	0.011	46.9	260	18522.5	5087	4360	10	0%	0.00
50% Clay 4; 50% Silt	2.5	72.5	2.5	Yes	0.80	1.5	98.00	0.006	2.9	260	18522.5	5498	4664	3	0%	0.00
50% Clay 4; 50% Silt	2.5	75	2.5	Yes	0.80	1.5	98.00	0.006	2.9	260	18522.5	5662	4807	3	0%	0.00
50% Clay 5; 50% Silt	5	87	5.0	Yes	2.00	1.5	98.00	0.006	4.7	260	18522.5	9336	5517	5	0%	0.00
50% Clay 5; 50% Silt	5	92	5.0	Yes	2.00	1.5	98.00	0.006	4.7	0	18262.5	9817	5808	5	0%	0.00
50% Clay 5; 50% Silt	4	96	4.0	Yes	2.00	1.5	98.00	0.006	3.0	0	18262.5	10249	6055	4	0%	0.00
Clay 5	15	111	15.0	Yes	2.00	1.5	98.00	0.012	42.2	0	18262.5	11163	6541	15	0%	0.00
Clay 5	7	120	7.0	Yes	2.00	1.5	98.00	0.012	9.2	0	18262.5	12420	7167	7	0%	0.00
Clay 5	4	126	4.0	Yes	2.00	1.5	98.00	0.012	3.0	0	18262.5	13149	7520	4	0%	0.00
Clay 5	2	136	2.0	Yes	2.00	1.5	98.00	0.012	0.8	0	18262.5	14237	8044	3	0%	0.00
Clay 5	20	158	20.0	Yes	2.00	1.5	98.00	0.012	75.0	0	18262.5	15494	8649	20	0%	0.00
Clay 5	32	200	32.0	Yes	2.00	1.5	98.00	0.012	192.0	0	18262.5	18993	10365	32	0%	0.00
															Total Secondary Settlement (in)	0.00

Note: Maximum number of sublayers is 50

Settle3 Model Layering

Bot. elev.	Layer	Thickness (ft)	Bottom Depth (ft)	Drained at Bottom?
4208	Unsaturated Sand/Clay	8	8	Yes
4204.4	60% Clay 1; 40% Silt 1	3.6	11.6	Yes
4200.8	60% Clay 1; 40% Silt 1	3.6	15.2	Yes
4197	60% Clay 1; 40% Silt 1	3.8	19	Yes
4193	Sand 1	4	23	Yes
4183	Clay 2	10	33	Yes
4180	50% Clay 3; 50% Silt	3	36	Yes
4177	50% Clay 3; 50% Silt	3	39	Yes
4171	85% Clay 3; 15% Silt	6	45	Yes
4165	85% Clay 3; 15% Silt	6	51	Yes
4160.5	50% Clay 3; 50% Silt	4.5	55.5	Yes
4156	50% Clay 3; 50% Silt	4.5	60	Yes
4146	Clay 4	10	70	Yes
4143.5	50% Clay 4; 50% Silt	2.5	72.5	Yes
4141	50% Clay 4; 50% Silt	2.5	75	Yes
4134	Sand 2	7	82	Yes
4129	50% Clay 5; 50% Silt	5	87	Yes
4124	50% Clay 5; 50% Silt	5	92	Yes
4120	50% Clay 5; 50% Silt	4	96	Yes
4105	Clay 5	15	111	Yes
4103	Sand 2	2	113	Yes
4096	Clay 5	7	120	Yes
4094	Sand 2	2	122	Yes
4090	Clay 5	4	126	Yes
4082	Sand 2	8	134	Yes
4080	Clay 5	2	136	Yes
4078	Sand 2	2	138	Yes
4058	Clay 5	20	158	Yes
4048	Sand 2	10	168	Yes
4016	Clay 5	32	200	Yes

Settle3 Model Clay Layers

Layer	Thickness (ft)	Bottom Depth (ft)	Double Drainage?
60% Clay 1; 40% Silt 1	3.6	11.6	Yes
60% Clay 1; 40% Silt 1	3.6	15.2	Yes
60% Clay 1; 40% Silt 1	3.8	19	Yes
Clay 2	10	33	Yes
50% Clay 3; 50% Silt	3	36	Yes
50% Clay 3; 50% Silt	3	39	Yes
85% Clay 3; 15% Silt	6	45	Yes
85% Clay 3; 15% Silt	6	51	Yes
50% Clay 3; 50% Silt	4.5	55.5	Yes
50% Clay 3; 50% Silt	4.5	60	Yes
Clay 4	10	70	Yes
50% Clay 4; 50% Silt	2.5	72.5	Yes
50% Clay 4; 50% Silt	2.5	75	Yes
50% Clay 5; 50% Silt	5	87	Yes
50% Clay 5; 50% Silt	5	92	Yes
50% Clay 5; 50% Silt	4	96	Yes
Clay 5	15	111	Yes
Clay 5	7	120	Yes
Clay 5	4	126	Yes
Clay 5	2	136	Yes
Clay 5	20	158	Yes
Clay 5	32	200	Yes

Soil Parameters

Layer	Coefficient of Consolidation, Cv (ft2/d)	CR	C_alpha/CR	C-alpha
60% Clay 1; 40% Silt 1	0.4	0.12	0.0442	0.005
Clay 2	2	0.24	0.0591	0.014
50% Clay 3; 50% Silt	1.3	0.07	0.0591	0.004
85% Clay 3; 15% Silt	1.3	0.119	0.0442	0.005
Clay 4	0.8	0.25	0.0442	0.011
50% Clay 4; 50% Silt	0.8	0.125	0.0442	0.006
50% Clay 5; 50% Silt	2	0.135	0.0442	0.006
Clay 5	2	0.27	0.0442	0.012

Existing Preconsolidation Pressure

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_grid_11-23-2021.s3z
Graph Title: Pre-consolidation Stress vs. Depth

Query Point 27 (Existing = 0 d)

Pre-consolidation Str	Depth (ft)
0.0265882	0
0.0531765	0.470588
0.106353	0.941176
0.159529	1.41176
0.212706	1.88235
0.265882	2.35294
0.319059	2.82353
0.372235	3.29412
0.425412	3.76471
0.478588	4.23529
0.531765	4.70588
0.584941	5.17647
0.638118	5.64706
0.691294	6.11765
0.744471	6.58824
0.797647	7.05882
0.850824	7.52941
1.18515	8
1.53938	8.51429
1.63237	9.02857
1.72392	9.54286
1.80122	10.0571
1.85426	10.5714
1.8959	11.0857
1.93754	11.6
1.97917	12.1143
2.02081	12.6286
2.06245	13.1429
2.10408	13.6571
2.14572	14.1714
2.18736	14.6857
2.22957	15.2
2.27294	15.7429
2.31689	16.2857
2.36084	16.8286
2.40479	17.3714
2.44874	17.9143
2.49269	18.4571
2.05636	19
1.6107	19.5
1.636	20
1.6613	20.5
1.6866	21
1.7119	21.5
1.7372	22
1.7625	22.5
2.32794	23
2.90096	23.5
2.94144	24
2.98192	24.5
3.0224	25

Maximum Effective Vertical Stress

10.1
72.5

Effective Stress Zz	Depth (ft)	
0	0	
4.157E-09	0.470588	
3.325E-08	0.941176	
1.122E-07	1.41176	
0.0078002	1.88235	
0.0609738	2.35294	
0.11424	2.82353	
0.167465	3.29412	
0.220706	3.76471	
0.273966	4.23529	
0.327246	4.70588	
0.380548	5.17647	
0.433874	5.64706	
0.487228	6.11765	
0.540609	6.58824	
0.59402	7.05882	
0.647464	7.52941	
0.700941	8	
0.759424	8.51429	
0.817952	9.02857	
0.876526	9.54286	
1.64254	10.0571	22
1.66849	10.5714	23
1.69443	11.0857	24
1.72037	11.6	25
1.7463	12.1143	26
1.77222	12.6286	27
1.79813	13.1429	28
1.82404	13.6571	29
1.84993	14.1714	30
1.87582	14.6857	31
1.9017	15.2	32
1.929	15.7429	33
1.9563	16.2857	34
1.98358	16.8286	35
2.01086	17.3714	36
2.03812	17.9143	37
2.06537	18.4571	38
2.09261	19	39
2.11769	19.5	40
2.14276	20	41
2.16781	20.5	42
2.19286	21	43
2.2179	21.5	44
2.24293	22	45
2.26794	22.5	46
2.29295	23	47
2.31794	23.5	48
2.34292	24	49
2.3679	24.5	50
2.39286	25	51

50 years

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_grid_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 27 (50 Years PC = 18850 d)

Effective Stress Zz	Depth (ft)
0	0
4.16E-09	0.470588
3.33E-08	0.941176
1.12E-07	1.41176
0.0078002	1.88235
0.0609738	2.35294
0.11424	2.82353
0.167465	3.29412
0.220706	3.76471
0.273966	4.23529
0.327246	4.70588
0.380548	5.17647
0.433874	5.64706
0.487228	6.11765
0.540609	6.58824
0.59402	7.05882
0.647464	7.52941
0.700941	8
0.759424	8.51429
0.817952	9.02857
0.876526	9.54286
0.931582	10.0571
0.958162	10.5714
0.984793	11.0857
1.01148	11.6
1.03822	12.1143
1.06501	12.6286
1.09186	13.1429
1.11876	13.6571
1.14573	14.1714
1.17275	14.6857
1.19984	15.2
1.22849	15.7429
1.25721	16.2857
1.28599	16.8286
1.31485	17.3714
1.34377	17.9143
1.37275	18.4571
1.40181	19
1.42862	19.5
1.4555	20
1.48242	20.5
1.50941	21
1.53644	21.5
1.56353	22
1.59067	22.5
1.61786	23
1.6451	23.5
1.67239	24
1.69973	24.5
1.72712	25

End of Preloading

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_grid_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 27 (Excavation = 250 d)

Effective Stress Zz	Depth (ft)
-0.204903	0
-0.151726	0.470588
-0.09855	0.941176
-0.045375	1.41176
0.0077999	1.88235
0.0609733	2.35294
0.114239	2.82353
0.167463	3.29412
0.220704	3.76471
0.273963	4.23529
0.327241	4.70588
0.380542	5.17647
0.433867	5.64706
0.487218	6.11765
0.540598	6.58824
0.594006	7.05882
0.647447	7.52941
0.700921	8
0.7594	8.51429
0.817923	9.02857
0.876492	9.54286
1.64254	10.0571
1.66849	10.5714
1.69443	11.0857
1.72037	11.6
1.7463	12.1143
1.77222	12.6286
1.79813	13.1429
1.82404	13.6571
1.84993	14.1714
1.87582	14.6857
1.9017	15.2
1.929	15.7429
1.9563	16.2857
1.98358	16.8286
2.01086	17.3714
2.03812	17.9143
2.06537	18.4571
2.09261	19
2.11769	19.5
2.14276	20
2.16781	20.5
2.19286	21
2.2179	21.5
2.24293	22
2.26794	22.5
2.29295	23
2.31794	23.5
2.34292	24
2.3679	24.5
2.39286	25

Secondary Settlement

IPS Electrical Building

Secondary Settlement Calculation

Project: SLC WRF
Project No.: 60664196
Analysis: Electrical_Center (QP 6)
Date: 11/29/2021

Depth of the base of the foundation (ft): 0

Final σ'v to existing σ'p ratio for triggering secondary: 1.05

Time from preloading to construction (months): 0

Average Degree of consolidation at the end of primary consolidation (%): 98

Using Terzaghi equations the required Tv is: 1.500

Depth of the profile in which secondary consolidation is considered (ft): 200

Dividing each layer into at least 3 sublayer(s) with a maximum sublayer thickness of 1 ft

Soil layer	H (ft)	Depth of bot. of layer (ft)	$H_{modified}$ (ft)	double drainage	C_v (ft^2/day)	T_v check	U_{avg} check	$C_{\alpha r}$	t_{EOP} (days)	$t_{const.}$ (days)	t (days)	Mid. Layer existing σ'_p (psf)	Mid. Layer final σ'_v (psf)	No. of Sublayers	layer contribution to settlement (%)	ΔH (in)
60% Clay 1; 40% Silt 1	3.6	11.6	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	1763	1487	4	0%	0.00
60% Clay 1; 40% Silt 1	3.6	15.2	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	2083	1694	4	0%	0.00
60% Clay 1; 40% Silt 1	3.8	19	3.8	Yes	0.40	1.5	98.0	0.005	13.5	0	18262.5	2383	1889	4	0%	0.00
Clay 2	10	33	10.0	Yes	2.00	1.5	98.0	0.014	18.8	0	18262.5	3265	2432	10	0%	0.00
50% Clay 3; 50% Silt	3	36	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2725	2743	3	0%	0.00
50% Clay 3; 50% Silt	3	39	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2900	2885	3	0%	0.00
85% Clay 3; 15% Silt	6	45	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3162	3097	6	0%	0.00
85% Clay 3; 15% Silt	6	51	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3511	3381	6	0%	0.00
50% Clay 3; 50% Silt	4.5	55.5	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	3816	3631	5	0%	0.00
50% Clay 3; 50% Silt	4.5	60	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	4078	3846	5	0%	0.00
Clay 4	10	70	10.0	Yes	0.80	1.5	98.0	0.011	46.9	0	18262.5	5087	4194	10	0%	0.00
50% Clay 4; 50% Silt	2.5	72.5	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5498	4497	3	0%	0.00
50% Clay 4; 50% Silt	2.5	75	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5662	4618	3	0%	0.00
50% Clay 5; 50% Silt	5	87	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9336	5156	5	0%	0.00
50% Clay 5; 50% Silt	5	92	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9817	5401	5	0%	0.00
50% Clay 5; 50% Silt	4	96	4.0	Yes	2.00	1.5	98.0	0.006	3.0	0	18262.5	10249	5622	4	0%	0.00
Clay 5	15	111	15.0	Yes	2.00	1.5	98.0	0.012	42.2	0	18262.5	11163	6091	15	0%	0.00
Clay 5	7	120	7.0	Yes	2.00	1.5	98.0	0.012	9.2	0	18262.5	12420	6738	7	0%	0.00
Clay 5	4	126	4.0	Yes	2.00	1.5	98.0	0.012	3.0	0	18262.5	13149	7115	4	0%	0.00
Clay 5	2	136	2.0	Yes	2.00	1.5	98.0	0.012	0.8	0	18262.5	14237	7678	3	0%	0.00
Clay 5	20	158	20.0	Yes	2.00	1.5	98.0	0.012	75.0	0	18262.5	15494	8331	20	0%	0.00
Clay 5	32	200	32.0	Yes	2.00	1.5	98.0	0.012	192.0	0	18262.5	18993	10153	32	0%	0.00
															Total Secondary Settlement (in)	0.00

Note: Maximum number of sublayers is 50

Settle3 Model Layering

Bot. elev.	Layer	Thickness (ft)	Bottom Depth (ft)	Drained at Bottom?
4208	Unsaturated Sand/Clay	8	8	Yes
4204.4	60% Clay 1; 40% Silt 1	3.6	11.6	Yes
4200.8	60% Clay 1; 40% Silt 1	3.6	15.2	Yes
4197	60% Clay 1; 40% Silt 1	3.8	19	Yes
4193	Sand 1	4	23	Yes
4183	Clay 2	10	33	Yes
4180	50% Clay 3; 50% Silt	3	36	Yes
4177	50% Clay 3; 50% Silt	3	39	Yes
4171	85% Clay 3; 15% Silt	6	45	Yes
4165	85% Clay 3; 15% Silt	6	51	Yes
4160.5	50% Clay 3; 50% Silt	4.5	55.5	Yes
4156	50% Clay 3; 50% Silt	4.5	60	Yes
4146	Clay 4	10	70	Yes
4143.5	50% Clay 4; 50% Silt	2.5	72.5	Yes
4141	50% Clay 4; 50% Silt	2.5	75	Yes
4134	Sand 2	7	82	Yes
4129	50% Clay 5; 50% Silt	5	87	Yes
4124	50% Clay 5; 50% Silt	5	92	Yes
4120	50% Clay 5; 50% Silt	4	96	Yes
4105	Clay 5	15	111	Yes
4103	Sand 2	2	113	Yes
4096	Clay 5	7	120	Yes
4094	Sand 2	2	122	Yes
4090	Clay 5	4	126	Yes
4082	Sand 2	8	134	Yes
4080	Clay 5	2	136	Yes
4078	Sand 2	2	138	Yes
4058	Clay 5	20	158	Yes
4048	Sand 2	10	168	Yes
4016	Clay 5	32	200	Yes

Settle3 Model Clay Layers

Layer	Thickness (ft)	Bottom Depth (ft)	Double Drainage?
60% Clay 1; 40% Silt 1	3.6	11.6	Yes
60% Clay 1; 40% Silt 1	3.6	15.2	Yes
60% Clay 1; 40% Silt 1	3.8	19	Yes
Clay 2	10	33	Yes
50% Clay 3; 50% Silt	3	36	Yes
50% Clay 3; 50% Silt	3	39	Yes
85% Clay 3; 15% Silt	6	45	Yes
85% Clay 3; 15% Silt	6	51	Yes
50% Clay 3; 50% Silt	4.5	55.5	Yes
50% Clay 3; 50% Silt	4.5	60	Yes
Clay 4	10	70	Yes
50% Clay 4; 50% Silt	2.5	72.5	Yes
50% Clay 4; 50% Silt	2.5	75	Yes
50% Clay 5; 50% Silt	5	87	Yes
50% Clay 5; 50% Silt	5	92	Yes
50% Clay 5; 50% Silt	4	96	Yes
Clay 5	15	111	Yes
Clay 5	7	120	Yes
Clay 5	4	126	Yes
Clay 5	2	136	Yes
Clay 5	20	158	Yes
Clay 5	32	200	Yes

Soil Parameters

Layer	Coefficient of Consolidation, Cv (ft2/d)	CR	C_alpha/CR	C-alpha
60% Clay 1; 40% Silt 1	0.4	0.12	0.0442	0.005
Clay 2	2	0.24	0.0591	0.014
50% Clay 3; 50% Silt	1.3	0.07	0.0591	0.004
85% Clay 3; 15% Silt	1.3	0.119	0.0442	0.005
Clay 4	0.8	0.25	0.0442	0.011
50% Clay 4; 50% Silt	0.8	0.125	0.0442	0.006
50% Clay 5; 50% Silt	2	0.135	0.0442	0.006
Clay 5	2	0.27	0.0442	0.012

Existing Preconsolidation Pressure

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Pre-consolidation Stress vs. Depth

Query Point 6 (Existing = 0 d)

Pre-consolidation St	Depth (ft)
0.0265882	0
0.0531765	0.470588
0.106353	0.941176
0.159529	1.41176
0.212706	1.88235
0.265882	2.35294
0.319059	2.82353
0.372235	3.29412
0.425412	3.76471
0.478588	4.23529
0.531765	4.70588
0.584941	5.17647
0.638118	5.64706
0.691294	6.11765
0.744471	6.58824
0.797647	7.05882
0.850824	7.52941
1.18515	8
1.53938	8.51429
1.63237	9.02857
1.72392	9.54286
1.80122	10.0571
1.85426	10.5714
1.8959	11.0857
1.93754	11.6
1.97917	12.1143
2.02081	12.6286
2.06245	13.1429
2.10408	13.6571
2.14572	14.1714
2.18736	14.6857
2.22957	15.2
2.27294	15.7429
2.31689	16.2857
2.36084	16.8286
2.40479	17.3714
2.44874	17.9143
2.49269	18.4571
2.05636	19
1.6107	19.5
1.636	20
1.6613	20.5
1.6866	21
1.7119	21.5
1.7372	22
1.7625	22.5
2.32794	23
2.90096	23.5
2.94144	24
2.98192	24.5
3.0224	25
3.06288	25.5

Maximum Effective Vertical Stress

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 6 (50 Years PC = 18850 d)

Effective Stress ZZ	Depth (ft)
0.36603	0
0.41921	0.470588
0.472411	0.941176
0.525635	1.41176
0.578913	1.88235
0.632255	2.35294
0.685672	2.82353
0.739176	3.29412
0.792774	3.76471
0.846474	4.23529
0.90028	4.70588
0.954192	5.17647
1.00821	5.64706
1.06233	6.11765
1.11655	6.58824
1.17086	7.05882
1.22526	7.52941
1.27972	8
1.33932	8.51429
1.39897	9.02857
1.45867	9.54286
1.51484	10.0571
1.54249	10.5714
1.57013	11.0857
1.59776	11.6
1.62536	12.1143
1.65291	12.6286
1.6804	13.1429
1.70782	13.6571
1.73516	14.1714
1.76242	14.6857
1.78958	15.2
1.81815	15.7429
1.84659	16.2857
1.87492	16.8286
1.90312	17.3714
1.93119	17.9143
1.95914	18.4571
1.98696	19
2.01247	19.5
2.03788	20
2.06318	20.5
2.08839	21
2.11349	21.5
2.1385	22
2.16341	22.5
2.18824	23
2.21298	23.5
2.23764	24
2.26221	24.5
2.28672	25
2.31115	25.5

Secondary Settlement

IPS Odor Control Building

Secondary Settlement Calculation

Project: SLC WRF
Project No.: 60664196
Analysis: Odor_Center (QP 2)
Date: 11/29/2021

Depth of the base of the foundation (ft): 0

Final σ'v to existing σ'p ratio for triggering secondary: 1.05

Time from preloading to construction (months): 0

Average Degree of consolidation at the end of primary consolidation (%): 98

Using Terzaghi equations the required Tv is: 1.500

Depth of the profile in which secondary consolidation is considered (ft): 200

Dividing each layer into at least 3 sublayer(s) with a maximum sublayer thickness of 1 ft

Soil layer	H (ft)	Depth of bot. of layer (ft)	$H_{modified}$ (ft)	double drainage	C_v (ft^2/day)	T_v check	U_{avg} check	$C_{\alpha r}$	t_{EOP} (days)	$t_{const.}$ (days)	t (days)	Mid. Layer existing σ'_p (psf)	Mid. Layer final σ'_v (psf)	No. of Sublayers	layer contribution to settlement (%)	ΔH (in)
60% Clay 1; 40% Silt 1	3.6	11.6	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	1763	1700	4	0%	0.00
60% Clay 1; 40% Silt 1	3.6	15.2	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	2083	1882	4	0%	0.00
60% Clay 1; 40% Silt 1	3.8	19	3.8	Yes	0.40	1.5	98.0	0.005	13.5	0	18262.5	2383	2052	4	0%	0.00
Clay 2	10	33	10.0	Yes	2.00	1.5	98.0	0.014	18.8	0	18262.5	3265	2559	10	0%	0.00
50% Clay 3; 50% Silt	3	36	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2725	2865	3	67%	0.38
50% Clay 3; 50% Silt	3	39	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2900	3008	3	0%	0.00
85% Clay 3; 15% Silt	6	45	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3162	3222	6	0%	0.00
85% Clay 3; 15% Silt	6	51	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3511	3509	6	0%	0.00
50% Clay 3; 50% Silt	4.5	55.5	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	3816	3760	5	0%	0.00
50% Clay 3; 50% Silt	4.5	60	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	4078	3976	5	0%	0.00
Clay 4	10	70	10.0	Yes	0.80	1.5	98.0	0.011	46.9	0	18262.5	5087	4325	10	0%	0.00
50% Clay 4; 50% Silt	2.5	72.5	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5498	4626	3	0%	0.00
50% Clay 4; 50% Silt	2.5	75	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5662	4747	3	0%	0.00
50% Clay 5; 50% Silt	5	87	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9336	5282	5	0%	0.00
50% Clay 5; 50% Silt	5	92	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9817	5526	5	0%	0.00
50% Clay 5; 50% Silt	4	96	4.0	Yes	2.00	1.5	98.0	0.006	3.0	0	18262.5	10249	5745	4	0%	0.00
Clay 5	15	111	15.0	Yes	2.00	1.5	98.0	0.012	42.2	0	18262.5	11163	6211	15	0%	0.00
Clay 5	7	120	7.0	Yes	2.00	1.5	98.0	0.012	9.2	0	18262.5	12420	6854	7	0%	0.00
Clay 5	4	126	4.0	Yes	2.00	1.5	98.0	0.012	3.0	0	18262.5	13149	7227	4	0%	0.00
Clay 5	2	136	2.0	Yes	2.00	1.5	98.0	0.012	0.8	0	18262.5	14237	7786	3	0%	0.00
Clay 5	20	158	20.0	Yes	2.00	1.5	98.0	0.012	75.0	0	18262.5	15494	8433	20	0%	0.00
Clay 5	32	200	32.0	Yes	2.00	1.5	98.0	0.012	192.0	0	18262.5	18993	10236	32	0%	0.00
															Total Secondary Settlement (in)	0.38

Note: Maximum number of sublayers is 50

Settle3 Model Layering

Bot. elev.	Layer	Thickness (ft)	Bottom Depth (ft)	Drained at Bottom?
4208	Unsaturated Sand/Clay	8	8	Yes
4204.4	60% Clay 1; 40% Silt 1	3.6	11.6	Yes
4200.8	60% Clay 1; 40% Silt 1	3.6	15.2	Yes
4197	60% Clay 1; 40% Silt 1	3.8	19	Yes
4193	Sand 1	4	23	Yes
4183	Clay 2	10	33	Yes
4180	50% Clay 3; 50% Silt	3	36	Yes
4177	50% Clay 3; 50% Silt	3	39	Yes
4171	85% Clay 3; 15% Silt	6	45	Yes
4165	85% Clay 3; 15% Silt	6	51	Yes
4160.5	50% Clay 3; 50% Silt	4.5	55.5	Yes
4156	50% Clay 3; 50% Silt	4.5	60	Yes
4146	Clay 4	10	70	Yes
4143.5	50% Clay 4; 50% Silt	2.5	72.5	Yes
4141	50% Clay 4; 50% Silt	2.5	75	Yes
4134	Sand 2	7	82	Yes
4129	50% Clay 5; 50% Silt	5	87	Yes
4124	50% Clay 5; 50% Silt	5	92	Yes
4120	50% Clay 5; 50% Silt	4	96	Yes
4105	Clay 5	15	111	Yes
4103	Sand 2	2	113	Yes
4096	Clay 5	7	120	Yes
4094	Sand 2	2	122	Yes
4090	Clay 5	4	126	Yes
4082	Sand 2	8	134	Yes
4080	Clay 5	2	136	Yes
4078	Sand 2	2	138	Yes
4058	Clay 5	20	158	Yes
4048	Sand 2	10	168	Yes
4016	Clay 5	32	200	Yes

Settle3 Model Clay Layers

Layer	Thickness (ft)	Bottom Depth (ft)	Double Drainage?
60% Clay 1; 40% Silt 1	3.6	11.6	Yes
60% Clay 1; 40% Silt 1	3.6	15.2	Yes
60% Clay 1; 40% Silt 1	3.8	19	Yes
Clay 2	10	33	Yes
50% Clay 3; 50% Silt	3	36	Yes
50% Clay 3; 50% Silt	3	39	Yes
85% Clay 3; 15% Silt	6	45	Yes
85% Clay 3; 15% Silt	6	51	Yes
50% Clay 3; 50% Silt	4.5	55.5	Yes
50% Clay 3; 50% Silt	4.5	60	Yes
Clay 4	10	70	Yes
50% Clay 4; 50% Silt	2.5	72.5	Yes
50% Clay 4; 50% Silt	2.5	75	Yes
50% Clay 5; 50% Silt	5	87	Yes
50% Clay 5; 50% Silt	5	92	Yes
50% Clay 5; 50% Silt	4	96	Yes
Clay 5	15	111	Yes
Clay 5	7	120	Yes
Clay 5	4	126	Yes
Clay 5	2	136	Yes
Clay 5	20	158	Yes
Clay 5	32	200	Yes

Soil Parameters

Layer	Coefficient of Consolidation, Cv (ft2/d)	CR	C_alpha/CR	C-alpha
60% Clay 1; 40% Silt 1	0.4	0.12	0.0442	0.005
Clay 2	2	0.24	0.0591	0.014
50% Clay 3; 50% Silt	1.3	0.07	0.0591	0.004
85% Clay 3; 15% Silt	1.3	0.119	0.0442	0.005
Clay 4	0.8	0.25	0.0442	0.011
50% Clay 4; 50% Silt	0.8	0.125	0.0442	0.006
50% Clay 5; 50% Silt	2	0.135	0.0442	0.006
Clay 5	2	0.27	0.0442	0.012

Existing Preconsolidation Pressure

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Pre-consolidation Stress vs. Depth

Query Point 2 (Existing = 0 d)

Pre-consolidation St	Depth (ft)
0.0265882	0
0.0531765	0.470588
0.106353	0.941176
0.159529	1.41176
0.212706	1.88235
0.265882	2.35294
0.319059	2.82353
0.372235	3.29412
0.425412	3.76471
0.478588	4.23529
0.531765	4.70588
0.584941	5.17647
0.638118	5.64706
0.691294	6.11765
0.744471	6.58824
0.797647	7.05882
0.850824	7.52941
1.18515	8
1.53938	8.51429
1.63237	9.02857
1.72392	9.54286
1.80122	10.0571
1.85426	10.5714
1.8959	11.0857
1.93754	11.6
1.97917	12.1143
2.02081	12.6286
2.06245	13.1429
2.10408	13.6571
2.14572	14.1714
2.18736	14.6857
2.22957	15.2
2.27294	15.7429
2.31689	16.2857
2.36084	16.8286
2.40479	17.3714
2.44874	17.9143
2.49269	18.4571
2.05636	19
1.6107	19.5
1.636	20
1.6613	20.5
1.6866	21
1.7119	21.5
1.7372	22
1.7625	22.5
2.32794	23
2.90096	23.5
2.94144	24
2.98192	24.5
3.0224	25
3.06288	25.5

Maximum Effective Vertical Stress

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 2 (50 Years PC = 18850 d)

Effective Stress Z	Depth (ft)
0.609284	0
0.662565	0.470588
0.71562	0.941176
0.768745	1.41176
0.821828	1.88235
0.874854	2.35294
0.927809	2.82353
0.980683	3.29412
1.03347	3.76471
1.08616	4.23529
1.13874	4.70588
1.19122	5.17647
1.24359	5.64706
1.29585	6.11765
1.348	6.58824
1.40005	7.05882
1.452	7.52941
1.50384	8
1.5604	8.51429
1.61685	9.02857
1.67321	9.54286
1.72591	10.0571
1.75001	10.5714
1.77404	11.0857
1.798	11.6
1.82191	12.1143
1.84578	12.6286
1.86961	13.1429
1.8934	13.6571
1.91717	14.1714
1.94092	14.6857
1.96466	15.2
1.98971	15.7429
2.01475	16.2857
2.03979	16.8286
2.06483	17.3714
2.08989	17.9143
2.11495	18.4571
2.14003	19
2.16314	19.5
2.18627	20
2.20941	20.5
2.23257	21
2.25575	21.5
2.27895	22
2.30217	22.5
2.32541	23
2.34867	23.5
2.37195	24
2.39525	24.5
2.41858	25
2.44192	25.5

Secondary Settlement

IPS Generator Pad

Secondary Settlement Calculation

Project: SLC WRF
Project No.: 60664196
Analysis: Gen_Center (QP 1)
Date: 11/29/2021

Depth of the base of the foundation (ft): 0

Final σ'v to existing σ'p ratio for triggering secondary: 1.05

Time from preloading to construction (months): 0

Average Degree of consolidation at the end of primary consolidation (%): 98

Using Terzaghi equations the required Tv is: 1.500

Depth of the profile in which secondary consolidation is considered (ft): 200

Dividing each layer into at least 3 sublayer(s) with a maximum sublayer thickness of 1 ft

Soil layer	H (ft)	Depth of bot. of layer (ft)	$H_{modified}$ (ft)	double drainage	C_v (ft^2/day)	T_v check	U_{avg} check	$C_{\alpha r}$	t_{EOP} (days)	$t_{const.}$ (days)	t (days)	Mid. Layer existing σ'_p (psf)	Mid. Layer final σ'_v (psf)	No. of Sublayers	layer contribution to settlement (%)	ΔH (in)
60% Clay 1; 40% Silt 1	3.6	11.6	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	1763	1404	4	0%	0.00
60% Clay 1; 40% Silt 1	3.6	15.2	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	2083	1598	4	0%	0.00
60% Clay 1; 40% Silt 1	3.8	19	3.8	Yes	0.40	1.5	98.0	0.005	13.5	0	18262.5	2383	1782	4	0%	0.00
Clay 2	10	33	10.0	Yes	2.00	1.5	98.0	0.014	18.8	0	18262.5	3265	2319	10	0%	0.00
50% Clay 3; 50% Silt	3	36	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2725	2637	3	0%	0.00
50% Clay 3; 50% Silt	3	39	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2900	2784	3	0%	0.00
85% Clay 3; 15% Silt	6	45	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3162	3004	6	0%	0.00
85% Clay 3; 15% Silt	6	51	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3511	3297	6	0%	0.00
50% Clay 3; 50% Silt	4.5	55.5	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	3816	3555	5	0%	0.00
50% Clay 3; 50% Silt	4.5	60	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	4078	3776	5	0%	0.00
Clay 4	10	70	10.0	Yes	0.80	1.5	98.0	0.011	46.9	0	18262.5	5087	4134	10	0%	0.00
50% Clay 4; 50% Silt	2.5	72.5	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5498	4444	3	0%	0.00
50% Clay 4; 50% Silt	2.5	75	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5662	4568	3	0%	0.00
50% Clay 5; 50% Silt	5	87	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9336	5121	5	0%	0.00
50% Clay 5; 50% Silt	5	92	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9817	5374	5	0%	0.00
50% Clay 5; 50% Silt	4	96	4.0	Yes	2.00	1.5	98.0	0.006	3.0	0	18262.5	10249	5601	4	0%	0.00
Clay 5	15	111	15.0	Yes	2.00	1.5	98.0	0.012	42.2	0	18262.5	11163	6083	15	0%	0.00
Clay 5	7	120	7.0	Yes	2.00	1.5	98.0	0.012	9.2	0	18262.5	12420	6747	7	0%	0.00
Clay 5	4	126	4.0	Yes	2.00	1.5	98.0	0.012	3.0	0	18262.5	13149	7132	4	0%	0.00
Clay 5	2	136	2.0	Yes	2.00	1.5	98.0	0.012	0.8	0	18262.5	14237	7705	3	0%	0.00
Clay 5	20	158	20.0	Yes	2.00	1.5	98.0	0.012	75.0	0	18262.5	15494	8365	20	0%	0.00
Clay 5	32	200	32.0	Yes	2.00	1.5	98.0	0.012	192.0	0	18262.5	18993	10194	32	0%	0.00
															Total Secondary Settlement (in)	0.00

Note: Maximum number of sublayers is 50

Settle3 Model Layering

Bot. elev.	Layer	Thickness (ft)	Bottom Depth (ft)	Drained at Bottom?
4208	Unsaturated Sand/Clay	8	8	Yes
4204.4	60% Clay 1; 40% Silt 1	3.6	11.6	Yes
4200.8	60% Clay 1; 40% Silt 1	3.6	15.2	Yes
4197	60% Clay 1; 40% Silt 1	3.8	19	Yes
4193	Sand 1	4	23	Yes
4183	Clay 2	10	33	Yes
4180	50% Clay 3; 50% Silt	3	36	Yes
4177	50% Clay 3; 50% Silt	3	39	Yes
4171	85% Clay 3; 15% Silt	6	45	Yes
4165	85% Clay 3; 15% Silt	6	51	Yes
4160.5	50% Clay 3; 50% Silt	4.5	55.5	Yes
4156	50% Clay 3; 50% Silt	4.5	60	Yes
4146	Clay 4	10	70	Yes
4143.5	50% Clay 4; 50% Silt	2.5	72.5	Yes
4141	50% Clay 4; 50% Silt	2.5	75	Yes
4134	Sand 2	7	82	Yes
4129	50% Clay 5; 50% Silt	5	87	Yes
4124	50% Clay 5; 50% Silt	5	92	Yes
4120	50% Clay 5; 50% Silt	4	96	Yes
4105	Clay 5	15	111	Yes
4103	Sand 2	2	113	Yes
4096	Clay 5	7	120	Yes
4094	Sand 2	2	122	Yes
4090	Clay 5	4	126	Yes
4082	Sand 2	8	134	Yes
4080	Clay 5	2	136	Yes
4078	Sand 2	2	138	Yes
4058	Clay 5	20	158	Yes
4048	Sand 2	10	168	Yes
4016	Clay 5	32	200	Yes

Settle3 Model Clay Layers

Layer	Thickness (ft)	Bottom Depth (ft)	Double Drainage?
60% Clay 1; 40% Silt 1	3.6	11.6	Yes
60% Clay 1; 40% Silt 1	3.6	15.2	Yes
60% Clay 1; 40% Silt 1	3.8	19	Yes
Clay 2	10	33	Yes
50% Clay 3; 50% Silt	3	36	Yes
50% Clay 3; 50% Silt	3	39	Yes
85% Clay 3; 15% Silt	6	45	Yes
85% Clay 3; 15% Silt	6	51	Yes
50% Clay 3; 50% Silt	4.5	55.5	Yes
50% Clay 3; 50% Silt	4.5	60	Yes
Clay 4	10	70	Yes
50% Clay 4; 50% Silt	2.5	72.5	Yes
50% Clay 4; 50% Silt	2.5	75	Yes
50% Clay 5; 50% Silt	5	87	Yes
50% Clay 5; 50% Silt	5	92	Yes
50% Clay 5; 50% Silt	4	96	Yes
Clay 5	15	111	Yes
Clay 5	7	120	Yes
Clay 5	4	126	Yes
Clay 5	2	136	Yes
Clay 5	20	158	Yes
Clay 5	32	200	Yes

Soil Parameters

Layer	Coefficient of Consolidation, Cv (ft2/d)	CR	C_alpha/CR	C-alpha
60% Clay 1; 40% Silt 1	0.4	0.12	0.0442	0.005
Clay 2	2	0.24	0.0591	0.014
50% Clay 3; 50% Silt	1.3	0.07	0.0591	0.004
85% Clay 3; 15% Silt	1.3	0.119	0.0442	0.005
Clay 4	0.8	0.25	0.0442	0.011
50% Clay 4; 50% Silt	0.8	0.125	0.0442	0.006
50% Clay 5; 50% Silt	2	0.135	0.0442	0.006
Clay 5	2	0.27	0.0442	0.012

Existing Preconsolidation Pressure

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Pre-consolidation Stress vs. Depth

Query Point 1 (Existing = 0 d)

Pre-consolidation St	Depth (ft)
0.0265882	0
0.0531765	0.470588
0.106353	0.941176
0.159529	1.41176
0.212706	1.88235
0.265882	2.35294
0.319059	2.82353
0.372235	3.29412
0.425412	3.76471
0.478588	4.23529
0.531765	4.70588
0.584941	5.17647
0.638118	5.64706
0.691294	6.11765
0.744471	6.58824
0.797647	7.05882
0.850824	7.52941
1.18515	8
1.53938	8.51429
1.63237	9.02857
1.72392	9.54286
1.80122	10.0571
1.85426	10.5714
1.8959	11.0857
1.93754	11.6
1.97917	12.1143
2.02081	12.6286
2.06245	13.1429
2.10408	13.6571
2.14572	14.1714
2.18736	14.6857
2.22957	15.2
2.27294	15.7429
2.31689	16.2857
2.36084	16.8286
2.40479	17.3714
2.44874	17.9143
2.49269	18.4571
2.05636	19
1.6107	19.5
1.636	20
1.6613	20.5
1.6866	21
1.7119	21.5
1.7372	22
1.7625	22.5
2.32794	23
2.90096	23.5
2.94144	24
2.98192	24.5
3.0224	25
3.06288	25.5

Maximum Effective Vertical Stress

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 1 (50 Years PC = 18850 d)

Effective Stress ZZ	Depth (ft)
0.300368	0
0.353555	0.470588
0.406751	0.941176
0.459938	1.41176
0.513106	1.88235
0.566265	2.35294
0.619424	2.82353
0.67258	3.29412
0.725728	3.76471
0.778866	4.23529
0.831992	4.70588
0.885105	5.17647
0.938204	5.64706
0.991288	6.11765
1.04436	6.58824
1.09741	7.05882
1.15044	7.52941
1.20346	8
1.26138	8.51429
1.31928	9.02857
1.37716	9.54286
1.43144	10.0571
1.45718	10.5714
1.4829	11.0857
1.5086	11.6
1.53427	12.1143
1.55992	12.6286
1.58554	13.1429
1.61115	13.6571
1.63673	14.1714
1.66229	14.6857
1.68784	15.2
1.71478	15.7429
1.74169	16.2857
1.76859	16.8286
1.79546	17.3714
1.82232	17.9143
1.84916	18.4571
1.87597	19
1.90066	19.5
1.92533	20
1.94999	20.5
1.97463	21
1.99926	21.5
2.02388	22
2.04849	22.5
2.07308	23
2.09767	23.5
2.12224	24
2.1468	24.5
2.17136	25
2.19591	25.5

Attachment 3: Differential Secondary Settlement Calculations

Attachment 3

Differential Settlement Calculations

Differential Settlement

IPS Building

Secondary Settlement Calculation

Project: SLC WRF
Project No.: 60664196
Analysis: IPS_NW (QP 15)
Date: 11/29/2021

Depth of the base of the foundation (ft): 52

Final σ'v to existing σ'p ratio for triggering secondary: 1.05

Time from preloading to construction (months): 0

Average Degree of consolidation at the end of primary consolidation (%): 98

Using Terzaghi equations the required Tv is: 1.500

Depth of the profile in which secondary consolidation is considered (ft): 200

Dividing each layer into at least 3 sublayer(s) with a maximum sublayer thickness of 1 ft

Soil layer	H (ft)	Depth of bot. of layer (ft)	$H_{modified}$ (ft)	double drainage	C_v (ft^2/day)	T_v check	U_{avg} check	$C_{\alpha r}$	t_{EOP} (days)	$t_{const.}$ (days)	t (days)	Mid. Layer existing σ'_p (psf)	Mid. Layer final σ'_v (psf)	No. of Sublayers	layer contribution to settlement (%)	ΔH (in)
60% Clay 1; 40% Silt 1	3.6	11.6	0.0	Yes	0.40	#N/A	#N/A	0.005	#N/A	0	18262.5	1938	1668	3	0%	#N/A
60% Clay 1; 40% Silt 1	3.6	15.2	0.0	Yes	0.40	#N/A	#N/A	0.005	#N/A	0	18262.5	2230	1849	3	0%	#N/A
60% Clay 1; 40% Silt 1	3.8	19	0.0	Yes	0.40	#N/A	#N/A	0.005	#N/A	260	18522.5	2056	2041	3	0%	#N/A
Clay 2	10	33	0.0	Yes	2.00	#N/A	#N/A	0.014	#N/A	260	18522.5	3151	2743	3	0%	#N/A
50% Clay 3; 50% Silt	3	36	0.0	Yes	1.30	#N/A	#N/A	0.004	#N/A	260	18522.5	2812	2892	3	0%	#N/A
50% Clay 3; 50% Silt	3	39	0.0	Yes	1.30	#N/A	#N/A	0.004	#N/A	260	18522.5	2987	3042	3	0%	#N/A
85% Clay 3; 15% Silt	6	45	0.0	Yes	1.30	#N/A	#N/A	0.005	#N/A	260	18522.5	3336	3340	3	0%	#N/A
85% Clay 3; 15% Silt	6	51	0.0	Yes	1.30	#N/A	#N/A	0.005	#N/A	260	18522.5	3685	3636	3	0%	#N/A
50% Clay 3; 50% Silt	4.5	55.5	3.5	Yes	1.30	1.5	98.00	0.004	3.5	260	18522.5	3845	3787	4	0%	0.00
50% Clay 3; 50% Silt	4.5	60	4.5	Yes	1.30	1.5	98.00	0.004	5.8	260	18522.5	4078	4126	5	0%	0.00
Clay 4	10	70	10.0	Yes	0.80	1.5	98.00	0.011	46.9	0	18262.5	5087	4674	10	0%	0.00
50% Clay 4; 50% Silt	2.5	72.5	2.5	Yes	0.80	1.5	98.00	0.006	2.9	0	18262.5	5498	5012	3	0%	0.00
50% Clay 4; 50% Silt	2.5	75	2.5	Yes	0.80	1.5	98.00	0.006	2.9	0	18262.5	5662	5133	3	0%	0.00
50% Clay 5; 50% Silt	5	87	5.0	Yes	2.00	1.5	98.00	0.006	4.7	0	18262.5	9336	5636	5	0%	0.00
50% Clay 5; 50% Silt	5	92	5.0	Yes	2.00	1.5	98.00	0.006	4.7	0	18262.5	9817	5861	5	0%	0.00
50% Clay 5; 50% Silt	4	96	4.0	Yes	2.00	1.5	98.00	0.006	3.0	0	18262.5	10249	6065	4	0%	0.00
Clay 5	15	111	15.0	Yes	2.00	1.5	98.00	0.012	42.2	0	18262.5	11163	6497	15	0%	0.00
Clay 5	7	120	7.0	Yes	2.00	1.5	98.00	0.012	9.2	0	18262.5	12420	7098	7	0%	0.00
Clay 5	4	126	4.0	Yes	2.00	1.5	98.00	0.012	3.0	0	18262.5	13149	7450	4	0%	0.00
Clay 5	2	136	2.0	Yes	2.00	1.5	98.00	0.012	0.8	0	18262.5	14237	7979	3	0%	0.00
Clay 5	20	158	20.0	Yes	2.00	1.5	98.00	0.012	75.0	0	18262.5	15494	8595	20	0%	0.00
Clay 5	32	200	32.0	Yes	2.00	1.5	98.00	0.012	192.0	0	18262.5	18993	10335	32	0%	0.00
															Total Secondary Settlement (in)	0.00

Note: Maximum number of sublayers is 50

Settle3 Model Layering

Bot. elev.	Layer	Thickness (ft)	Bottom Depth (ft)	Drained at Bottom?
4208	Unsaturated Sand/Clay	8	8	Yes
4204.4	60% Clay 1; 40% Silt 1	3.6	11.6	Yes
4200.8	60% Clay 1; 40% Silt 1	3.6	15.2	Yes
4197	60% Clay 1; 40% Silt 1	3.8	19	Yes
4193	Sand 1	4	23	Yes
4183	Clay 2	10	33	Yes
4180	50% Clay 3; 50% Silt	3	36	Yes
4177	50% Clay 3; 50% Silt	3	39	Yes
4171	85% Clay 3; 15% Silt	6	45	Yes
4165	85% Clay 3; 15% Silt	6	51	Yes
4160.5	50% Clay 3; 50% Silt	4.5	55.5	Yes
4156	50% Clay 3; 50% Silt	4.5	60	Yes
4146	Clay 4	10	70	Yes
4143.5	50% Clay 4; 50% Silt	2.5	72.5	Yes
4141	50% Clay 4; 50% Silt	2.5	75	Yes
4134	Sand 2	7	82	Yes
4129	50% Clay 5; 50% Silt	5	87	Yes
4124	50% Clay 5; 50% Silt	5	92	Yes
4120	50% Clay 5; 50% Silt	4	96	Yes
4105	Clay 5	15	111	Yes
4103	Sand 2	2	113	Yes
4096	Clay 5	7	120	Yes
4094	Sand 2	2	122	Yes
4090	Clay 5	4	126	Yes
4082	Sand 2	8	134	Yes
4080	Clay 5	2	136	Yes
4078	Sand 2	2	138	Yes
4058	Clay 5	20	158	Yes
4048	Sand 2	10	168	Yes
4016	Clay 5	32	200	Yes

Settle3 Model Clay Layers

Layer	Thickness (ft)	Bottom Depth (ft)	Double Drainage?
60% Clay 1; 40% Silt 1	3.6	11.6	Yes
60% Clay 1; 40% Silt 1	3.6	15.2	Yes
60% Clay 1; 40% Silt 1	3.8	19	Yes
Clay 2	10	33	Yes
50% Clay 3; 50% Silt	3	36	Yes
50% Clay 3; 50% Silt	3	39	Yes
85% Clay 3; 15% Silt	6	45	Yes
85% Clay 3; 15% Silt	6	51	Yes
50% Clay 3; 50% Silt	4.5	55.5	Yes
50% Clay 3; 50% Silt	4.5	60	Yes
Clay 4	10	70	Yes
50% Clay 4; 50% Silt	2.5	72.5	Yes
50% Clay 4; 50% Silt	2.5	75	Yes
50% Clay 5; 50% Silt	5	87	Yes
50% Clay 5; 50% Silt	5	92	Yes
50% Clay 5; 50% Silt	4	96	Yes
Clay 5	15	111	Yes
Clay 5	7	120	Yes
Clay 5	4	126	Yes
Clay 5	2	136	Yes
Clay 5	20	158	Yes
Clay 5	32	200	Yes

Soil Parameters

Layer	Coefficient of Consolidation, Cv (ft2/d)	CR	C_alpha/CR	C-alpha
60% Clay 1; 40% Silt 1	0.4	0.12	0.0442	0.005
Clay 2	2	0.24	0.0591	0.014
50% Clay 3; 50% Silt	1.3	0.07	0.0591	0.004
85% Clay 3; 15% Silt	1.3	0.119	0.0442	0.005
Clay 4	0.8	0.25	0.0442	0.011
50% Clay 4; 50% Silt	0.8	0.125	0.0442	0.006
50% Clay 5; 50% Silt	2	0.135	0.0442	0.006
Clay 5	2	0.27	0.0442	0.012

Existing Preconsolidation Pressure

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_grid_11-23-2021.s3z
Graph Title: Pre-consolidation Stress vs. Depth

Query Point 15 (Existing = 0 d)

Pre-consolidation St	Depth (ft)
0.0265882	0
0.0531765	0.470588
0.106353	0.941176
0.159529	1.41176
0.212706	1.88235
0.265882	2.35294
0.319059	2.82353
0.372235	3.29412
0.425412	3.76471
0.478588	4.23529
0.531765	4.70588
0.584941	5.17647
0.638118	5.64706
0.691294	6.11765
0.744471	6.58824
0.797647	7.05882
0.850824	7.52941
1.18515	8
1.53938	8.51429
1.63237	9.02857
1.72392	9.54286
1.80122	10.0571
1.85426	10.5714
1.8959	11.0857
1.93754	11.6
1.97917	12.1143
2.02081	12.6286
2.06245	13.1429
2.10408	13.6571
2.14572	14.1714
2.18736	14.6857
2.22957	15.2
2.27294	15.7429
2.31689	16.2857
2.36084	16.8286
2.40479	17.3714
2.44874	17.9143
2.49269	18.4571
2.05636	19
1.6107	19.5
1.636	20
1.6613	20.5
1.6866	21
1.7119	21.5
1.7372	22
1.7625	22.5
2.32794	23
2.90096	23.5
2.94144	24
2.98192	24.5
3.0224	25

Maximum Effective Vertical Stress

Effective Stress Z	Depth (ft)	
0	0	
1.08E-08	0.470588	
8.641E-08	0.941176	
2.915E-07	1.41176	
7.413E-07	1.88235	
0.0086428	2.35294	
0.062171	2.82353	
0.11583	3.29412	
0.169636	3.76471	
0.223604	4.23529	
0.277745	4.70588	
0.332068	5.17647	
0.386581	5.64706	
0.441288	6.11765	
0.496191	6.58824	
0.551291	7.05882	
0.606585	7.52941	
0.662071	8	
0.722923	8.51429	
0.783989	9.02857	
0.845259	9.54286	
1.58989	10.0571	22
1.61587	10.5714	23
1.64185	11.0857	24
1.66782	11.6	25
1.69378	12.1143	26
1.71975	12.6286	27
1.7457	13.1429	28
1.77166	13.6571	29
1.7976	14.1714	30
1.82354	14.6857	31
1.84948	15.2	32
1.87685	15.7429	33
1.90421	16.2857	34
1.93157	16.8286	35
1.95892	17.3714	36
1.98626	17.9143	37
2.0136	18.4571	38
2.04093	19	39
2.06609	19.5	40
2.09125	20	41
2.1164	20.5	42
2.14155	21	43
2.16668	21.5	44
2.19181	22	45
2.21694	22.5	46
2.24205	23	47
2.26716	23.5	48
2.29227	24	49
2.31736	24.5	50
2.34245	25	51

10.1
52.5

50 years

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_grid_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 15 (50 Years PC = 18850 d)

Effective Stress Z	Depth (ft)
0	0
1.08E-08	0.470588
8.64E-08	0.941176
2.91E-07	1.41176
7.41E-07	1.88235
0.0086428	2.35294
0.062171	2.82353
0.11583	3.29412
0.169636	3.76471
0.223604	4.23529
0.277745	4.70588
0.332068	5.17647
0.386581	5.64706
0.441288	6.11765
0.496191	6.58824
0.551291	7.05882
0.606585	7.52941
0.662071	8
0.722923	8.51429
0.783989	9.02857
0.845259	9.54286
0.903157	10.0571
0.93271	10.5714
0.962431	11.0857
0.992306	11.6
1.02232	12.1143
1.05247	12.6286
1.08272	13.1429
1.11308	13.6571
1.14353	14.1714
1.17405	14.6857
1.20464	15.2
1.23699	15.7429
1.26938	16.2857
1.3018	16.8286
1.33426	17.3714
1.36673	17.9143
1.3992	18.4571
1.43168	19
1.46158	19.5
1.49147	20
1.52134	20.5
1.55119	21
1.58101	21.5
1.61081	22
1.64057	22.5
1.6703	23
1.69999	23.5
1.72965	24
1.75926	24.5
1.78882	25

End of Preloading

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_grid_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 15 (Excavation = 250 d)

Effective Stress Z	Depth (ft)
-0.257734	0
-0.204557	0.470588
-0.151381	0.941176
-0.098096	1.41176
-0.044774	1.88235
0.0086413	2.35294
0.0621684	2.82353
0.115826	3.29412
0.16963	3.76471
0.223596	4.23529
0.277733	4.70588
0.332053	5.17647
0.386561	5.64706
0.441263	6.11765
0.49616	6.58824
0.551252	7.05882
0.606539	7.52941
0.662016	8
0.722857	8.51429
0.78391	9.02857
0.845166	9.54286
1.58989	10.0571
1.61587	10.5714
1.64185	11.0857
1.66782	11.6
1.69378	12.1143
1.71975	12.6286
1.7457	13.1429
1.77166	13.6571
1.7976	14.1714
1.82354	14.6857
1.84948	15.2
1.87685	15.7429
1.90421	16.2857
1.93157	16.8286
1.95892	17.3714
1.98626	17.9143
2.0136	18.4571
2.04093	19
2.06609	19.5
2.09125	20
2.1164	20.5
2.14155	21
2.16668	21.5
2.19181	22
2.21694	22.5
2.24205	23
2.26716	23.5
2.29227	24
2.31736	24.5
2.34245	25

Differential Settlement

IPS Electrical Building

Secondary Settlement Calculation

Project: SLC WRF
Project No.: 60664196
Analysis: Electrical_N (QP 4)
Date: 11/29/2021

Depth of the base of the foundation (ft): 0

Final σ'v to existing σ'p ratio for triggering secondary: 1.05

Time from preloading to construction (months): 0

Average Degree of consolidation at the end of primary consolidation (%): 98

Using Terzaghi equations the required Tv is: 1.500

Depth of the profile in which secondary consolidation is considered (ft): 200

Dividing each layer into at least 3 sublayer(s) with a maximum sublayer thickness of 1 ft

Soil layer	H (ft)	Depth of bot. of layer (ft)	$H_{modified}$ (ft)	double drainage	C_v (ft^2/day)	T_v check	U_{avg} check	$C_{\alpha r}$	t_{EOP} (days)	$t_{const.}$ (days)	t (days)	Mid. Layer existing σ'_p (psf)	Mid. Layer final σ'_v (psf)	No. of Sublayers	layer contribution to settlement (%)	ΔH (in)
60% Clay 1; 40% Silt 1	3.6	11.6	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	1763	1647	4	0%	0.00
60% Clay 1; 40% Silt 1	3.6	15.2	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	2083	1740	4	0%	0.00
60% Clay 1; 40% Silt 1	3.8	19	3.8	Yes	0.40	1.5	98.0	0.005	13.5	0	18262.5	2383	1873	4	0%	0.00
Clay 2	10	33	10.0	Yes	2.00	1.5	98.0	0.014	18.8	0	18262.5	3265	2351	10	0%	0.00
50% Clay 3; 50% Silt	3	36	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2725	2655	3	0%	0.00
50% Clay 3; 50% Silt	3	39	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2900	2798	3	0%	0.00
85% Clay 3; 15% Silt	6	45	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3162	3013	6	0%	0.00
85% Clay 3; 15% Silt	6	51	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3511	3303	6	0%	0.00
50% Clay 3; 50% Silt	4.5	55.5	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	3816	3558	5	0%	0.00
50% Clay 3; 50% Silt	4.5	60	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	4078	3777	5	0%	0.00
Clay 4	10	70	10.0	Yes	0.80	1.5	98.0	0.011	46.9	0	18262.5	5087	4133	10	0%	0.00
50% Clay 4; 50% Silt	2.5	72.5	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5498	4440	3	0%	0.00
50% Clay 4; 50% Silt	2.5	75	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5662	4564	3	0%	0.00
50% Clay 5; 50% Silt	5	87	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9336	5109	5	0%	0.00
50% Clay 5; 50% Silt	5	92	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9817	5358	5	0%	0.00
50% Clay 5; 50% Silt	4	96	4.0	Yes	2.00	1.5	98.0	0.006	3.0	0	18262.5	10249	5581	4	0%	0.00
Clay 5	15	111	15.0	Yes	2.00	1.5	98.0	0.012	42.2	0	18262.5	11163	6054	15	0%	0.00
Clay 5	7	120	7.0	Yes	2.00	1.5	98.0	0.012	9.2	0	18262.5	12420	6707	7	0%	0.00
Clay 5	4	126	4.0	Yes	2.00	1.5	98.0	0.012	3.0	0	18262.5	13149	7086	4	0%	0.00
Clay 5	2	136	2.0	Yes	2.00	1.5	98.0	0.012	0.8	0	18262.5	14237	7653	3	0%	0.00
Clay 5	20	158	20.0	Yes	2.00	1.5	98.0	0.012	75.0	0	18262.5	15494	8309	20	0%	0.00
Clay 5	32	200	32.0	Yes	2.00	1.5	98.0	0.012	192.0	0	18262.5	18993	10137	32	0%	0.00
															Total Secondary Settlement (in)	0.00

Note: Maximum number of sublayers is 50

Settle3 Model Layering

Bot. elev.	Layer	Thickness (ft)	Bottom Depth (ft)	Drained at Bottom?
4208	Unsaturated Sand/Clay	8	8	Yes
4204.4	60% Clay 1; 40% Silt 1	3.6	11.6	Yes
4200.8	60% Clay 1; 40% Silt 1	3.6	15.2	Yes
4197	60% Clay 1; 40% Silt 1	3.8	19	Yes
4193	Sand 1	4	23	Yes
4183	Clay 2	10	33	Yes
4180	50% Clay 3; 50% Silt	3	36	Yes
4177	50% Clay 3; 50% Silt	3	39	Yes
4171	85% Clay 3; 15% Silt	6	45	Yes
4165	85% Clay 3; 15% Silt	6	51	Yes
4160.5	50% Clay 3; 50% Silt	4.5	55.5	Yes
4156	50% Clay 3; 50% Silt	4.5	60	Yes
4146	Clay 4	10	70	Yes
4143.5	50% Clay 4; 50% Silt	2.5	72.5	Yes
4141	50% Clay 4; 50% Silt	2.5	75	Yes
4134	Sand 2	7	82	Yes
4129	50% Clay 5; 50% Silt	5	87	Yes
4124	50% Clay 5; 50% Silt	5	92	Yes
4120	50% Clay 5; 50% Silt	4	96	Yes
4105	Clay 5	15	111	Yes
4103	Sand 2	2	113	Yes
4096	Clay 5	7	120	Yes
4094	Sand 2	2	122	Yes
4090	Clay 5	4	126	Yes
4082	Sand 2	8	134	Yes
4080	Clay 5	2	136	Yes
4078	Sand 2	2	138	Yes
4058	Clay 5	20	158	Yes
4048	Sand 2	10	168	Yes
4016	Clay 5	32	200	Yes

Settle3 Model Clay Layers

Layer	Thickness (ft)	Bottom Depth (ft)	Double Drainage?
60% Clay 1; 40% Silt 1	3.6	11.6	Yes
60% Clay 1; 40% Silt 1	3.6	15.2	Yes
60% Clay 1; 40% Silt 1	3.8	19	Yes
Clay 2	10	33	Yes
50% Clay 3; 50% Silt	3	36	Yes
50% Clay 3; 50% Silt	3	39	Yes
85% Clay 3; 15% Silt	6	45	Yes
85% Clay 3; 15% Silt	6	51	Yes
50% Clay 3; 50% Silt	4.5	55.5	Yes
50% Clay 3; 50% Silt	4.5	60	Yes
Clay 4	10	70	Yes
50% Clay 4; 50% Silt	2.5	72.5	Yes
50% Clay 4; 50% Silt	2.5	75	Yes
50% Clay 5; 50% Silt	5	87	Yes
50% Clay 5; 50% Silt	5	92	Yes
50% Clay 5; 50% Silt	4	96	Yes
Clay 5	15	111	Yes
Clay 5	7	120	Yes
Clay 5	4	126	Yes
Clay 5	2	136	Yes
Clay 5	20	158	Yes
Clay 5	32	200	Yes

Soil Parameters

Layer	Coefficient of Consolidation, Cv (ft2/d)	CR	C_alpha/CR	C-alpha
60% Clay 1; 40% Silt 1	0.4	0.12	0.0442	0.005
Clay 2	2	0.24	0.0591	0.014
50% Clay 3; 50% Silt	1.3	0.07	0.0591	0.004
85% Clay 3; 15% Silt	1.3	0.119	0.0442	0.005
Clay 4	0.8	0.25	0.0442	0.011
50% Clay 4; 50% Silt	0.8	0.125	0.0442	0.006
50% Clay 5; 50% Silt	2	0.135	0.0442	0.006
Clay 5	2	0.27	0.0442	0.012

Existing Preconsolidation Pressure

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Pre-consolidation Stress vs. Depth

Query Point 4 (Existing = 0 d)

Pre-consolidation St	Depth (ft)
0.0265882	0
0.0531765	0.470588
0.106353	0.941176
0.159529	1.41176
0.212706	1.88235
0.265882	2.35294
0.319059	2.82353
0.372235	3.29412
0.425412	3.76471
0.478588	4.23529
0.531765	4.70588
0.584941	5.17647
0.638118	5.64706
0.691294	6.11765
0.744471	6.58824
0.797647	7.05882
0.850824	7.52941
1.18515	8
1.53938	8.51429
1.63237	9.02857
1.72392	9.54286
1.80122	10.0571
1.85426	10.5714
1.8959	11.0857
1.93754	11.6
1.97917	12.1143
2.02081	12.6286
2.06245	13.1429
2.10408	13.6571
2.14572	14.1714
2.18736	14.6857
2.22957	15.2
2.27294	15.7429
2.31689	16.2857
2.36084	16.8286
2.40479	17.3714
2.44874	17.9143
2.49269	18.4571
2.05636	19
1.6107	19.5
1.636	20
1.6613	20.5
1.6866	21
1.7119	21.5
1.7372	22
1.7625	22.5
2.32794	23
2.90096	23.5
2.94144	24
2.98192	24.5
3.0224	25
3.06288	25.5

Maximum Effective Vertical Stress

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 4 (50 Years PC = 18850 d)

Effective Stress Z	Depth (ft)
1.5798	0
1.60521	0.470588
1.64366	0.941176
1.66207	1.41176
1.65976	1.88235
1.64131	2.35294
1.61315	2.82353
1.58143	3.29412
1.55094	3.76471
1.52478	4.23529
1.50467	4.70588
1.49134	5.17647
1.48486	5.64706
1.4849	6.11765
1.49096	6.58824
1.50245	7.05882
1.51876	7.52941
1.53933	8
1.56604	8.51429
1.59659	9.02857
1.63043	9.54286
1.66353	10.0571
1.67054	10.5714
1.67965	11.0857
1.69056	11.6
1.70302	12.1143
1.71683	12.6286
1.7318	13.1429
1.74779	13.6571
1.76466	14.1714
1.7823	14.6857
1.80061	15.2
1.82058	15.7429
1.84114	16.2857
1.86219	16.8286
1.8837	17.3714
1.9056	17.9143
1.92786	18.4571
1.95042	19
1.97146	19.5
1.9927	20
2.01415	20.5
2.03577	21
2.05755	21.5
2.07948	22
2.10155	22.5
2.12374	23
2.14605	23.5
2.16847	24
2.19099	24.5
2.2136	25
2.2363	25.5

Secondary Settlement Calculation

Project: SLC WRF
Project No.: 60664196
Analysis: Electrical_NW (QP 3)
Date: 11/29/2021

Depth of the base of the foundation (ft): 0

Final σ'v to existing σ'p ratio for triggering secondary: 1.05

Time from preloading to construction (months): 0

Average Degree of consolidation at the end of primary consolidation (%): 98

Using Terzaghi equations the required Tv is: 1.500

Depth of the profile in which secondary consolidation is considered (ft): 200

Dividing each layer into at least 3 sublayer(s) with a maximum sublayer thickness of 1 ft

Soil layer	H (ft)	Depth of bot. of layer (ft)	$H_{modified}$ (ft)	double drainage	C_v (ft^2/day)	T_v check	U_{avg} check	$C_{\alpha r}$	t_{EOP} (days)	$t_{const.}$ (days)	t (days)	Mid. Layer existing σ'_p (psf)	Mid. Layer final σ'_v (psf)	No. of Sublayers	layer contribution to settlement (%)	ΔH (in)
60% Clay 1; 40% Silt 1	3.6	11.6	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	1763	1618	4	0%	0.00
60% Clay 1; 40% Silt 1	3.6	15.2	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	2083	1710	4	0%	0.00
60% Clay 1; 40% Silt 1	3.8	19	3.8	Yes	0.40	1.5	98.0	0.005	13.5	0	18262.5	2383	1843	4	0%	0.00
Clay 2	10	33	10.0	Yes	2.00	1.5	98.0	0.014	18.8	0	18262.5	3265	2325	10	0%	0.00
50% Clay 3; 50% Silt	3	36	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2725	2634	3	0%	0.00
50% Clay 3; 50% Silt	3	39	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2900	2778	3	0%	0.00
85% Clay 3; 15% Silt	6	45	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3162	2997	6	0%	0.00
85% Clay 3; 15% Silt	6	51	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3511	3290	6	0%	0.00
50% Clay 3; 50% Silt	4.5	55.5	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	3816	3548	5	0%	0.00
50% Clay 3; 50% Silt	4.5	60	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	4078	3769	5	0%	0.00
Clay 4	10	70	10.0	Yes	0.80	1.5	98.0	0.011	46.9	0	18262.5	5087	4128	10	0%	0.00
50% Clay 4; 50% Silt	2.5	72.5	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5498	4438	3	0%	0.00
50% Clay 4; 50% Silt	2.5	75	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5662	4562	3	0%	0.00
50% Clay 5; 50% Silt	5	87	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9336	5110	5	0%	0.00
50% Clay 5; 50% Silt	5	92	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9817	5359	5	0%	0.00
50% Clay 5; 50% Silt	4	96	4.0	Yes	2.00	1.5	98.0	0.006	3.0	0	18262.5	10249	5584	4	0%	0.00
Clay 5	15	111	15.0	Yes	2.00	1.5	98.0	0.012	42.2	0	18262.5	11163	6058	15	0%	0.00
Clay 5	7	120	7.0	Yes	2.00	1.5	98.0	0.012	9.2	0	18262.5	12420	6712	7	0%	0.00
Clay 5	4	126	4.0	Yes	2.00	1.5	98.0	0.012	3.0	0	18262.5	13149	7092	4	0%	0.00
Clay 5	2	136	2.0	Yes	2.00	1.5	98.0	0.012	0.8	0	18262.5	14237	7660	3	0%	0.00
Clay 5	20	158	20.0	Yes	2.00	1.5	98.0	0.012	75.0	0	18262.5	15494	8317	20	0%	0.00
Clay 5	32	200	32.0	Yes	2.00	1.5	98.0	0.012	192.0	0	18262.5	18993	10145	32	0%	0.00
															Total Secondary Settlement (in)	0.00

Note: Maximum number of sublayers is 50

Settle3 Model Layering

Bot. elev.	Layer	Thickness (ft)	Bottom Depth (ft)	Drained at Bottom?
4208	Unsaturated Sand/Clay	8	8	Yes
4204.4	60% Clay 1; 40% Silt 1	3.6	11.6	Yes
4200.8	60% Clay 1; 40% Silt 1	3.6	15.2	Yes
4197	60% Clay 1; 40% Silt 1	3.8	19	Yes
4193	Sand 1	4	23	Yes
4183	Clay 2	10	33	Yes
4180	50% Clay 3; 50% Silt	3	36	Yes
4177	50% Clay 3; 50% Silt	3	39	Yes
4171	85% Clay 3; 15% Silt	6	45	Yes
4165	85% Clay 3; 15% Silt	6	51	Yes
4160.5	50% Clay 3; 50% Silt	4.5	55.5	Yes
4156	50% Clay 3; 50% Silt	4.5	60	Yes
4146	Clay 4	10	70	Yes
4143.5	50% Clay 4; 50% Silt	2.5	72.5	Yes
4141	50% Clay 4; 50% Silt	2.5	75	Yes
4134	Sand 2	7	82	Yes
4129	50% Clay 5; 50% Silt	5	87	Yes
4124	50% Clay 5; 50% Silt	5	92	Yes
4120	50% Clay 5; 50% Silt	4	96	Yes
4105	Clay 5	15	111	Yes
4103	Sand 2	2	113	Yes
4096	Clay 5	7	120	Yes
4094	Sand 2	2	122	Yes
4090	Clay 5	4	126	Yes
4082	Sand 2	8	134	Yes
4080	Clay 5	2	136	Yes
4078	Sand 2	2	138	Yes
4058	Clay 5	20	158	Yes
4048	Sand 2	10	168	Yes
4016	Clay 5	32	200	Yes

Settle3 Model Clay Layers

Layer	Thickness (ft)	Bottom Depth (ft)	Double Drainage?
60% Clay 1; 40% Silt 1	3.6	11.6	Yes
60% Clay 1; 40% Silt 1	3.6	15.2	Yes
60% Clay 1; 40% Silt 1	3.8	19	Yes
Clay 2	10	33	Yes
50% Clay 3; 50% Silt	3	36	Yes
50% Clay 3; 50% Silt	3	39	Yes
85% Clay 3; 15% Silt	6	45	Yes
85% Clay 3; 15% Silt	6	51	Yes
50% Clay 3; 50% Silt	4.5	55.5	Yes
50% Clay 3; 50% Silt	4.5	60	Yes
Clay 4	10	70	Yes
50% Clay 4; 50% Silt	2.5	72.5	Yes
50% Clay 4; 50% Silt	2.5	75	Yes
50% Clay 5; 50% Silt	5	87	Yes
50% Clay 5; 50% Silt	5	92	Yes
50% Clay 5; 50% Silt	4	96	Yes
Clay 5	15	111	Yes
Clay 5	7	120	Yes
Clay 5	4	126	Yes
Clay 5	2	136	Yes
Clay 5	20	158	Yes
Clay 5	32	200	Yes

Soil Parameters

Layer	Coefficient of Consolidation, Cv (ft2/d)	CR	C_alpha/CR	C-alpha
60% Clay 1; 40% Silt 1	0.4	0.12	0.0442	0.005
Clay 2	2	0.24	0.0591	0.014
50% Clay 3; 50% Silt	1.3	0.07	0.0591	0.004
85% Clay 3; 15% Silt	1.3	0.119	0.0442	0.005
Clay 4	0.8	0.25	0.0442	0.011
50% Clay 4; 50% Silt	0.8	0.125	0.0442	0.006
50% Clay 5; 50% Silt	2	0.135	0.0442	0.006
Clay 5	2	0.27	0.0442	0.012

Existing Preconsolidation Pressure

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Pre-consolidation Stress vs. Depth

Query Point 3 (Existing = 0 d)

Pre-consolidation St	Depth (ft)
0.0265882	0
0.0531765	0.470588
0.106353	0.941176
0.159529	1.41176
0.212706	1.88235
0.265882	2.35294
0.319059	2.82353
0.372235	3.29412
0.425412	3.76471
0.478588	4.23529
0.531765	4.70588
0.584941	5.17647
0.638118	5.64706
0.691294	6.11765
0.744471	6.58824
0.797647	7.05882
0.850824	7.52941
1.18515	8
1.53938	8.51429
1.63237	9.02857
1.72392	9.54286
1.80122	10.0571
1.85426	10.5714
1.8959	11.0857
1.93754	11.6
1.97917	12.1143
2.02081	12.6286
2.06245	13.1429
2.10408	13.6571
2.14572	14.1714
2.18736	14.6857
2.22957	15.2
2.27294	15.7429
2.31689	16.2857
2.36084	16.8286
2.40479	17.3714
2.44874	17.9143
2.49269	18.4571
2.05636	19
1.6107	19.5
1.636	20
1.6613	20.5
1.6866	21
1.7119	21.5
1.7372	22
1.7625	22.5
2.32794	23
2.90096	23.5
2.94144	24
2.98192	24.5
3.0224	25
3.06288	25.5

Maximum Effective Vertical Stress

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 3 (50 Years PC = 18850 d)

Effective Stress ZZ	Depth (ft)
1.52954	0
1.58013	0.470588
1.61869	0.941176
1.637	1.41176
1.63468	1.88235
1.6162	2.35294
1.58796	2.82353
1.55614	3.29412
1.52551	3.76471
1.49919	4.23529
1.47889	4.70588
1.46535	5.17647
1.45863	5.64706
1.45841	6.11765
1.4642	6.58824
1.47541	7.05882
1.49144	7.52941
1.51172	8
1.53812	8.51429
1.56836	9.02857
1.60192	9.54286
1.63475	10.0571
1.64151	10.5714
1.65039	11.0857
1.66109	11.6
1.67337	12.1143
1.68703	12.6286
1.70187	13.1429
1.71776	13.6571
1.73455	14.1714
1.75214	14.6857
1.77044	15.2
1.79041	15.7429
1.81099	16.2857
1.83211	16.8286
1.85369	17.3714
1.87569	17.9143
1.89807	18.4571
1.92078	19
1.94196	19.5
1.96336	20
1.98498	20.5
2.00679	21
2.02877	21.5
2.05091	22
2.0732	22.5
2.09562	23
2.11817	23.5
2.14084	24
2.16361	24.5
2.18648	25
2.20945	25.5

Differential Settlement

IPS Odor Control Building

Secondary Settlement Calculation

Project: SLC WRF
Project No.: 60664196
Analysis: Odor_NW (QP 7)
Date: 11/29/2021

Depth of the base of the foundation (ft): 0

Final σ'v to existing σ'p ratio for triggering secondary: 1.05

Time from preloading to construction (months): 0

Average Degree of consolidation at the end of primary consolidation (%): 98

Using Terzaghi equations the required Tv is: 1.500

Depth of the profile in which secondary consolidation is considered (ft): 200

Dividing each layer into at least 3 sublayer(s) with a maximum sublayer thickness of 1 ft

Soil layer	H (ft)	Depth of bot. of layer (ft)	$H_{modified}$ (ft)	double drainage	C_v (ft^2/day)	T_v check	U_{avg} check	$C_{\alpha r}$	t_{EOP} (days)	$t_{const.}$ (days)	t (days)	Mid. Layer existing σ'_p (psf)	Mid. Layer final σ'_v (psf)	No. of Sublayers	layer contribution to settlement (%)	ΔH (in)
60% Clay 1; 40% Silt 1	3.6	11.6	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	1763	1624	4	0%	0.00
60% Clay 1; 40% Silt 1	3.6	15.2	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	2083	1802	4	0%	0.00
60% Clay 1; 40% Silt 1	3.8	19	3.8	Yes	0.40	1.5	98.0	0.005	13.5	0	18262.5	2383	1974	4	0%	0.00
Clay 2	10	33	10.0	Yes	2.00	1.5	98.0	0.014	18.8	0	18262.5	3265	2495	10	0%	0.00
50% Clay 3; 50% Silt	3	36	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2725	2810	3	0%	0.00
50% Clay 3; 50% Silt	3	39	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2900	2955	3	0%	0.00
85% Clay 3; 15% Silt	6	45	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3162	3173	6	0%	0.00
85% Clay 3; 15% Silt	6	51	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3511	3464	6	0%	0.00
50% Clay 3; 50% Silt	4.5	55.5	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	3816	3718	5	0%	0.00
50% Clay 3; 50% Silt	4.5	60	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	4078	3937	5	0%	0.00
Clay 4	10	70	10.0	Yes	0.80	1.5	98.0	0.011	46.9	0	18262.5	5087	4290	10	0%	0.00
50% Clay 4; 50% Silt	2.5	72.5	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5498	4595	3	0%	0.00
50% Clay 4; 50% Silt	2.5	75	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5662	4718	3	0%	0.00
50% Clay 5; 50% Silt	5	87	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9336	5263	5	0%	0.00
50% Clay 5; 50% Silt	5	92	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9817	5511	5	0%	0.00
50% Clay 5; 50% Silt	4	96	4.0	Yes	2.00	1.5	98.0	0.006	3.0	0	18262.5	10249	5735	4	0%	0.00
Clay 5	15	111	15.0	Yes	2.00	1.5	98.0	0.012	42.2	0	18262.5	11163	6208	15	0%	0.00
Clay 5	7	120	7.0	Yes	2.00	1.5	98.0	0.012	9.2	0	18262.5	12420	6861	7	0%	0.00
Clay 5	4	126	4.0	Yes	2.00	1.5	98.0	0.012	3.0	0	18262.5	13149	7238	4	0%	0.00
Clay 5	2	136	2.0	Yes	2.00	1.5	98.0	0.012	0.8	0	18262.5	14237	7801	3	0%	0.00
Clay 5	20	158	20.0	Yes	2.00	1.5	98.0	0.012	75.0	0	18262.5	15494	8450	20	0%	0.00
Clay 5	32	200	32.0	Yes	2.00	1.5	98.0	0.012	192.0	0	18262.5	18993	10254	32	0%	0.00
															Total Secondary Settlement (in)	0.00

Note: Maximum number of sublayers is 50

Settle3 Model Layering

Bot. elev.	Layer	Thickness (ft)	Bottom Depth (ft)	Drained at Bottom?
4208	Unsaturated Sand/Clay	8	8	Yes
4204.4	60% Clay 1; 40% Silt 1	3.6	11.6	Yes
4200.8	60% Clay 1; 40% Silt 1	3.6	15.2	Yes
4197	60% Clay 1; 40% Silt 1	3.8	19	Yes
4193	Sand 1	4	23	Yes
4183	Clay 2	10	33	Yes
4180	50% Clay 3; 50% Silt	3	36	Yes
4177	50% Clay 3; 50% Silt	3	39	Yes
4171	85% Clay 3; 15% Silt	6	45	Yes
4165	85% Clay 3; 15% Silt	6	51	Yes
4160.5	50% Clay 3; 50% Silt	4.5	55.5	Yes
4156	50% Clay 3; 50% Silt	4.5	60	Yes
4146	Clay 4	10	70	Yes
4143.5	50% Clay 4; 50% Silt	2.5	72.5	Yes
4141	50% Clay 4; 50% Silt	2.5	75	Yes
4134	Sand 2	7	82	Yes
4129	50% Clay 5; 50% Silt	5	87	Yes
4124	50% Clay 5; 50% Silt	5	92	Yes
4120	50% Clay 5; 50% Silt	4	96	Yes
4105	Clay 5	15	111	Yes
4103	Sand 2	2	113	Yes
4096	Clay 5	7	120	Yes
4094	Sand 2	2	122	Yes
4090	Clay 5	4	126	Yes
4082	Sand 2	8	134	Yes
4080	Clay 5	2	136	Yes
4078	Sand 2	2	138	Yes
4058	Clay 5	20	158	Yes
4048	Sand 2	10	168	Yes
4016	Clay 5	32	200	Yes

Settle3 Model Clay Layers

Layer	Thickness (ft)	Bottom Depth (ft)	Double Drainage?
60% Clay 1; 40% Silt 1	3.6	11.6	Yes
60% Clay 1; 40% Silt 1	3.6	15.2	Yes
60% Clay 1; 40% Silt 1	3.8	19	Yes
Clay 2	10	33	Yes
50% Clay 3; 50% Silt	3	36	Yes
50% Clay 3; 50% Silt	3	39	Yes
85% Clay 3; 15% Silt	6	45	Yes
85% Clay 3; 15% Silt	6	51	Yes
50% Clay 3; 50% Silt	4.5	55.5	Yes
50% Clay 3; 50% Silt	4.5	60	Yes
Clay 4	10	70	Yes
50% Clay 4; 50% Silt	2.5	72.5	Yes
50% Clay 4; 50% Silt	2.5	75	Yes
50% Clay 5; 50% Silt	5	87	Yes
50% Clay 5; 50% Silt	5	92	Yes
50% Clay 5; 50% Silt	4	96	Yes
Clay 5	15	111	Yes
Clay 5	7	120	Yes
Clay 5	4	126	Yes
Clay 5	2	136	Yes
Clay 5	20	158	Yes
Clay 5	32	200	Yes

Soil Parameters

Layer	Coefficient of Consolidation, Cv (ft2/d)	CR	C_alpha/CR	C-alpha
60% Clay 1; 40% Silt 1	0.4	0.12	0.0442	0.005
Clay 2	2	0.24	0.0591	0.014
50% Clay 3; 50% Silt	1.3	0.07	0.0591	0.004
85% Clay 3; 15% Silt	1.3	0.119	0.0442	0.005
Clay 4	0.8	0.25	0.0442	0.011
50% Clay 4; 50% Silt	0.8	0.125	0.0442	0.006
50% Clay 5; 50% Silt	2	0.135	0.0442	0.006
Clay 5	2	0.27	0.0442	0.012

Existing Preconsolidation Pressure

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Pre-consolidation Stress vs. Depth

Query Point 7 (Existing = 0 d)

Pre-consolidation St	Depth (ft)
0.0265882	0
0.0531765	0.470588
0.106353	0.941176
0.159529	1.41176
0.212706	1.88235
0.265882	2.35294
0.319059	2.82353
0.372235	3.29412
0.425412	3.76471
0.478588	4.23529
0.531765	4.70588
0.584941	5.17647
0.638118	5.64706
0.691294	6.11765
0.744471	6.58824
0.797647	7.05882
0.850824	7.52941
1.18515	8
1.53938	8.51429
1.63237	9.02857
1.72392	9.54286
1.80122	10.0571
1.85426	10.5714
1.8959	11.0857
1.93754	11.6
1.97917	12.1143
2.02081	12.6286
2.06245	13.1429
2.10408	13.6571
2.14572	14.1714
2.18736	14.6857
2.22957	15.2
2.27294	15.7429
2.31689	16.2857
2.36084	16.8286
2.40479	17.3714
2.44874	17.9143
2.49269	18.4571
2.05636	19
1.6107	19.5
1.636	20
1.6613	20.5
1.6866	21
1.7119	21.5
1.7372	22
1.7625	22.5
2.32794	23
2.90096	23.5
2.94144	24
2.98192	24.5
3.0224	25
3.06288	25.5

Maximum Effective Vertical Stress

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 7 (50 Years PC = 18850 d)

Effective Stress Z	Depth (ft)
0.585544	0
0.638638	0.470588
0.691271	0.941176
0.743127	1.41176
0.794103	1.88235
0.844272	2.35294
0.89381	2.82353
0.942921	3.29412
0.991787	3.76471
1.04055	4.23529
1.08932	4.70588
1.13816	5.17647
1.18711	5.64706
1.23621	6.11765
1.28547	6.58824
1.33488	7.05882
1.38445	7.52941
1.43418	8
1.4887	8.51429
1.54339	9.02857
1.59825	9.54286
1.64969	10.0571
1.67275	10.5714
1.69594	11.0857
1.71926	11.6
1.7427	12.1143
1.76624	12.6286
1.78988	13.1429
1.81362	13.6571
1.83744	14.1714
1.86134	14.6857
1.88532	15.2
1.9107	15.7429
1.93615	16.2857
1.96167	16.8286
1.98725	17.3714
2.01288	17.9143
2.03857	18.4571
2.0643	19
2.08804	19.5
2.11181	20
2.13562	20.5
2.15946	21
2.18333	21.5
2.20722	22
2.23114	22.5
2.25508	23
2.27904	23.5
2.30302	24
2.32702	24.5
2.35104	25
2.37507	25.5

Differential Settlement

IPS Generator Pad

Secondary Settlement Calculation

Project: SLC WRF
Project No.: 60664196
Analysis: Gen_NW (QP 5)
Date: 11/29/2021

Depth of the base of the foundation (ft): 0

Final σ'v to existing σ'p ratio for triggering secondary: 1.05

Time from preloading to construction (months): 0

Average Degree of consolidation at the end of primary consolidation (%): 98

Using Terzaghi equations the required Tv is: 1.500

Depth of the profile in which secondary consolidation is considered (ft): 200

Dividing each layer into at least 3 sublayer(s) with a maximum sublayer thickness of 1 ft

Soil layer	H (ft)	Depth of bot. of layer (ft)	$H_{modified}$ (ft)	double drainage	C_v (ft^2/day)	T_v check	U_{avg} check	$C_{\alpha r}$	t_{EOP} (days)	$t_{const.}$ (days)	t (days)	Mid. Layer existing σ'_p (psf)	Mid. Layer final σ'_v (psf)	No. of Sublayers	layer contribution to settlement (%)	ΔH (in)
60% Clay 1; 40% Silt 1	3.6	11.6	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	1763	1362	4	0%	0.00
60% Clay 1; 40% Silt 1	3.6	15.2	3.6	Yes	0.40	1.5	98.0	0.005	12.2	0	18262.5	2083	1551	4	0%	0.00
60% Clay 1; 40% Silt 1	3.8	19	3.8	Yes	0.40	1.5	98.0	0.005	13.5	0	18262.5	2383	1731	4	0%	0.00
Clay 2	10	33	10.0	Yes	2.00	1.5	98.0	0.014	18.8	0	18262.5	3265	2264	10	0%	0.00
50% Clay 3; 50% Silt	3	36	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2725	2584	3	0%	0.00
50% Clay 3; 50% Silt	3	39	3.0	Yes	1.30	1.5	98.0	0.004	2.6	0	18262.5	2900	2732	3	0%	0.00
85% Clay 3; 15% Silt	6	45	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3162	2954	6	0%	0.00
85% Clay 3; 15% Silt	6	51	6.0	Yes	1.30	1.5	98.0	0.005	10.4	0	18262.5	3511	3252	6	0%	0.00
50% Clay 3; 50% Silt	4.5	55.5	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	3816	3513	5	0%	0.00
50% Clay 3; 50% Silt	4.5	60	4.5	Yes	1.30	1.5	98.0	0.004	5.8	0	18262.5	4078	3737	5	0%	0.00
Clay 4	10	70	10.0	Yes	0.80	1.5	98.0	0.011	46.9	0	18262.5	5087	4098	10	0%	0.00
50% Clay 4; 50% Silt	2.5	72.5	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5498	4410	3	0%	0.00
50% Clay 4; 50% Silt	2.5	75	2.5	Yes	0.80	1.5	98.0	0.006	2.9	0	18262.5	5662	4535	3	0%	0.00
50% Clay 5; 50% Silt	5	87	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9336	5088	5	0%	0.00
50% Clay 5; 50% Silt	5	92	5.0	Yes	2.00	1.5	98.0	0.006	4.7	0	18262.5	9817	5339	5	0%	0.00
50% Clay 5; 50% Silt	4	96	4.0	Yes	2.00	1.5	98.0	0.006	3.0	0	18262.5	10249	5565	4	0%	0.00
Clay 5	15	111	15.0	Yes	2.00	1.5	98.0	0.012	42.2	0	18262.5	11163	6044	15	0%	0.00
Clay 5	7	120	7.0	Yes	2.00	1.5	98.0	0.012	9.2	0	18262.5	12420	6704	7	0%	0.00
Clay 5	4	126	4.0	Yes	2.00	1.5	98.0	0.012	3.0	0	18262.5	13149	7087	4	0%	0.00
Clay 5	2	136	2.0	Yes	2.00	1.5	98.0	0.012	0.8	0	18262.5	14237	7659	3	0%	0.00
Clay 5	20	158	20.0	Yes	2.00	1.5	98.0	0.012	75.0	0	18262.5	15494	8320	20	0%	0.00
Clay 5	32	200	32.0	Yes	2.00	1.5	98.0	0.012	192.0	0	18262.5	18993	10155	32	0%	0.00
															Total Secondary Settlement (in)	0.00

Note: Maximum number of sublayers is 50

Settle3 Model Layering

Bot. elev.	Layer	Thickness (ft)	Bottom Depth (ft)	Drained at Bottom?
4208	Unsaturated Sand/Clay	8	8	Yes
4204.4	60% Clay 1; 40% Silt 1	3.6	11.6	Yes
4200.8	60% Clay 1; 40% Silt 1	3.6	15.2	Yes
4197	60% Clay 1; 40% Silt 1	3.8	19	Yes
4193	Sand 1	4	23	Yes
4183	Clay 2	10	33	Yes
4180	50% Clay 3; 50% Silt	3	36	Yes
4177	50% Clay 3; 50% Silt	3	39	Yes
4171	85% Clay 3; 15% Silt	6	45	Yes
4165	85% Clay 3; 15% Silt	6	51	Yes
4160.5	50% Clay 3; 50% Silt	4.5	55.5	Yes
4156	50% Clay 3; 50% Silt	4.5	60	Yes
4146	Clay 4	10	70	Yes
4143.5	50% Clay 4; 50% Silt	2.5	72.5	Yes
4141	50% Clay 4; 50% Silt	2.5	75	Yes
4134	Sand 2	7	82	Yes
4129	50% Clay 5; 50% Silt	5	87	Yes
4124	50% Clay 5; 50% Silt	5	92	Yes
4120	50% Clay 5; 50% Silt	4	96	Yes
4105	Clay 5	15	111	Yes
4103	Sand 2	2	113	Yes
4096	Clay 5	7	120	Yes
4094	Sand 2	2	122	Yes
4090	Clay 5	4	126	Yes
4082	Sand 2	8	134	Yes
4080	Clay 5	2	136	Yes
4078	Sand 2	2	138	Yes
4058	Clay 5	20	158	Yes
4048	Sand 2	10	168	Yes
4016	Clay 5	32	200	Yes

Settle3 Model Clay Layers

Layer	Thickness (ft)	Bottom Depth (ft)	Double Drainage?
60% Clay 1; 40% Silt 1	3.6	11.6	Yes
60% Clay 1; 40% Silt 1	3.6	15.2	Yes
60% Clay 1; 40% Silt 1	3.8	19	Yes
Clay 2	10	33	Yes
50% Clay 3; 50% Silt	3	36	Yes
50% Clay 3; 50% Silt	3	39	Yes
85% Clay 3; 15% Silt	6	45	Yes
85% Clay 3; 15% Silt	6	51	Yes
50% Clay 3; 50% Silt	4.5	55.5	Yes
50% Clay 3; 50% Silt	4.5	60	Yes
Clay 4	10	70	Yes
50% Clay 4; 50% Silt	2.5	72.5	Yes
50% Clay 4; 50% Silt	2.5	75	Yes
50% Clay 5; 50% Silt	5	87	Yes
50% Clay 5; 50% Silt	5	92	Yes
50% Clay 5; 50% Silt	4	96	Yes
Clay 5	15	111	Yes
Clay 5	7	120	Yes
Clay 5	4	126	Yes
Clay 5	2	136	Yes
Clay 5	20	158	Yes
Clay 5	32	200	Yes

Soil Parameters

Layer	Coefficient of Consolidation, Cv (ft2/d)	CR	C_alpha/CR	C-alpha
60% Clay 1; 40% Silt 1	0.4	0.12	0.0442	0.005
Clay 2	2	0.24	0.0591	0.014
50% Clay 3; 50% Silt	1.3	0.07	0.0591	0.004
85% Clay 3; 15% Silt	1.3	0.119	0.0442	0.005
Clay 4	0.8	0.25	0.0442	0.011
50% Clay 4; 50% Silt	0.8	0.125	0.0442	0.006
50% Clay 5; 50% Silt	2	0.135	0.0442	0.006
Clay 5	2	0.27	0.0442	0.012

Existing Preconsolidation Pressure

Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Pre-consolidation Stress vs. Depth

Query Point 5 (Existing = 0 d)

Pre-consolidation St	Depth (ft)
0.0265882	0
0.0531765	0.470588
0.106353	0.941176
0.159529	1.41176
0.212706	1.88235
0.265882	2.35294
0.319059	2.82353
0.372235	3.29412
0.425412	3.76471
0.478588	4.23529
0.531765	4.70588
0.584941	5.17647
0.638118	5.64706
0.691294	6.11765
0.744471	6.58824
0.797647	7.05882
0.850824	7.52941
1.18515	8
1.53938	8.51429
1.63237	9.02857
1.72392	9.54286
1.80122	10.0571
1.85426	10.5714
1.8959	11.0857
1.93754	11.6
1.97917	12.1143
2.02081	12.6286
2.06245	13.1429
2.10408	13.6571
2.14572	14.1714
2.18736	14.6857
2.22957	15.2
2.27294	15.7429
2.31689	16.2857
2.36084	16.8286
2.40479	17.3714
2.44874	17.9143
2.49269	18.4571
2.05636	19
1.6107	19.5
1.636	20
1.6613	20.5
1.6866	21
1.7119	21.5
1.7372	22
1.7625	22.5
2.32794	23
2.90096	23.5
2.94144	24
2.98192	24.5
3.0224	25
3.06288	25.5

Maximum Effective Vertical Stress

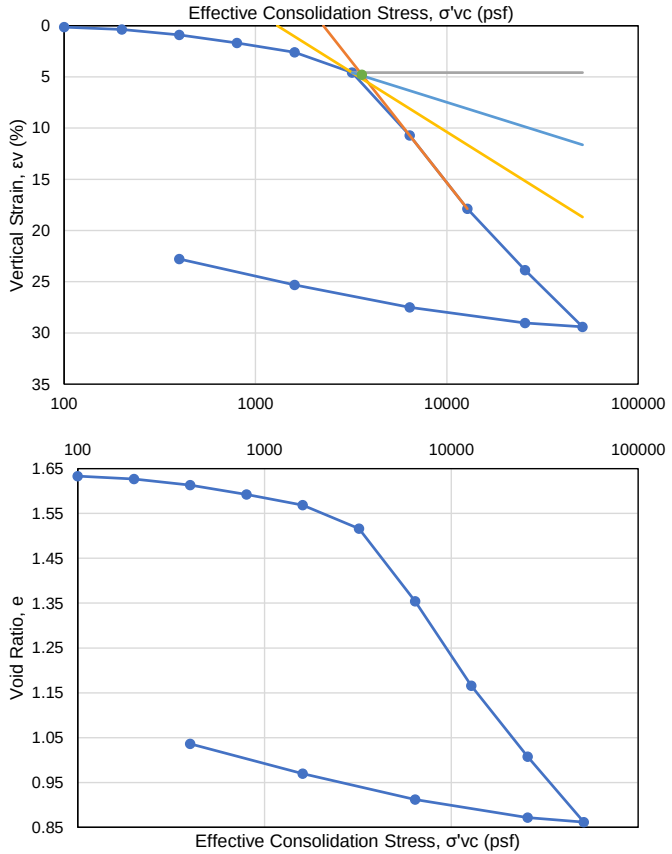
Project Title: Offsite IPS Settlement
Filename: New_IPS_R2_shallow_11-23-2021.s3z
Graph Title: Effective Stress ZZ vs. Depth

Query Point 5 (50 Years PC = 18850 d)

Effective Stress Z	Depth (ft)
0.3	0
0.320584	0.470588
0.373727	0.941176
0.426815	1.41176
0.479831	1.88235
0.532764	2.35294
0.585612	2.82353
0.638378	3.29412
0.691069	3.76471
0.743693	4.23529
0.796259	4.70588
0.848776	5.17647
0.901251	5.64706
0.953691	6.11765
1.0061	6.58824
1.05849	7.05882
1.11086	7.52941
1.16321	8
1.2204	8.51429
1.27758	9.02857
1.33474	9.54286
1.38833	10.0571
1.41338	10.5714
1.43843	11.0857
1.46347	11.6
1.4885	12.1143
1.51353	12.6286
1.53855	13.1429
1.56357	13.6571
1.5886	14.1714
1.61362	14.6857
1.63864	15.2
1.66506	15.7429
1.69148	16.2857
1.71791	16.8286
1.74434	17.3714
1.77077	17.9143
1.79722	18.4571
1.82367	19
1.84804	19.5
1.87242	20
1.89681	20.5
1.92121	21
1.94561	21.5
1.97003	22
1.99445	22.5
2.01888	23
2.04333	23.5
2.06778	24
2.09225	24.5
2.11672	25
2.14121	25.5

Attachment 4: Interpretations of Laboratory Consolidation Tests

Stress (psf)	Dial (in)	1-D εv (%)	Hc (in)	e
Seating	0.0000	0	0.919	1.6369
100	0.0013	0.14	0.9177	1.6333
200	0.0034	0.37	0.9156	1.6271
400	0.0082	0.89	0.9108	1.6133
800	0.0155	1.68	0.9035	1.5925
1600	0.0238	2.59	0.8952	1.5685
3200	0.0421	4.58	0.8769	1.5162
6400	0.0985	10.72	0.8205	1.3543
12800	0.1642	17.87	0.7548	1.1658
25600	0.2194	23.87	0.6996	1.0074
51200	0.2702	29.4	0.6488	0.8616
25600	0.2667	29.02	0.6523	0.8717
6400	0.2527	27.5	0.6663	0.9118
1600	0.2326	25.31	0.6864	0.9695
400	0.2093	22.77	0.7097	1.0364



Boring No.: BH19-ES-1
Sample: 10
ility **Depth:** 35'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

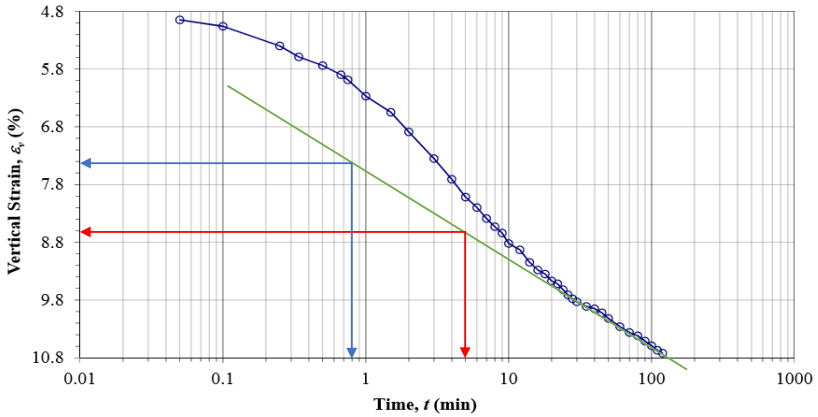
Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9190	1.6369
100	0.0013	0.14	0.9177	1.6333
200	0.0034	0.37	0.9156	1.6271
400	0.0082	0.89	0.9108	1.6133
800	0.0155	1.68	0.9035	1.5925
1600	0.0238	2.59	0.8952	1.5685
3200	0.0421	4.58	0.8769	1.5162
6400	0.0985	10.72	0.8205	1.3543
12800	0.1642	17.87	0.7548	1.1658
25600	0.2194	23.87	0.6996	1.0074
51200	0.2702	29.40	0.6488	0.8616
25600	0.2667	29.02	0.6523	0.8717
6400	0.2527	27.50	0.6663	0.9118
1600	0.2326	25.31	0.6864	0.9695
400	0.2093	22.77	0.7097	1.0364

Boring No.	ES-1			Adjustment
Depth	35	ft		Max Strain 0.294
				Min Strain 0
Compression Ratios				Span 0.294
CR	0.238			Adjustment 5.102040816
RR	0.042			
CR/RR	5.6			Strain - Virgin Points
				12800 17.87
Compression Indices				2263.838758 0
Cc	0.626			
Cr	0.111			Strain - Knee Line
Cc/Cr	5.6			3200 4.58
				51200 4.58
Casagrande Preconsolidation Pressure				
Knee	3200			Strain Tangent
Sig'c	3600	4.78496376		1300.242868 0
D-Slope Ratio	0.705782313			51200 18.68
Alignment	Good			
Calpha	0.0151			Strain - Bisector
Calpha/CR	0.0635			3200 4.58
Quality	Fair			51200 11.63

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

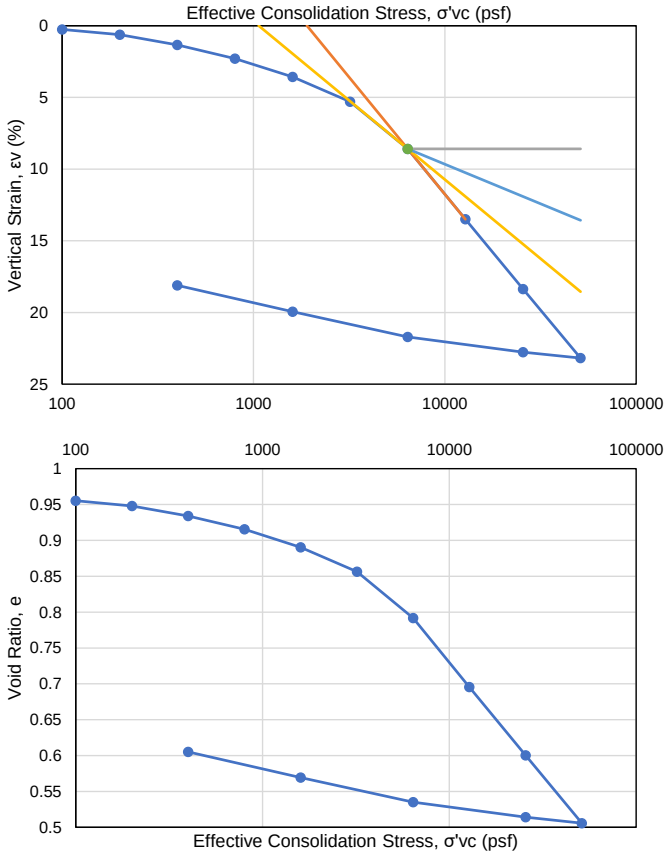
Boring No.: BH19-ES-1
Sample: 10
Depth: 35'

Constant Load Step: 7 of 14
Stress: 6400 psf



C_alpha		
time_a	0.8	mins
Strain_a	7.4	%
time_b	5	mins
Strain_b	8.6	%

Stress (psf)	Dial (in)	1-D εv (%)	Hc (in)	e
Seating	0.0000	0	0.92	0.9603
100	0.0024	0.26	0.9176	0.9553
200	0.0058	0.63	0.9142	0.9479
400	0.0123	1.34	0.9077	0.934
800	0.0210	2.29	0.899	0.9155
1600	0.0328	3.57	0.8872	0.8904
3200	0.0488	5.3	0.8712	0.8564
6400	0.0791	8.59	0.8409	0.7918
12800	0.1242	13.5	0.7958	0.6957
25600	0.1689	18.36	0.7511	0.6004
51200	0.2133	23.18	0.7067	0.5058
25600	0.2094	22.76	0.7106	0.5141
6400	0.1996	21.7	0.7204	0.535
1600	0.1835	19.95	0.7365	0.5693
400	0.1666	18.11	0.7534	0.6053



Boring No.: BH19-ES-1
Sample: 21
Depth: 85'
cility
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9200	0.9603
100	0.0024	0.26	0.9176	0.9553
200	0.0058	0.63	0.9142	0.9479
400	0.0123	1.34	0.9077	0.9340
800	0.0210	2.29	0.8990	0.9155
1600	0.0328	3.57	0.8872	0.8904
3200	0.0488	5.30	0.8712	0.8564
6400	0.0791	8.59	0.8409	0.7918
12800	0.1242	13.50	0.7958	0.6957
25600	0.1689	18.36	0.7511	0.6004
51200	0.2133	23.18	0.7067	0.5058
25600	0.2094	22.76	0.7106	0.5141
6400	0.1996	21.70	0.7204	0.5350
1600	0.1835	19.95	0.7365	0.5693
400	0.1666	18.11	0.7534	0.6053

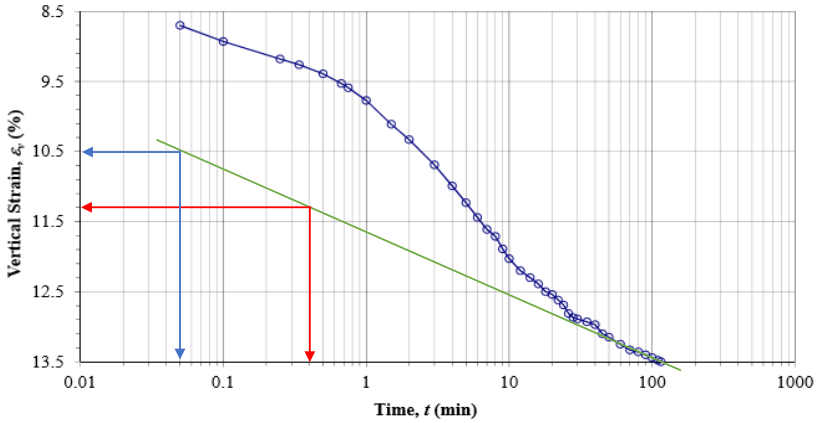
Boring No.	ES-1
Depth	85 ft
Compression Ratios	
CR	0.163
RR	0.031
CR/RR	5.3
Compression Indices	
Cc	0.319
Cr	0.060
Cc/Cr	5.3
Casagrande Preconsolidation Pressure	
Knee	6400
Sig'c	6400
D-Slope Ratio	0.406015038
Alignment	Fair
Calpha	0.0089
Calpha/CR	0.0543
Quality	Poor

Adjustment		
Max Strain	0.2318	
Min Strain	0	
Span	0.2318	
Adjustment	6.471095772	
Strain - Virgin Points		
	12800	13.5
	1903.403026	0
Strain - Knee Line		
	6400	8.59
	51200	8.59
	8.59	
Strain Tangent		
	1064.903357	0
	51200	18.55
Strain - Bisector		
	6400	8.59
	51200	13.57

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

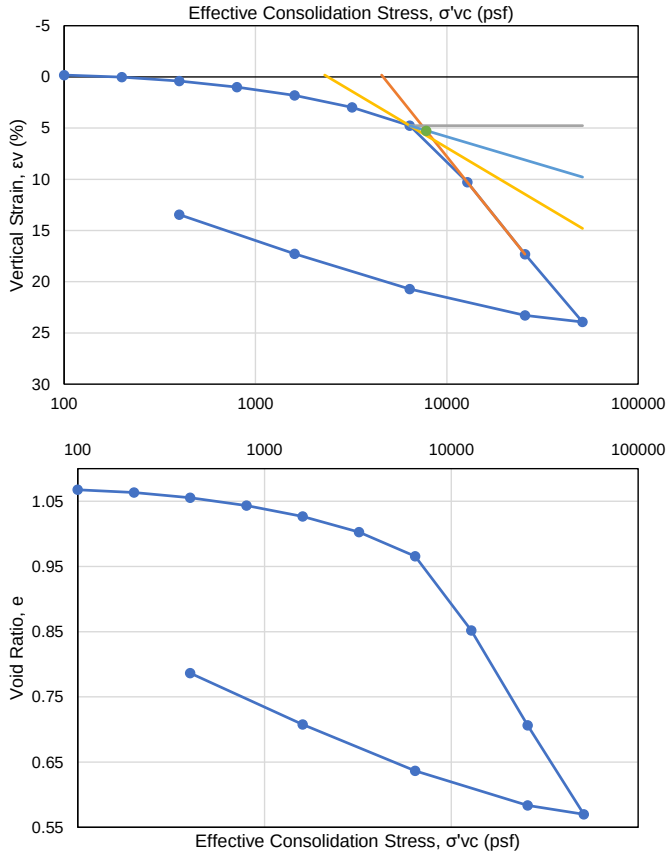
Boring No.: BH19-ES-1
Sample: 21
Depth: 85'

Constant Load Step: 8 of 14
Stress: 12800 psf



C_alpha	
time_a	0.05 mins
Strain_a	10.5 %
time_b	0.4 mins
Strain_b	11.3 %

Stress (psf)	Dial (in)	1-D εv (%)	Hc (in)	e
Seating	0.0000	0	0.919	1.0638
100	-0.0017	-0.18	0.9207	1.0676
200	0.0001	0.02	0.9189	1.0635
400	0.0037	0.41	0.9153	1.0554
800	0.0091	0.99	0.9099	1.0433
1600	0.0166	1.8	0.9024	1.0266
3200	0.0273	2.97	0.8918	1.0026
6400	0.0437	4.76	0.8753	0.9656
12800	0.0945	10.28	0.8245	0.8517
25600	0.1591	17.31	0.7599	0.7065
51200	0.2199	23.93	0.6991	0.57
25600	0.2139	23.28	0.7051	0.5835
6400	0.1903	20.71	0.7287	0.6365
1600	0.1586	17.26	0.7604	0.7076
400	0.1235	13.44	0.7955	0.7865



Boring No.: BH19-ES-1
Sample: 24
ility **Depth:** 100'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

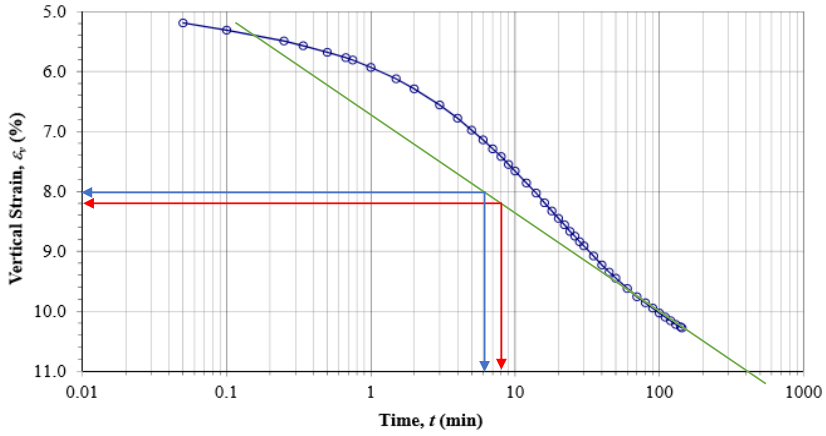
Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9190	1.0638
100	-0.0017	-0.18	0.9207	1.0676
200	0.0001	0.02	0.9189	1.0635
400	0.0037	0.41	0.9153	1.0554
800	0.0091	0.99	0.9099	1.0433
1600	0.0166	1.80	0.9024	1.0266
3200	0.0273	2.97	0.8918	1.0026
6400	0.0437	4.76	0.8753	0.9656
12800	0.0945	10.28	0.8245	0.8517
25600	0.1591	17.31	0.7599	0.7065
51200	0.2199	23.93	0.6991	0.5700
25600	0.2139	23.28	0.7051	0.5835
6400	0.1903	20.71	0.7287	0.6365
1600	0.1586	17.26	0.7604	0.7076
400	0.1235	13.44	0.7955	0.7865

Boring No.	ES-1		Adjustment	
Depth	100	ft	Max Strain	0.2393
			Min Strain	-0.00018
Compression Ratios			Span	0.23948
CR	0.234		Adjustment	6.263571071
RR	0.063			
CR/RR	3.7		Strain - Virgin Points	
			25600	17.31
Compression Indices			4563.570262	-0.18
Cc	0.482			
Cr	0.131		Strain - Knee Line	
Cc/Cr	3.7		6400	4.76
			51200	4.76
Casagrande Preconsolidation Pressure				
Knee	6400		Strain Tangent	
Sig'c	7800	5.256377599	2299.373474	-0.18
D-Slope Ratio	0.728515625		51200	14.795
Alignment	Good			
Calpha	0.0160		Strain - Bisector	
Calpha/CR	0.0685		6400	4.76
Quality	Fair		51200	9.7775

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

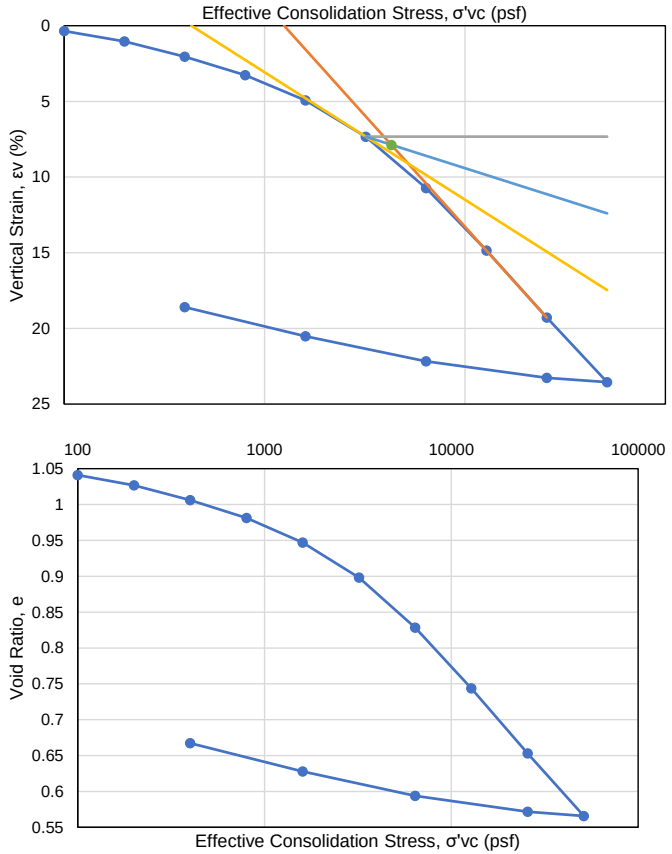
Boring No.: BH19-ES-1
Sample: 24
Depth: 100'

Constant Load Step: 8 of 14
Stress: 12800 psf



C_alpha	
time_a	6 mins
Strain_a	8 %
time_b	8 mins
Strain_b	8.2 %

Stress (psf)	Dial (in)	1-D εv (%)	Hc (in)	e
Seating	0.0000	0	0.921	1.0481
100	0.0032	0.35	0.9178	1.041
200	0.0096	1.04	0.9114	1.0268
400	0.0189	2.05	0.9021	1.0062
800	0.0302	3.27	0.8908	0.9811
1600	0.0455	4.94	0.8755	0.947
3200	0.0675	7.33	0.8535	0.898
6400	0.0988	10.73	0.8222	0.8283
12800	0.1369	14.86	0.7841	0.7437
25600	0.1777	19.29	0.7433	0.653
51200	0.2169	23.55	0.7041	0.5658
25600	0.2142	23.26	0.7068	0.5718
6400	0.2042	22.17	0.7168	0.594
1600	0.1890	20.52	0.732	0.6278
400	0.1713	18.6	0.7497	0.6672



Boring No.: BH19-ES-2
Sample: 6
ility **Depth:** 20'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

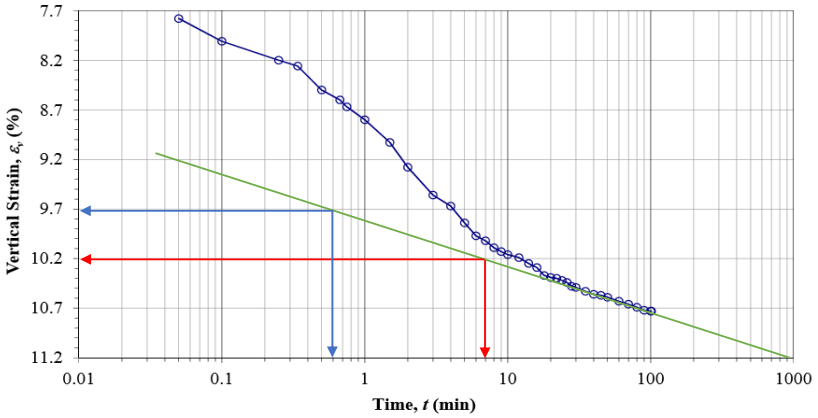
Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9210	1.0481
100	0.0032	0.35	0.9178	1.0410
200	0.0096	1.04	0.9114	1.0268
400	0.0189	2.05	0.9021	1.0062
800	0.0302	3.27	0.8908	0.9811
1600	0.0455	4.94	0.8755	0.9470
3200	0.0675	7.33	0.8535	0.8980
6400	0.0988	10.73	0.8222	0.8283
12800	0.1369	14.86	0.7841	0.7437
25600	0.1777	19.29	0.7433	0.6530
51200	0.2169	23.55	0.7041	0.5658
25600	0.2142	23.26	0.7068	0.5718
6400	0.2042	22.17	0.7168	0.5940
1600	0.1890	20.52	0.7320	0.6278
400	0.1713	18.60	0.7497	0.6672

Boring No.	ES-2		Adjustment	
Depth	20	ft	Max Strain	0.2355
			Min Strain	0
Compression Ratios			Span	0.2355
CR	0.147		Adjustment	6.369426752
RR	0.032			
CR/RR	4.6		Strain - Virgin Points	
			25600	19.29
Compression Indices			1251.510243	0
Cc	0.301			
Cr	0.065		Strain - Knee Line	
Cc/Cr	4.6		3200	7.33
			51200	7.33
Casagrande Preconsolidation Pressure				
Knee	3200		Strain Tangent	
Sig'c	4300	7.888352863	431.2370885	0
D-Slope Ratio	0.291066282		51200	17.47
Alignment	Poor			
Calpha	0.0047		Strain - Bisector	
Calpha/CR	0.0318		3200	7.33
Quality	Good		51200	12.4

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

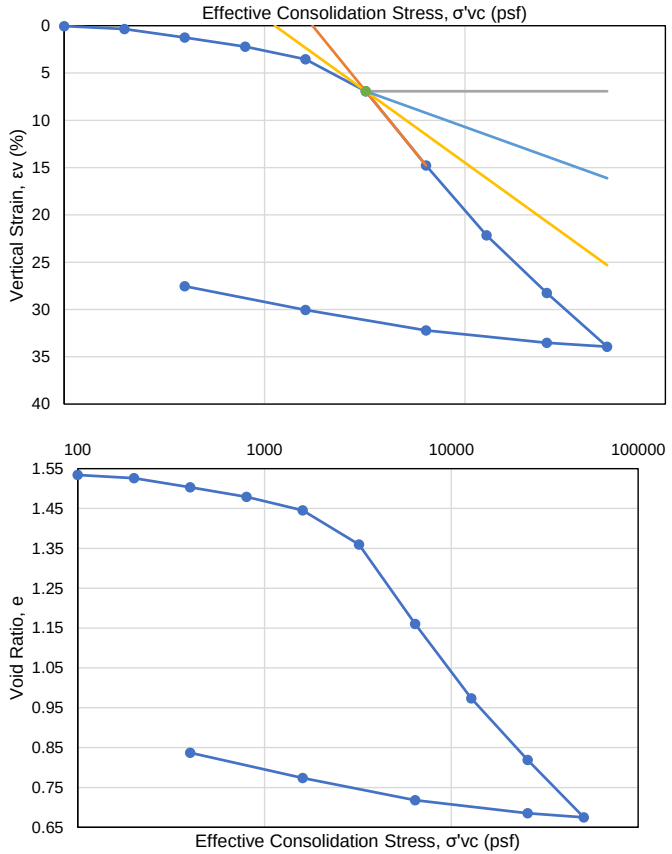
Boring No.: BH19-ES-2
Sample: 6
Depth: 20'

Constant Load Step: 7 of 14
Stress: 6400 psf



C_alpha	
time_a	0.6 mins
Strain_a	9.7 %
time_b	7 mins
Strain_b	10.2 %

Stress (psf)	Dial (in)	1-D εv (%)	Hc (in)	e
Seating	0.0000	0	0.919	1.5352
100	0.0004	0.04	0.9186	1.5341
200	0.0033	0.35	0.9157	1.5262
400	0.0115	1.25	0.9075	1.5034
800	0.0203	2.21	0.8987	1.4791
1600	0.0326	3.55	0.8864	1.4453
3200	0.0637	6.93	0.8553	1.3594
6400	0.1358	14.78	0.7832	1.1605
12800	0.2036	22.15	0.7154	0.9735
25600	0.2596	28.25	0.6594	0.819
51200	0.3118	33.93	0.6072	0.675
25600	0.3081	33.53	0.6109	0.6852
6400	0.2961	32.22	0.6229	0.7183
1600	0.2761	30.04	0.6429	0.7735
400	0.2530	27.53	0.666	0.8372



Boring No.: BH19-ES-2
Sample: 10
lity **Depth:** 35'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

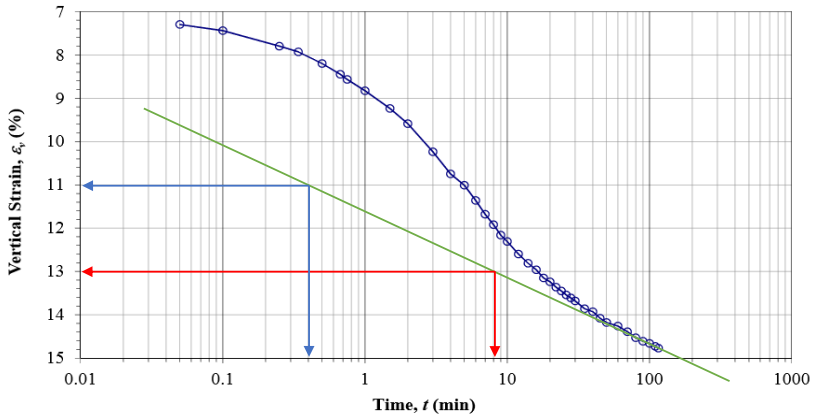
Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9190	1.5352
100	0.0004	0.04	0.9186	1.5341
200	0.0033	0.35	0.9157	1.5262
400	0.0115	1.25	0.9075	1.5034
800	0.0203	2.21	0.8987	1.4791
1600	0.0326	3.55	0.8864	1.4453
3200	0.0637	6.93	0.8553	1.3594
6400	0.1358	14.78	0.7832	1.1605
12800	0.2036	22.15	0.7154	0.9735
25600	0.2596	28.25	0.6594	0.8190
51200	0.3118	33.93	0.6072	0.6750
25600	0.3081	33.53	0.6109	0.6852
6400	0.2961	32.22	0.6229	0.7183
1600	0.2761	30.04	0.6429	0.7735
400	0.2530	27.53	0.6660	0.8372

Boring No.	ES-2		Adjustment
Depth	35	ft	Max Strain 0.3393
			Min Strain 0
Compression Ratios			Span 0.3393
CR	0.261		Adjustment 4.42086649
RR	0.042		
CR/RR	6.3		Strain - Virgin Points
			6400 14.78
Compression Indices			1735.401351 0
Cc	0.661		
Cr	0.106		Strain - Knee Line
Cc/Cr	6.2		3200 6.93
			51200 6.93
Casagrande Preconsolidation Pressure			
Knee	3200		Strain Tangent
Sig'c	3200	6.93	1124.988973 0
D-Slope Ratio	0.677786202		51200 25.31
Alignment	Good		
Calpha	0.0154		Strain - Bisector
Calpha/CR	0.0589		3200 6.93
Quality	Fair		51200 16.12

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

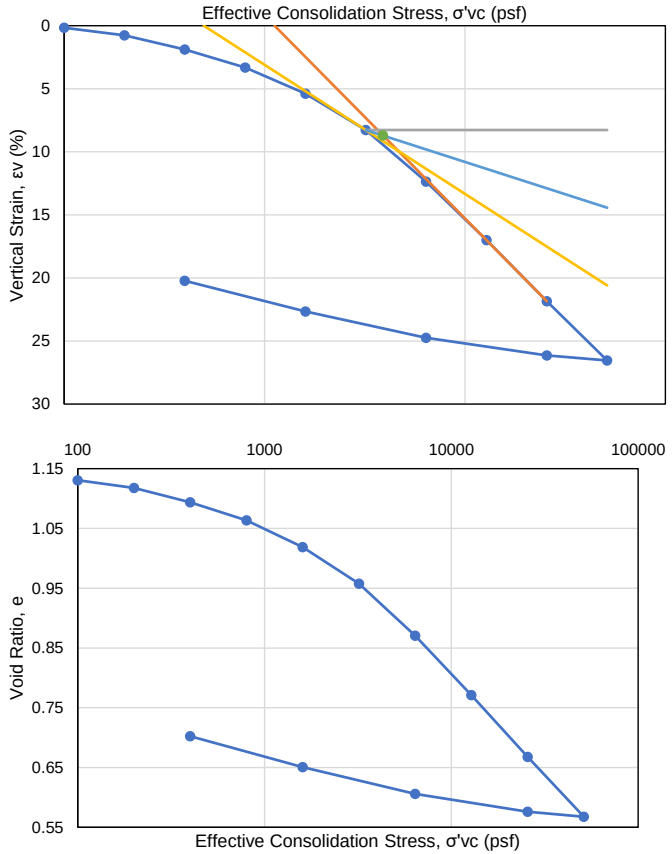
Boring No.: BH19-ES-2
Sample: 10
Depth: 35'

Constant Load Step: 7 of 14
Stress: 6400 psf



C_alpha	
time_a	0.4 mins
Strain_a	11 %
time_b	8 mins
Strain_b	13 %

Stress (psf)	Dial (in)	1-D εv (%)	Hc (in)	e
Seating	0.0000	0	0.924	1.134
100	0.0015	0.16	0.9225	1.1306
200	0.0071	0.77	0.9169	1.1177
400	0.0174	1.89	0.9066	1.0938
800	0.0306	3.31	0.8934	1.0634
1600	0.0498	5.39	0.8742	1.0189
3200	0.0764	8.27	0.8476	0.9575
6400	0.1141	12.35	0.8099	0.8705
12800	0.1571	17	0.7669	0.7712
25600	0.2018	21.84	0.7222	0.668
51200	0.2452	26.54	0.6788	0.5677
25600	0.2416	26.15	0.6824	0.576
6400	0.2287	24.75	0.6953	0.6058
1600	0.2093	22.65	0.7147	0.6506
400	0.1869	20.23	0.7371	0.7024



Boring No.: BH19-ES-2
Sample: 14
ility **Depth:** 55'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

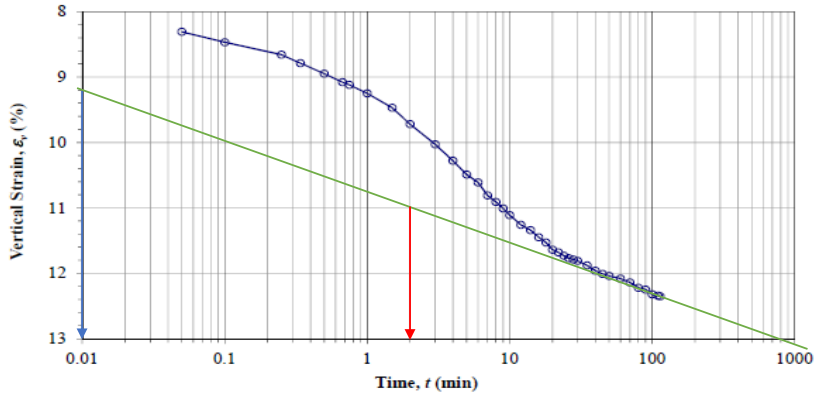
Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9240	1.1340
100	0.0015	0.16	0.9225	1.1306
200	0.0071	0.77	0.9169	1.1177
400	0.0174	1.89	0.9066	1.0938
800	0.0306	3.31	0.8934	1.0634
1600	0.0498	5.39	0.8742	1.0189
3200	0.0764	8.27	0.8476	0.9575
6400	0.1141	12.35	0.8099	0.8705
12800	0.1571	17.00	0.7669	0.7712
25600	0.2018	21.84	0.7222	0.6680
51200	0.2452	26.54	0.6788	0.5677
25600	0.2416	26.15	0.6824	0.5760
6400	0.2287	24.75	0.6953	0.6058
1600	0.2093	22.65	0.7147	0.6506
400	0.1869	20.23	0.7371	0.7024

Boring No.	ES-2			Adjustment
Depth	55	ft		Max Strain 0.2654
				Min Strain 0
Compression Ratios				Span 0.2654
CR	0.161			Adjustment 5.65184627
RR	0.040			
CR/RR	4.0			Strain - Virgin Points
				25600 21.84
Compression Indices				1121.69093 0
Cc	0.343			
Cr	0.086			Strain - Knee Line
Cc/Cr	4.0			3200 8.27
				51200 8.27
Casagrande Preconsolidation Pressure				
Knee	3200			Strain Tangent
Sig'c	3900	8.701346739		497.5822649 0
D-Slope Ratio	0.330578512			51200 20.59
Alignment	Poor			
Calpha	0.0122			Strain - Bisector
Calpha/CR	0.0757			3200 8.27
Quality	Good			51200 14.43

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

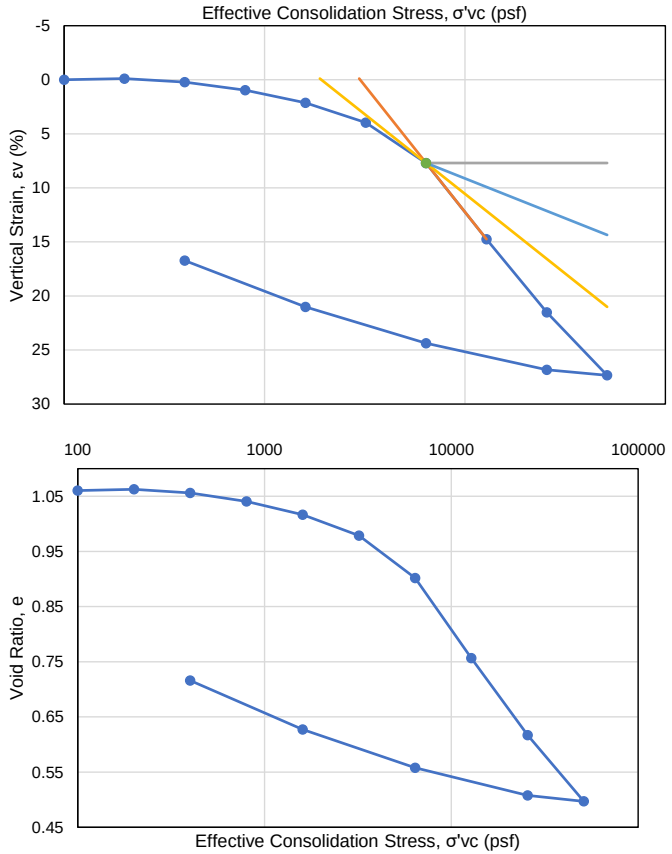
Boring No.: BH19-ES-2
Sample: 14
Depth: 55'

Constant Load Step: 7 of 14
Stress: 6400 psf



C_alpha	
time_a	0.01 mins
Strain_a	8.2 %
time_b	2 mins
Strain_b	11 %

Stress (psf)	Dial (in)	1-D εv (%)	Hc (in)	e
Seating	0.0000	0	0.918	1.0604
100	0.0000	0	0.918	1.0604
200	-0.0010	-0.11	0.919	1.0625
400	0.0020	0.22	0.916	1.0558
800	0.0089	0.97	0.9091	1.0405
1600	0.0196	2.13	0.8985	1.0165
3200	0.0363	3.96	0.8817	0.9788
6400	0.0707	7.7	0.8474	0.9018
12800	0.1353	14.74	0.7827	0.7567
25600	0.1975	21.51	0.7205	0.6171
51200	0.2510	27.34	0.667	0.497
25600	0.2462	26.82	0.6718	0.5078
6400	0.2238	24.38	0.6942	0.5581
1600	0.1929	21.01	0.7251	0.6274
400	0.1535	16.72	0.7645	0.7159



Boring No.: BH19-ES-2
Sample: 23
Depth: 100'
Sample Description: Grey clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from Shelby tube

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.0000	0.00	0.9180	1.0604
100	0.0000	0.00	0.9180	1.0604
200	-0.0010	-0.11	0.9190	1.0625
400	0.0020	0.22	0.9160	1.0558
800	0.0089	0.97	0.9091	1.0405
1600	0.0196	2.13	0.8985	1.0165
3200	0.0363	3.96	0.8817	0.9788
6400	0.0707	7.70	0.8474	0.9018
12800	0.1353	14.74	0.7827	0.7567
25600	0.1975	21.51	0.7205	0.6171
51200	0.2510	27.34	0.6670	0.4970
25600	0.2462	26.82	0.6718	0.5078
6400	0.2238	24.38	0.6942	0.5581
1600	0.1929	21.01	0.7251	0.6274
400	0.1535	16.72	0.7645	0.7159

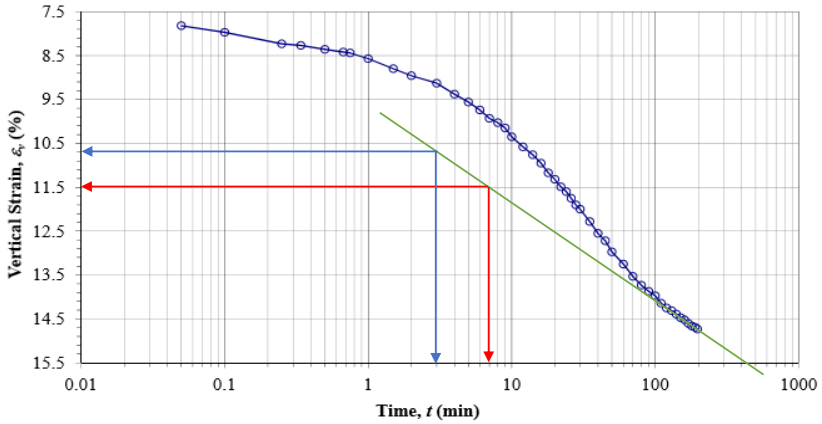
Boring No.	ES-2		
Depth	100	ft	
Compression Ratios			
CR	0.234		
RR	0.071		
CR/RR	3.3		
Compression Indices			
Cc	0.482		
Cr	0.147		
Cc/Cr	3.3		
Casagrande Preconsolidation Pressure			
Knee	6400		
Sig'c	6400		
D-Slope Ratio	0.674157303		
Alignment	Good		
Calpha	0.0217		
Calpha/CR	0.0930		
Quality	Poor		

Adjustment			
Max Strain	0.2734		
Min Strain	-0.00011		
Span	0.27351		
Adjustment	5.484260173		
Strain - Virgin Points			
	12800	14.74	
	2966.3666	-0.11	
Strain - Knee Line			
	6400	7.7	
	51200	7.7	
Strain Tangent			
7.7	1888.289279	-0.11	
	51200	21.005	
Strain - Bisector			
	6400	7.7	
	51200	14.3525	

Project: AECOM
No: 00100-015, 3G2 (XIII)
Location: SLCity Public Utilities Waste Water Reclamation Facility

Boring No.: BH19-ES-2
Sample: 23
Depth: 100'

Constant Load Step: 8 of 14
Stress: 12800 psf



C_alpha	
time_a	3 mins
Strain_a	10.7 %
time_b	7 mins
Strain_b	11.5 %

Salt Lake City Water Reclamation Facility
Influent Pump Station
Lateral Earth Pressure Calculation

Purpose

This calculation references the source and details the approach and methodology used to estimate lateral earth pressure for the Influent Pump Station (IPS) facilities planned at the New Salt Lake City New Water Reclamation Facility (New WRF). The project is located at 2300 North, west of Interstate 15 highway in Salt Lake County, Utah. The Influent Pump Station (IPS) and associated facilities are located approximately 0.5 mile southeast of the other liquid train facilities, near 1200 West and Reclamation Rd immediately south of the existing Salt Lake City Department of Public Utilities (SLCDPU) pump station site. The Influent Force Main Pipeline extends from the IPS to the beginning of the remaining Liquid Train facilities, which are located near the southwest corner of the New WRF site.

Data Available

Geotechnical explorations of subsurface conditions were performed by AECOM and a subconsultant, IGES, between 2018 and 2021 for the proposed locations of the IPS and Influent Pipeline. Soil parameters were selected based on available field and laboratory testing from explorations near the IPS and Influent Pipeline. Unit weight and friction angle of the fill were assumed and are described under the Assumptions section. In this calculation, unit weights were selected separately for facilities considering the proximity of the facilities to the available investigations. Field investigations used for each facility are summarized in Table 1. For the IPS and associated facilities, and for the Influent Force Main Pipeline, input soil parameters were selected based on a review of available field and laboratory testing from the liquid train area, as well as from the investigations in the immediate vicinity of the IPS and Influent Force Main Pipeline.

For the IPS and associated facilities, unit weight was selected based on the range and average of unit weight tests from explorations in the in the immediate vicinity of the IPS. Fill is anticipated to be limited to approximately 2 to 4 feet adjacent to facilities associated with the IPS (Electrical facility, Odor Control, Generator Pad). For the IPS, excavation shoring is anticipated to facilitate an excavation of approximately 48 feet below original grade. Lateral earth pressures were developed based on native materials, which may be needed for shoring design, as well as for standard weight backfill and lightweight backfill which are being considered for use adjacent to the IPS. Shear strengths for these materials were selected based on available lab test data and experience with similar materials. For the Influent Force Main Pipeline, soil parameters were selected based on a review of field and laboratory data from explorations performed in the area of the IPS and along the Influent Force Main Pipeline. For conservatism, shear strength parameters were generally selected on the low side of the anticipated range, and unit weight parameters were selected on the high side for active and at-rest calculations and on the low side for passive calculations.

Table 1. Field Investigations and Layer Thickness Considered for Facilities

Structure	Field Investigation(s)	Native Clay Thickness (feet)	Fill Thickness (feet)
IPS	All B21-OIPS and B21-IS Investigations	48.0	4.0
IPS Electrical Building	All B21-OIPS and B21-IS Investigations	2.0	1.0
IPS Odor Control	All B21-OIPS and B21-IS Investigations	1.5	1.0
IPS Generator Pad	All B21-OIPS and B21-IS Investigations	1.5	1.0
Influent Force Main Pipeline	All B21-OIPS and B21-IS Investigations	12.0[1]	0.0[1]

Notes:
1. Fill thickness and depth of pipeline vary along the alignment. For lateral earth pressure analyses, native clay soil parameters were used for the full depth of the pipeline.

The unit weights used for the Active, At-rest, and Passive cases are summarized in Table 2 and Table 3, respectively. Table 4 presents the friction angles used in analysis.

Table 2. Soil Unit Weight for At-rest and Active Cases

Structure	Fill Unit Weight (pcf)	Native Clay Unit Weight (pcf)	Weighted Average (pcf)
IPS Area – Native	--	125.0	--
IPS Area – Fill	135.0	--	--
IPS Area – Lightweight Fill	100.0	--	--
Influent Force Main Pipeline	--	125.0	--

Table 3. Soil Unit Weight for Passive Case

Structure	Fill Unit Weight (pcf)	Native Clay Unit Weight (pcf)	Weighted Average (pcf)
IPS Area – Native	--	105.0	--
IPS Area – Fill	115.0	--	--
IPS Area – Lightweight Fill	70.0	--	--
Influent Force Main Pipeline	--	105.0	--

Table 4. Soil Friction Angle

Structure	Fill Friction Angle (degrees)	Native Clay Friction Angle (degrees)	Weighted Average Friction Angle (degrees)
IPS Area – Native	--	26.0	--
IPS Area – Fill	34.0	--	--
IPS Area – Lightweight Fill	30.0	--	--
Influent Force Main Pipeline	--	26.0	--

According to AASHTO LRDF BDS 8th Ed. 2017 Section A11.3.2.p 11-112, where a small amount of deflection can be tolerated, k_h can be taken as half of the peak ground acceleration. Where structures are assumed to be non-displacing, the full peak ground acceleration is used. In this study, the value of peak ground acceleration was obtained from a site-specific seismic hazard analysis for the new water reclamation facility done by Lettis Consultants International in accordance with ASCE 7-16 (ASCE 2016). The geometric mean peak ground acceleration, PGA_M is listed in Table 5.

Table 5. Summary of 2,475-Year Return Period Ground Motion Design Parameters

Source	Mean Earthquake Magnitude, M (-)	Mean Source-Site Distance, D (km)	Modal Earthquake Magnitude, M (-)	Modal Source-Site Distance, D (km)	Peak Ground Acceleration, PGA (g)	Peak Ground Acceleration adjusted for Site Class effects, PGA_M (g)
PSHA, 2018[1]	7.1	3.2	7.1	2.5	0.62	0.62

Notes: g = acceleration due to gravity; km = kilometer; PGA = peak ground acceleration

1. "Site-Specific Seismic Hazard Analyses and Development of Seismic Design Ground Motions for the Salt Lake City Water Reclamation Facility, Utah." LCI, 2018.

Assumptions

The following assumptions were made regarding this calculation and supporting data:

- Laboratory tests were performed in accordance with the referenced American Society for Testing and Materials (ASTM) standards and are reported accurately by the subcontracted testing facility.

- Samples tested in the laboratory are representative of the soil unit from which they were obtained. Further, the results of the testing are indicative of material properties for the soil unit.
- The friction angle of the fill is approximately 34 degrees or more. The unit weight of the fill is approximately 135 pcf for the active and at-rest conditions, while it is assumed to be 115 pcf for the passive case.
- The friction angle of the lightweight fill, if used, is approximately 30 degrees or more. The unit weight of the lightweight fill is approximately 100 pcf for the active and at-rest conditions, while it is assumed to be 70 pcf for the passive case.
- Frictional resistance between the soil and wall is characterized by an interface friction angle of two-thirds the soil friction angle for the granular fill material and one-half the soil friction angle for clay material. In some cases where the structure was embedded in both materials, a weighted average based on layer thickness was used.
- The vertical seismic coefficient is assumed to be zero.

Methodology

Earth-retaining and buried structures should be designed considering the lateral earth pressure presented in this package. Typically, to facilitate the application of lateral earth pressure in design for each of the structures, an equivalent fluid weight will be reported for the static and seismic load cases. Equivalent fluid pressures have a triangular pressure distribution in a form similar to that of water but having a different magnitude. In other words, the lateral earth pressure of soil is assumed to increase linearly from the ground surface (i.e., top of the soil adjacent to the wall or foundation) to the base of the wall or foundation if the soil layer is homogenous. In some cases where the embedding depth is below 4,211 feet and the foundation or wall is in contact with a 2-layered soil system, lateral earth pressure of soil is assumed to increase linearly from the ground surface to the interface between two soils. The lateral earth pressure is then assumed to continue to increase linearly with a different slope from the interface down to the bottom of the foundation or wall. The lateral earth pressure coefficients were converted to equivalent fluid weights using the following relationship:

$$\gamma_{LE} = K\gamma'$$

where, γ_{LE} = Equivalent Fluid Weight (same units as γ')

K = Lateral Earth Pressure Coefficient (active/at-rest/passive)

γ' = Effective Soil Unit Weight

The structural designer will be provided equivalent fluid weights and dynamic components of equivalent fluid weights for each of the load cases. Equivalent fluid weights are intended to account only for soil pressure; water pressures must be added to the lateral earth pressures developed in this calculation.

More movement is required to mobilize full passive earth pressures than active earth pressures. More soil strain and movement generally are needed for fine-grained soils to develop full strength, as compared to coarser-grained soils. The magnitude of movement required to mobilize full active and passive earth pressures can be approximated in terms of the ratio of movement of the top of the wall (needed to reach minimum active or maximum passive pressure) to the height of the wall. For the conditions and soil types observed, it is recommended that values of 0.002 and 0.04 be assumed for this ratio in active and passive earth pressure conditions, respectively, for structures bearing in granular fill (above an elevation of 4,218 feet in the IPS area). For structures bearing in clay (below an elevation of 4,218 feet in the IPS area, or below original ground surface along the Influent Force Main Pipeline), it is recommended that ratios of movement at the top of wall to the height of wall of 0.01 and 0.05 be used for active and passive earth pressure conditions, respectively.

Results

The lateral earth pressure coefficients were calculated using the soil parameters described in the Data Available and Assumptions sections. The recommended lateral earth pressure coefficients and dynamic components of lateral earth pressure coefficients are presented in Table 6, and the associated equivalent fluid weights and dynamic components of equivalent fluid weights are presented in Table 7. The dynamic components of earth pressure coefficients and equivalent fluid weights, respectively, should be added to the static earth pressure coefficients and equivalent fluid weights, as needed, for the seismic (pseudostatic) condition.

Table 6. Recommended Lateral Earth Pressure Coefficients for Static and Seismic Cases

Structure	Static			Dynamic (Seismic) Component[1]		
	Active	Passive	At-rest	Active[2]	Passive	At-rest
IPS Area – Native	0.35	3.75	0.76	0.31	-0.86	0.41
IPS Area – Fill[2,3]	0.25	7.79	0.44	0.26	-2.57	0.41
IPS Area – Lightweight Fill[2]	0.30	5.69	0.50	0.29	-1.82	0.41
Influent Force Main Pipeline	0.35	3.75	0.76	0.31	-0.86	0.41

Notes:

1. The dynamic components of earth pressure coefficients and equivalent fluid weights, respectively, should be added to the static earth pressure coefficients and equivalent fluid weights, as needed, for the seismic (pseudostatic) case.
2. Soil characteristics are obtained solely from the fill.
3. Recommended for facilities in the IPS area bearing in fill (at or above an elevation of approximately 4218 feet).

Table 7. Recommended Lateral Equivalent Fluid Weights for Static and Seismic Cases

Structure	Static [Submerged[1]]			Dynamic (Seismic) Component[2] [Submerged[1]]		
	Active (pcf)	Passive (pcf)	At-rest (pcf)	Active (pcf)	Passive (pcf)	At-Rest (pcf)
IPS Area – Native	44.2 [22.1]	393.7 [159.7]	95.1 [47.6]	39.1 [19.6]	-90.0 [-36.5]	51.7 [25.9]
IPS Area – Fill[3,4]	34.3 [18.5]	895.6 [409.6]	59.5 [32.0]	35.0 [18.8]	-295.5 [-135.1]	55.8 [30.0]
IPS Area – Lightweight Fill[3]	29.7 [11.2]	398.4 [43.3]	50.0 [18.8]	28.9 [10.9]	-127.0 [-13.8]	41.3 [15.5]
Influent Force Main Pipeline	44.2 [22.1]	393.7 [159.7]	95.1 [47.6]	39.1 [19.6]	-90.0 [-36.5]	51.7 [25.9]

Notes:

1. Equivalent fluid weights are calculating using a weighted average soil unit weight. Submerged unit weights are appropriate where the surrounding soil is submerged and only account for soil pressure; submerged equivalent fluid pressures do not include water pressures, which must be added for design.
2. The dynamic components of earth pressure coefficients and equivalent fluid weights, respectively, should be added to the static earth pressure coefficients and equivalent fluid weights, as needed, for the seismic (pseudostatic) case.
3. Soil characteristics are obtained solely from the fill.
4. Recommended for facilities in the IPS area bearing in fill (at or above an elevation of approximately 4218 feet).

References

American Association of State Highway and Transportation Officials [AASHTO]. (2017). *AASHTO LRFD Bridge Design Specifications, U.S. Customary Units*. Washington, D.C.

American Society of Civil Engineers (ASCE). 2010. *Minimum Design Loads for Buildings and Other Structures (ASCE/SEI 7-10)*. ASCE Standards, Reston, VA.

Attachments

Attachment 1: Lateral Earth Pressure Calculations

Attachment 1

Lateral Earth Pressure

Client	SLC Department of Public Utilities
Project name	SLC WRF IPS area near 1200 W - earth pressures from native
Project Number	60664196
Date	9/24/2021

Wall Design Parameters

Total Unit Weight of Soil for Active and At-Rest Calculations, γ (pcf)	125
Total Unit Weight of Soil for Passive Calculations, γ (pcf)	105
Friction Angle of Soil, ϕ' (°)	26
Soil-Wall Interface Friction Angle from Normal, δ' (°)	13.0
Slope of Backfill from Horizontal, α (°)	0
Backslope of Wall from Vertical, θ (°)	0
Free Field PGA	0.62
Horizontal Seismic Coefficient, K_h	0.31
Vertical Seismic Coefficient, K_v	0

At-Rest

Mayne and Kulhawy (1982)

Reference: Mayne & Kulhawy (1982) from Das, B. M. and Sobhan, K. (2014). Principles of Geotechnical Engineering. Cengage Learning, Stamford, CT. p. 494-495

Total Unit Weight of Soil, γ (pcf)	125
Friction Angle of Soil, ϕ' (°)	26
Over Consolidation Ration (OCR)	2.0
At-Rest Earth Pressure Coefficient, K_0	0.76
At-Rest Equivalent Fluid Density, γ_e (pcf)	**95.1**
Submerged At-Rest Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**47.6**

$$K_0 = (1 - \sin\varphi)(\mathrm{OCR})^{\sin\varphi}$$

$$\gamma_e = \gamma_m K_0 \qquad \gamma_{e_{(sub)}} = (\gamma - \gamma_{water})K_0$$

At-Rest Seismic

Mikola & Sitar (2013)

Free Field PGA	0.62
Total Unit Weight of Soil, γ (pcf)	125
Dynamic Component of At-Rest Seismic Earth Pressure Coefficient, ΔK_{0e}	0.41
Total Seismic At-Rest Earth Pressure Coefficient, K_{0e}	1.17
Total At-Rest Seismic Equivalent Fluid Density, γ_e (pcf)	**146.8**
Dynamic Component of At-Rest Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**51.7**
Submerged Dynamic Component of At-Rest Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf)	**25.9**

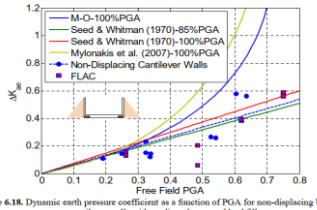


Figure 6.18. Dynamic earth pressure coefficient as a function of PGA for non-displacing U- shaped cantilever walls with medium dense sand backfill.

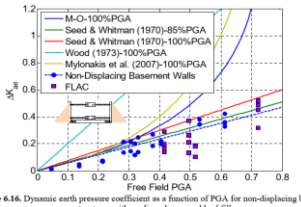


Figure 6.16. Dynamic earth pressure coefficient as a function of PGA for non-displacing basement structures with medium dense sand backfill.

$$\gamma_e = \gamma_m K_{0e} \qquad \Delta\gamma_e = \gamma_m \Delta K_{0e}$$

Active

Coulomb (1776)

Reference: Coulomb (1776) from Das, B. M. and Sobhan, K. (2014). Principles of Geotechnical Engineering. Cengage Learning, Stamford, CT. p. 518-519; See Figure 13.19 p. 518.

Total Unit Weight of Soil, γ (pcf)	125
Friction Angle of Soil, ϕ' (°)	26
Soil-Wall Interface Friction Angle from Normal, δ' (°)	13
Slope of Backfill from Horizontal, α (°)	0
Backslope of Wall from Vertical, θ (°)	0
Active Earth Pressure Coefficient, K_a	0.35
Active Equivalent Fluid Density, γ_e (pcf)	**44.2**
Submerged Active Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**22.1**

$$K_a = \frac{\cos^2(\varphi' - \theta)}{\cos^2\theta\cos(\delta' + \theta)\left[1 + \sqrt{\frac{\sin(\delta' + \varphi')\sin(\varphi' - \alpha)}{\cos(\delta' + \theta)\cos(\theta - \alpha)}}\right]^2}$$

$$\gamma_e = \gamma_m K_a \qquad \gamma_{e_{(sub)}} = (\gamma - \gamma_{water})Ka$$

Active Seismic

	Mononobe-Okabe
Total Unit Weight of Soil, γ (pcf)	125
Friction Angle of Soil, ϕ' (°)	26
Soil-Wall Interface Friction Angle from Normal, δ' (°)	13
Slope of Backfill from Horizontal, β (°)	0
Backslope of Wall from Vertical, θ (°)	0
Horizontal Seismic Coefficient, K_h	0.31
Vertical Seismic Coefficient, K_v	0.0
Seismic Inertia Angle, Ψ (°)	17.22
Static Active Lateral Earth Pressure Coefficient, K_a	0.35
Total Seismic Active Earth Pressure Coefficient, K_{ae}	0.666
Dynamic Component of K_{ae}, ΔK_{ae}	0.312
Total Active Seismic Equivalent Fluid Density, γ_e (pcf)	**83.2**
Dynamic Component of Active Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**39.1**
Submerged Dynamic Component of Active Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf)	**19.6**

Reference: Okabe (1926) & Mononobe and Matsuo (1929) from Kramer, S. L. (1996). Geotechnical Earthquake Engineering. Prentice Hall, Upper Saddle River, NJ. p. 478-480

$$\psi = \tan^{-1}\frac{K_h}{1 - Kv}$$

$$K_{ae} = \frac{cos^2(\varphi - \psi - \theta)}{cos\psi\, cos^2\theta\, \cos(\psi + \theta + \delta)\left[1 + \sqrt{\frac{\sin(\varphi + \delta)\sin(\varphi - \psi - \beta)}{\cos(\beta - \theta)\cos(\psi + \theta + \delta)}}\right]^2}$$

$$\Delta K_{ae} = Kae - Ka$$

$$\gamma_e = \gamma_m K_{ae} \qquad \Delta\gamma_e = \gamma_m \Delta K_{ae}$$

Passive

	Log-Spiral
Total Unit Weight of Soil, γ (pcf)	105
Friction Angle of Soil, ϕ' (°)	26
Soil-Wall Interface Friction Angle from Normal, δ' (°)	13
Slope of Backfill from Horizontal, β (°)	0
Backslope of Wall from Horizontal, θ (°)	90
-δ/ϕ'$_f$ ratio	-0.500
β/ϕ'$_f$ ratio	0.000
Passive Earth Pressure Coefficient from Chart, $K_{p\text{-}Chart}$	4.712
Reduction Factor, R_f	0.796
Passive Earth Pressure Coefficient, K_p	3.749
Skew Angle of Wall from Normal, θ_{skew} (°)	0.0
Reduction Factor for Skew Effects, R_{skew}	1.000
Passive Earth Pressure Coefficient with Skew Effects, $K_{p\text{-}skewed}$	3.749
Passive Equivalent Fluid Density, γ_e (pcf)	**393.7**
Submerged Passive Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**159.7**

References:
1. U.S Department of the Navy (1982) from American Association of State Highway and Transportation Officials [AASHTO]. (2017). AASHTO LRFD Bridge Design Specifications, U.S. Customary Units. Washington, D.C. Section 3.11.5.4 p. 3-117 to p. 3-118
2. Rollins, K. M., and Jessee, S. J. (2013). "Passive Force-Deflection Curves for Skewed Abutments." Journal of Bridge Engineering, 18(10), 1086–1094.

$$R_{skew} = (7.79 * 10^{-5})\theta_{skew}{}^2 - 0.018\theta_{skew} + 1$$

$$K_{pskewed} = RskewKp$$

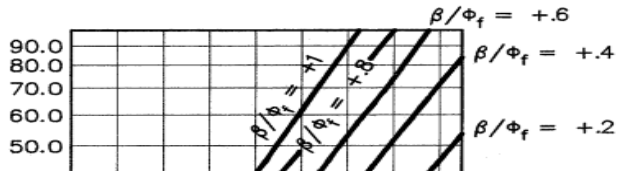
$$\gamma_e = \gamma_m K_p$$

$$\gamma_{e_{(sub)}} = (\gamma - \gamma_{water})Kp$$

Graphical Solution for Log-Spiral Passive Earth Pressure Coefficient:

REDUCTION FACTOR (R) OF k_p FOR VARIOUS RATIOS OF $-\delta/\Phi_f$

Φ_f \ δ/Φ_f	−0.7	−0.6	−0.5	−0.4	−0.3	−0.2	−0.1	0.0
10	.978	.962	.946	.929	.912	.898	.881	.864
15	.961	.934	.907	.881	.854	.830	.803	.775
20	.939	.901	.862	.824	.787	.752	.716	.678
25	.912	.860	.808	.759	.711	.666	.620	.574



30	.878	.811	.746	.686	.627	.574	.520	.467
35	.836	.752	.674	.603	.536	.475	.417	.362
40	.783	.682	.592	.512	.439	.375	.316	.262
45	.718	.600	.500	.414	.339	.339	.221	.174

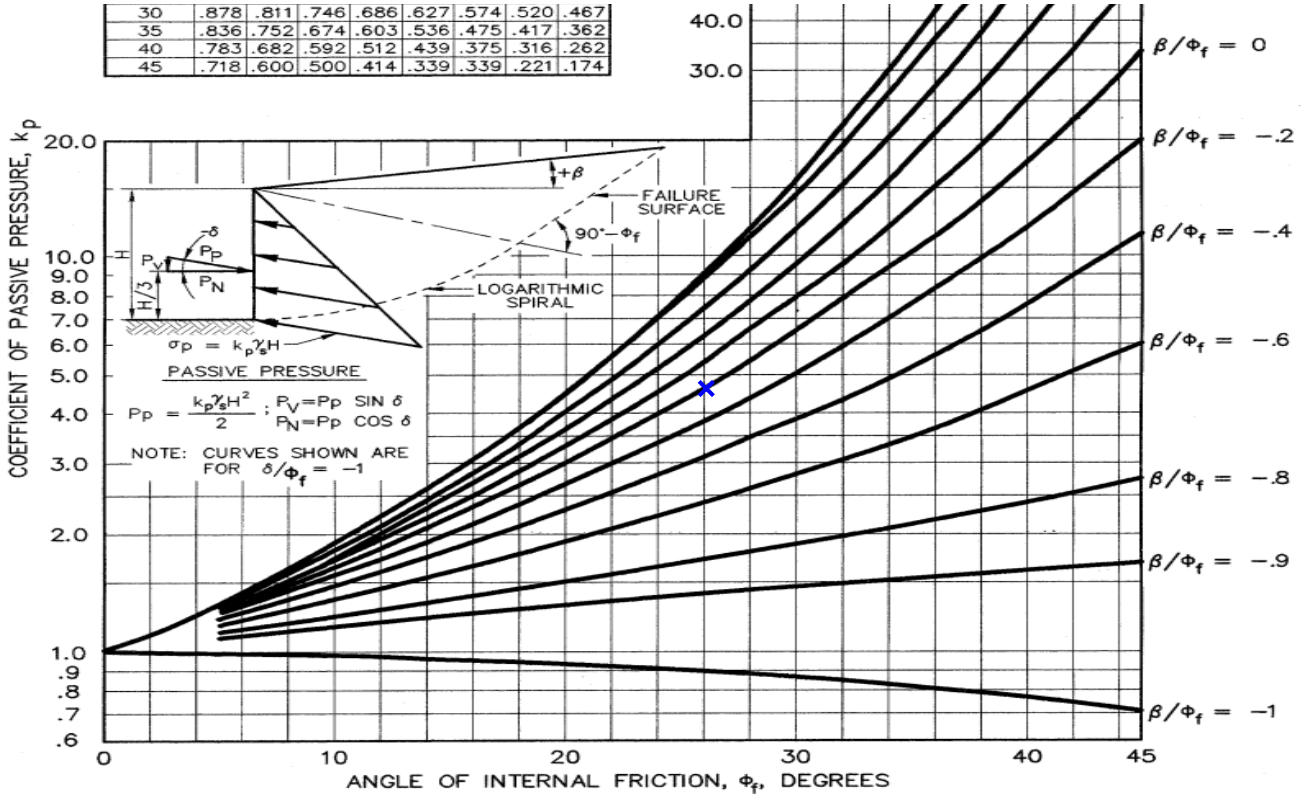


Figure 3.11.5.4-2—Computational Procedures for Passive Earth Pressures for Vertical Wall with Sloping Backfill (U.S. Department of the Navy, 1982a)

Passive Seismic	**Log-spiral & Anderson et al. (2008)**	
Total Unit Weight of Soil, γ (pcf)	105	
Effective Horizontal Acceleration, K_h (g)	0.31	
Friction Angle of Soil, ϕ'_f (°)	26	
Soil-Wall Interface Friction Angle from Normal, δ (°)	17	
Slope of Backfill from Horizontal, β (°)	0	
Skew Angle of Wall from Normal, θ_{skew} (°)	0.0	
δ/ϕ'_f ratio	0.67	
Total Passive Seismic Earth Pressure Coefficient, K_{pe}	2.892	
Total Passive Seismic Earth Pressure Coefficient with Skew Effects, $K_{pe\text{-}skewed}$	2.892	$K_{peskewed} = RskewKpe$
Dynamic Component of K_{pe}, ΔK_{pe}	-0.858	$\Delta K_{pe} = Kpe - Kp$
Dynamic Component of K_{pe} with Skew Effects, $\Delta K_{pe\text{-}skew}$	-0.858	
Total Passive Seismic Equivalent Fluid Density, γ_e (pcf)	**303.6**	$\gamma_e = \gamma_m K_{pe}$ $\quad$ $\Delta\gamma_e = \gamma_m \Delta K_{pe}$
Dynamic Component of Passive Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**-90.0**	(Skew effects included in results if applicable)

References:
1. Anderson et al. (2008) and U.S Department of the Navy (1982) from American Association of State Highway and Transportation Officials [AASHTO]. (2017). AASHTO LRFD Bridge Design Specifications, U.S. Customary Units. Washington, D.C.
Section A11.4 p. 11-115 to p. 11-119
2. Rollins, K. M., and Jessee, S. J. (2013). "Passive Force-Deflection Curves for Skewed Abutments." Journal of Bridge Engineering, 18(10), 1086–1094.

Submerged Dynamic Component of Passive Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf) **-36.5** (Skew effects included in results if applicable)

Graphical Solution for Log-Spiral Passive Seismic Earth Pressure Coefficient:

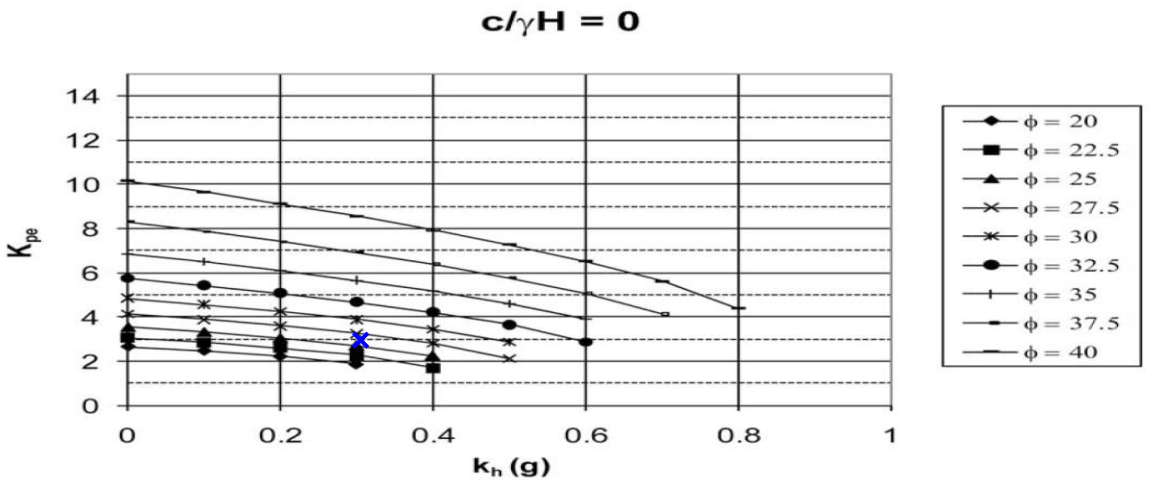


Figure A11.4-2—Seismic Passive Earth Pressure Coefficient Based on Log Spiral Procedure for $c/\gamma H = 0$ and 0.05 (c = soil cohesion, γ = soil unit weight, and H = height or depth of wall over which the passive resistance acts)

Note: $k_h = A_s = k_{ho}$ for wall heights greater than 20 ft.

Lateral Earth Pressure

Client	SLC Department of Public Utilities
Project name	SLC WRF IPS area near 1200 W - earth pressures from fill
Project Number	60664196
Date	9/24/2021

Wall Design Parameters

Total Unit Weight of Soil for Active and At-Rest Calculations, γ (pcf)	135
Total Unit Weight of Soil for Passive Calculations, γ (pcf)	115
Friction Angle of Soil, ϕ' (°)	34
Soil-Wall Interface Friction Angle from Normal, δ' (°)	22.8
Slope of Backfill from Horizontal, α (°)	0
Backslope of Wall from Vertical, θ (°)	0
Free Field PGA	0.62
Horizontal Seismic Coefficient, K_h	0.31
Vertical Seismic Coefficient, K_v	0

At-Rest

Mayne and Kulhawy (1982)

Reference: Mayne & Kulhawy (1982) from Das, B. M. and Sobhan, K. (2014). Principles of Geotechnical Engineering. Cengage Learning, Stamford, CT. p. 494-495

Total Unit Weight of Soil, γ (pcf)	135
Friction Angle of Soil, ϕ' (°)	34
Over Consolidation Ration (OCR)	1.0
At-Rest Earth Pressure Coefficient, K_0	0.44
At-Rest Equivalent Fluid Density, γ_e (pcf)	**59.5**
Submerged At-Rest Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**32**

$$K_0 = (1 - \sin\varphi)(\mathrm{OCR})^{\sin\varphi}$$

$$\gamma_e = \gamma_m K_0 \qquad \gamma_{e_{(sub)}} = (\gamma - \gamma_{water})K_0$$

At-Rest Seismic

Mikola & Sitar (2013)

Free Field PGA	0.62
Total Unit Weight of Soil, γ (pcf)	135
Dynamic Component of At-Rest Seismic Earth Pressure Coefficient, ΔK_{0e}	0.41
Total Seismic At-Rest Earth Pressure Coefficient, K_{0e}	0.85
Total At-Rest Seismic Equivalent Fluid Density, γ_e (pcf)	**115.3**
Dynamic Component of At-Rest Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**55.8**
Submerged Dynamic Component of At-Rest Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf)	**30.0**

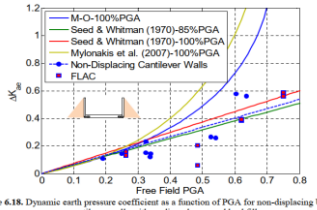


Figure 6.18. Dynamic earth pressure coefficient as a function of PGA for non-displacing U- shaped cantilever walls with medium dense sand backfill.

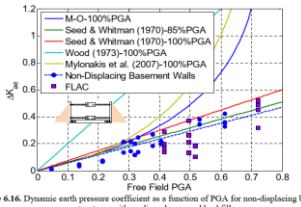


Figure 6.16. Dynamic earth pressure coefficient as a function of PGA for non-displacing basement structures with medium dense sand backfill.

$$\gamma_e = \gamma_m K_{0e} \qquad \Delta\gamma_e = \gamma_m \Delta K_{0e}$$

Active

Coulomb (1776)

Reference: Coulomb (1776) from Das, B. M. and Sobhan, K. (2014). Principles of Geotechnical Engineering. Cengage Learning, Stamford, CT. p. 518-519; See Figure 13.19 p. 518.

Total Unit Weight of Soil, γ (pcf)	135
Friction Angle of Soil, ϕ' (°)	34
Soil-Wall Interface Friction Angle from Normal, δ' (°)	22.78
Slope of Backfill from Horizontal, α (°)	0
Backslope of Wall from Vertical, θ (°)	0
Active Earth Pressure Coefficient, K_a	0.25
Active Equivalent Fluid Density, γ_e (pcf)	**34.3**
Submerged Active Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**18.5**

$$K_a = \frac{\cos^2(\varphi' - \theta)}{\cos^2\theta\cos(\delta' + \theta)\left[1 + \sqrt{\frac{\sin(\delta' + \varphi')\sin(\varphi' - \alpha)}{\cos(\delta' + \theta)\cos(\theta - \alpha)}}\right]^2}$$

$$\gamma_e = \gamma_m K_a \qquad \gamma_{e_{(sub)}} = (\gamma - \gamma_{water})Ka$$

Active Seismic

	Mononobe-Okabe
Total Unit Weight of Soil, γ (pcf)	135
Friction Angle of Soil, ϕ' (°)	34
Soil-Wall Interface Friction Angle from Normal, δ' (°)	22.78
Slope of Backfill from Horizontal, β (°)	0
Backslope of Wall from Vertical, θ (°)	0
Horizontal Seismic Coefficient, K_h	0.31
Vertical Seismic Coefficient, K_v	0.0
Seismic Inertia Angle, Ψ (°)	17.22
Static Active Lateral Earth Pressure Coefficient, K_a	0.25
Total Seismic Active Earth Pressure Coefficient, K_{ae}	0.514
Dynamic Component of K_{ae}, ΔK_{ae}	0.260
Total Active Seismic Equivalent Fluid Density, γ_e (pcf)	**69.4**
Dynamic Component of Active Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**35.0**
Submerged Dynamic Component of Active Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf)	**18.8**

Reference: Okabe (1926) & Mononobe and Matsuo (1929) from Kramer, S. L. (1996). Geotechnical Earthquake Engineering. Prentice Hall, Upper Saddle River, NJ. p. 478-480

$$\psi = \tan^{-1}\frac{K_h}{1 - Kv}$$

$$K_{ae} = \frac{cos^2(\varphi - \psi - \theta)}{cos\psi\, cos^2\theta\, \cos(\psi + \theta + \delta)\left[1 + \sqrt{\frac{\sin(\varphi + \delta)\sin(\varphi - \psi - \beta)}{\cos(\beta - \theta)\cos(\psi + \theta + \delta)}}\right]^2}$$

$$\Delta K_{ae} = Kae - Ka$$

$$\gamma_e = \gamma_m K_{ae} \qquad \Delta\gamma_e = \gamma_m \Delta K_{ae}$$

Passive

	Log-Spiral
Total Unit Weight of Soil, γ (pcf)	115
Friction Angle of Soil, ϕ' (°)	34
Soil-Wall Interface Friction Angle from Normal, δ' (°)	22.78
Slope of Backfill from Horizontal, β (°)	0
Backslope of Wall from Horizontal, θ (°)	90
-δ/ϕ'$_f$ ratio	-0.670
β/ϕ'$_f$ ratio	0.000
Passive Earth Pressure Coefficient from Chart, $K_{p\text{-Chart}}$	9.495
Reduction Factor, R_f	0.820
Passive Earth Pressure Coefficient, K_p	7.788
Skew Angle of Wall from Normal, θ_{skew} (°)	0.0
Reduction Factor for Skew Effects, R_{skew}	1.000
Passive Earth Pressure Coefficient with Skew Effects, $K_{p\text{-skewed}}$	7.788
Passive Equivalent Fluid Density, γ_e (pcf)	**895.6**
Submerged Passive Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**409.6**

References:
1. U.S Department of the Navy (1982) from American Association of State Highway and Transportation Officials [AASHTO]. (2017). AASHTO LRFD Bridge Design Specifications, U.S. Customary Units. Washington, D.C. Section 3.11.5.4 p. 3-117 to p. 3-118
2. Rollins, K. M., and Jessee, S. J. (2013). "Passive Force-Deflection Curves for Skewed Abutments." Journal of Bridge Engineering, 18(10), 1086–1094.

$$R_{skew} = (7.79 * 10^{-5})\theta_{skew}{}^2 - 0.018\theta_{skew} + 1$$

$$K_{pskewed} = RskewKp$$

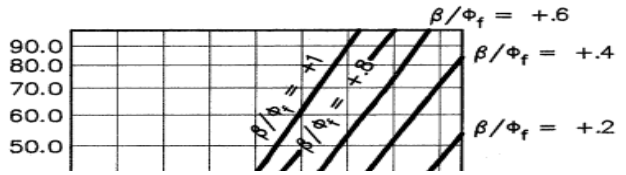
$$\gamma_e = \gamma_m K_p$$

$$\gamma_{e_{(sub)}} = (\gamma - \gamma_{water})Kp$$

Graphical Solution for Log-Spiral Passive Earth Pressure Coefficient:

REDUCTION FACTOR (R) OF k_p FOR VARIOUS RATIOS OF $-\delta/\Phi_f$

Φ_f \ δ/Φ_f	−0.7	−0.6	−0.5	−0.4	−0.3	−0.2	−0.1	0.0
10	.978	.962	.946	.929	.912	.898	.881	.864
15	.961	.934	.907	.881	.854	.830	.803	.775
20	.939	.901	.862	.824	.787	.752	.716	.678
25	.912	.860	.808	.759	.711	.666	.620	.574



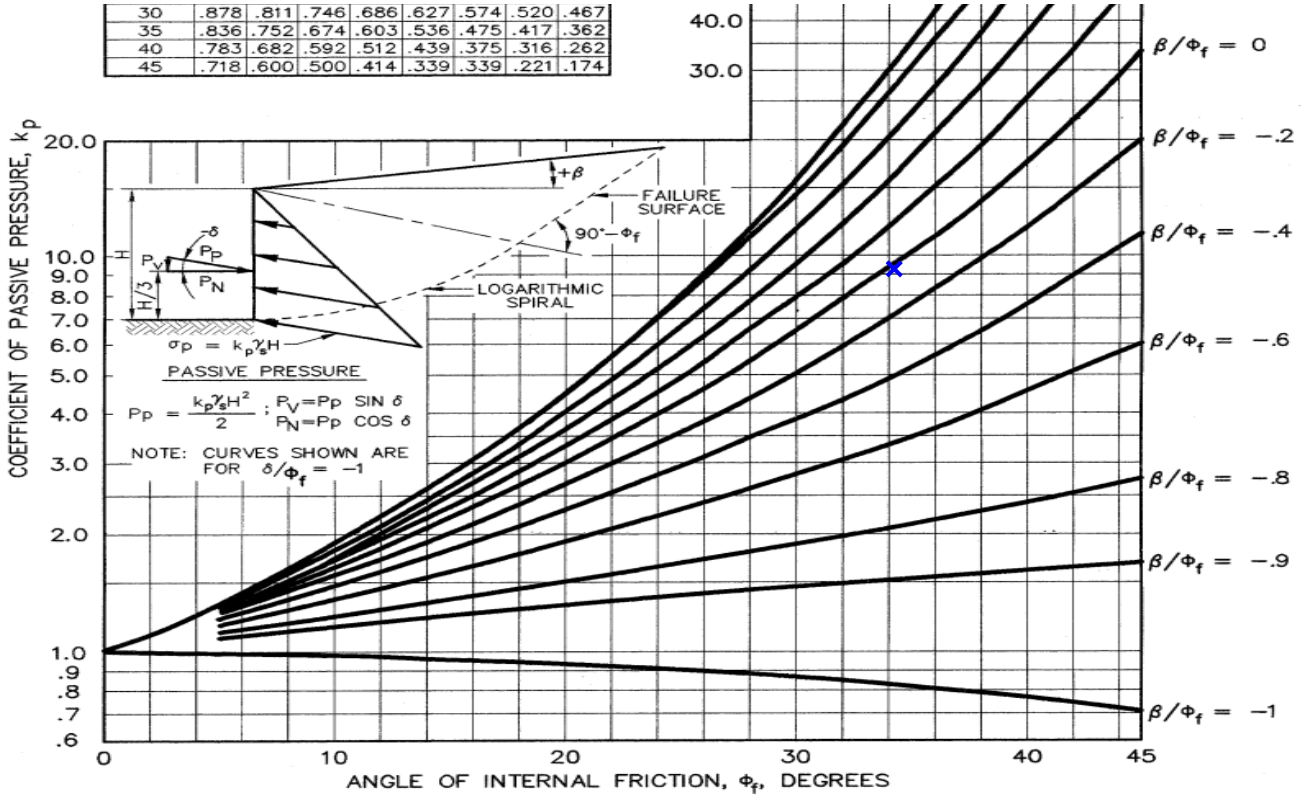


Figure 3.11.5.4-2—Computational Procedures for Passive Earth Pressures for Vertical Wall with Sloping Backfill (U.S. Department of the Navy, 1982a)

Passive Seismic	**Log-spiral & Anderson et al. (2008)**	
Total Unit Weight of Soil, γ (pcf)	115	
Effective Horizontal Acceleration, K_h (g)	0.31	
Friction Angle of Soil, ϕ'_f (°)	34	
Soil-Wall Interface Friction Angle from Normal, δ (°)	23	
Slope of Backfill from Horizontal, β (°)	0	
Skew Angle of Wall from Normal, θ_{skew} (°)	0.0	
δ/ϕ'_f ratio	0.67	
Total Passive Seismic Earth Pressure Coefficient, K_{pe}	5.219	
Total Passive Seismic Earth Pressure Coefficient with Skew Effects, $K_{pe\text{-}skewed}$	5.219	$K_{peskewed} = RskewKpe$
Dynamic Component of K_{pe}, ΔK_{pe}	-2.569	$\Delta K_{pe} = Kpe - Kp$
Dynamic Component of K_{pe} with Skew Effects, $\Delta K_{pe\text{-}skew}$	-2.569	
Total Passive Seismic Equivalent Fluid Density, γ_e (pcf)	**600.1**	$\gamma_e = \gamma_m K_{pe}$ $\quad \Delta\gamma_e = \gamma_m \Delta K_{pe}$
Dynamic Component of Passive Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**-295.5**	(Skew effects included in results if applicable)

References:
1. Anderson et al. (2008) and U.S Department of the Navy (1982) from American Association of State Highway and Transportation Officials [AASHTO]. (2017). AASHTO LRFD Bridge Design Specifications, U.S. Customary Units. Washington, D.C.
Section A11.4 p. 11-115 to p. 11-119
2. Rollins, K. M., and Jessee, S. J. (2013). "Passive Force-Deflection Curves for Skewed Abutments." Journal of Bridge Engineering, 18(10), 1086–1094.

Submerged Dynamic Component of Passive Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf) **-135.1** (Skew effects included in results if applicable)

Graphical Solution for Log-Spiral Passive Seismic Earth Pressure Coefficient:

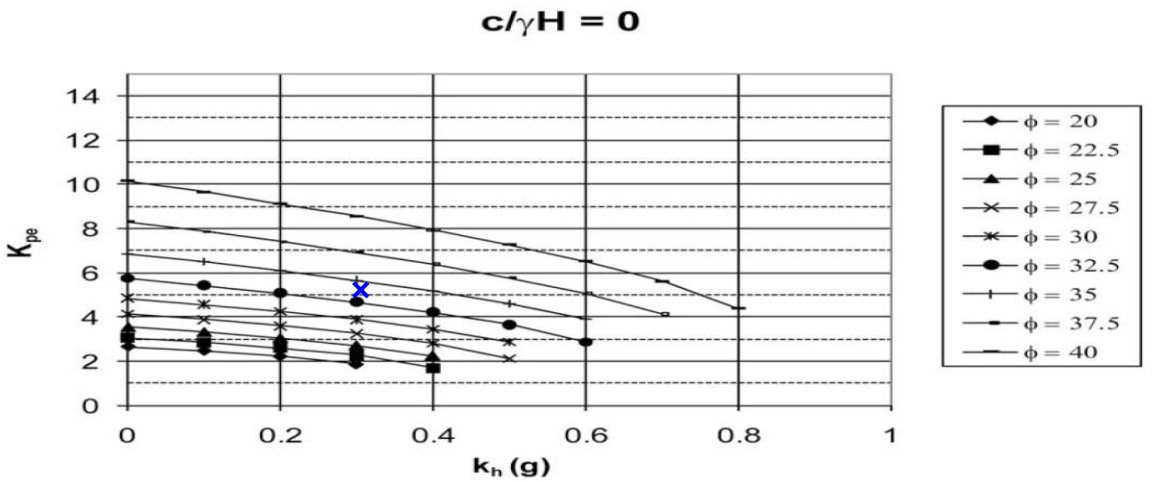


Figure A11.4-2—Seismic Passive Earth Pressure Coefficient Based on Log Spiral Procedure for $c/\gamma H = 0$ and 0.05 (c = soil cohesion, γ = soil unit weight, and H = height or depth of wall over which the passive resistance acts)

Note: $k_h = A_s = k_{ho}$ for wall heights greater than 20 ft.

Lateral Earth Pressure

Client	SLC Department of Public Utilities
Project name	SLC WRF IPS area near 1200 W - lightweight backfill
Project Number	60664196
Date	9/30/2021

Wall Design Parameters

Total Unit Weight of Soil for Active and At-Rest Calculations, γ (pcf)	100
Total Unit Weight of Soil for Passive Calculations, γ (pcf)	70
Friction Angle of Soil, ϕ' (°)	30
Soil-Wall Interface Friction Angle from Normal, δ' (°)	20.1
Slope of Backfill from Horizontal, α (°)	0
Backslope of Wall from Vertical, θ (°)	0
Free Field PGA	0.62
Horizontal Seismic Coefficient, K_h	0.31
Vertical Seismic Coefficient, K_v	0

At-Rest

Mayne and Kulhawy (1982)

Reference: Mayne & Kulhawy (1982) from Das, B. M. and Sobhan, K. (2014). Principles of Geotechnical Engineering. Cengage Learning, Stamford, CT. p. 494-495

Total Unit Weight of Soil, γ (pcf)	100
Friction Angle of Soil, ϕ' (°)	30
Over Consolidation Ration (OCR)	1.0
At-Rest Earth Pressure Coefficient, K_0	0.50
At-Rest Equivalent Fluid Density, γ_e (pcf)	**50.0**
Submerged At-Rest Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**18.8**

$$K_0 = (1 - \sin\varphi)(\mathrm{OCR})^{\sin\varphi}$$

$$\gamma_e = \gamma_m K_0 \qquad \gamma_{e_{(sub)}} = (\gamma - \gamma_{water})K_0$$

At-Rest Seismic

Mikola & Sitar (2013)

Free Field PGA	0.62
Total Unit Weight of Soil, γ (pcf)	100
Dynamic Component of At-Rest Seismic Earth Pressure Coefficient, ΔK_{0e}	0.41
Total Seismic At-Rest Earth Pressure Coefficient, K_{0e}	0.91
Total At-Rest Seismic Equivalent Fluid Density, γ_e (pcf)	**91.3**
Dynamic Component of At-Rest Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**41.3**
Submerged Dynamic Component of At-Rest Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf)	**15.5**

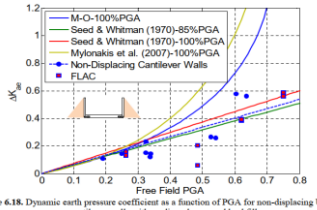


Figure 6.18. Dynamic earth pressure coefficient as a function of PGA for non-displacing U- shaped cantilever walls with medium dense sand backfill.

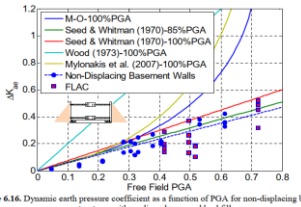


Figure 6.16. Dynamic earth pressure coefficient as a function of PGA for non-displacing basement structures with medium dense sand backfill.

$$\gamma_e = \gamma_m K_{0e} \qquad \Delta\gamma_e = \gamma_m \Delta K_{0e}$$

Active

Coulomb (1776)

Reference: Coulomb (1776) from Das, B. M. and Sobhan, K. (2014). Principles of Geotechnical Engineering. Cengage Learning, Stamford, CT. p. 518-519; See Figure 13.19 p. 518.

Total Unit Weight of Soil, γ (pcf)	100
Friction Angle of Soil, ϕ' (°)	30
Soil-Wall Interface Friction Angle from Normal, δ' (°)	20.1
Slope of Backfill from Horizontal, α (°)	0
Backslope of Wall from Vertical, θ (°)	0
Active Earth Pressure Coefficient, K_a	0.30
Active Equivalent Fluid Density, γ_e (pcf)	**29.7**
Submerged Active Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**11.2**

$$K_a = \frac{\cos^2(\varphi' - \theta)}{\cos^2\theta\cos(\delta' + \theta)\left[1 + \sqrt{\frac{\sin(\delta' + \varphi')\sin(\varphi' - \alpha)}{\cos(\delta' + \theta)\cos(\theta - \alpha)}}\right]^2}$$

$$\gamma_e = \gamma_m K_a \qquad \gamma_{e_{(sub)}} = (\gamma - \gamma_{water})Ka$$

Active Seismic

	Mononobe-Okabe
Total Unit Weight of Soil, γ (pcf)	100
Friction Angle of Soil, ϕ' (°)	30
Soil-Wall Interface Friction Angle from Normal, δ' (°)	20.1
Slope of Backfill from Horizontal, β (°)	0
Backslope of Wall from Vertical, θ (°)	0
Horizontal Seismic Coefficient, K_h	0.31
Vertical Seismic Coefficient, K_v	0.0
Seismic Inertia Angle, Ψ (°)	17.22
Static Active Lateral Earth Pressure Coefficient, K_a	0.30
Total Seismic Active Earth Pressure Coefficient, K_{ae}	0.586
Dynamic Component of K_{ae}, ΔK_{ae}	0.289
Total Active Seismic Equivalent Fluid Density, γ_e (pcf)	**58.6**
Dynamic Component of Active Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**28.9**
Submerged Dynamic Component of Active Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf)	**10.9**

Reference: Okabe (1926) & Mononobe and Matsuo (1929) from Kramer, S. L. (1996). Geotechnical Earthquake Engineering. Prentice Hall, Upper Saddle River, NJ. p. 478-480

$$\psi = \tan^{-1}\frac{K_h}{1 - Kv}$$

$$K_{ae} = \frac{cos^2(\varphi - \psi - \theta)}{cos\psi\, cos^2\theta\, \cos(\psi + \theta + \delta)\left[1 + \sqrt{\frac{\sin(\varphi + \delta)\sin(\varphi - \psi - \beta)}{\cos(\beta - \theta)\cos(\psi + \theta + \delta)}}\right]^2}$$

$$\Delta K_{ae} = Kae - Ka$$

$$\gamma_e = \gamma_m K_{ae} \qquad \Delta\gamma_e = \gamma_m \Delta K_{ae}$$

Passive

	Log-Spiral
Total Unit Weight of Soil, γ (pcf)	70
Friction Angle of Soil, ϕ' (°)	30
Soil-Wall Interface Friction Angle from Normal, δ' (°)	20.1
Slope of Backfill from Horizontal, β (°)	0
Backslope of Wall from Horizontal, θ (°)	90
-δ/ϕ'$_f$ ratio	-0.670
β/ϕ'$_f$ ratio	0.000
Passive Earth Pressure Coefficient from Chart, $K_{p\text{-}Chart}$	6.635
Reduction Factor, R_f	0.858
Passive Earth Pressure Coefficient, K_p	5.692
Skew Angle of Wall from Normal, θ_{skew} (°)	0.0
Reduction Factor for Skew Effects, R_{skew}	1.000
Passive Earth Pressure Coefficient with Skew Effects, $K_{p\text{-}skewed}$	5.692
Passive Equivalent Fluid Density, γ_e (pcf)	**398.4**
Submerged Passive Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**43.3**

References:
1. U.S Department of the Navy (1982) from American Association of State Highway and Transportation Officials [AASHTO]. (2017). AASHTO LRFD Bridge Design Specifications, U.S. Customary Units. Washington, D.C. Section 3.11.5.4 p. 3-117 to p. 3-118
2. Rollins, K. M., and Jessee, S. J. (2013). "Passive Force-Deflection Curves for Skewed Abutments." Journal of Bridge Engineering, 18(10), 1086–1094.

$$R_{skew} = (7.79 * 10^{-5})\theta_{skew}{}^2 - 0.018\theta_{skew} + 1$$

$$K_{pskewed} = RskewKp$$

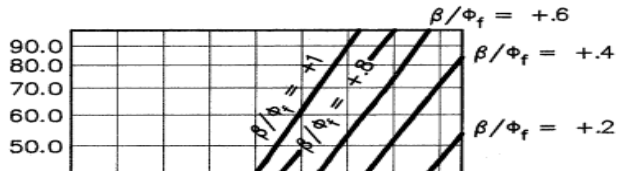
$$\gamma_e = \gamma_m K_p$$

$$\gamma_{e_{(sub)}} = (\gamma - \gamma_{water})Kp$$

Graphical Solution for Log-Spiral Passive Earth Pressure Coefficient:

REDUCTION FACTOR (R) OF k_p FOR VARIOUS RATIOS OF $-\delta/\Phi_f$

Φ_f \ δ/Φ_f	−0.7	−0.6	−0.5	−0.4	−0.3	−0.2	−0.1	0.0
10	.978	.962	.946	.929	.912	.898	.881	.864
15	.961	.934	.907	.881	.854	.830	.803	.775
20	.939	.901	.862	.824	.787	.752	.716	.678
25	.912	.860	.808	.759	.711	.666	.620	.574



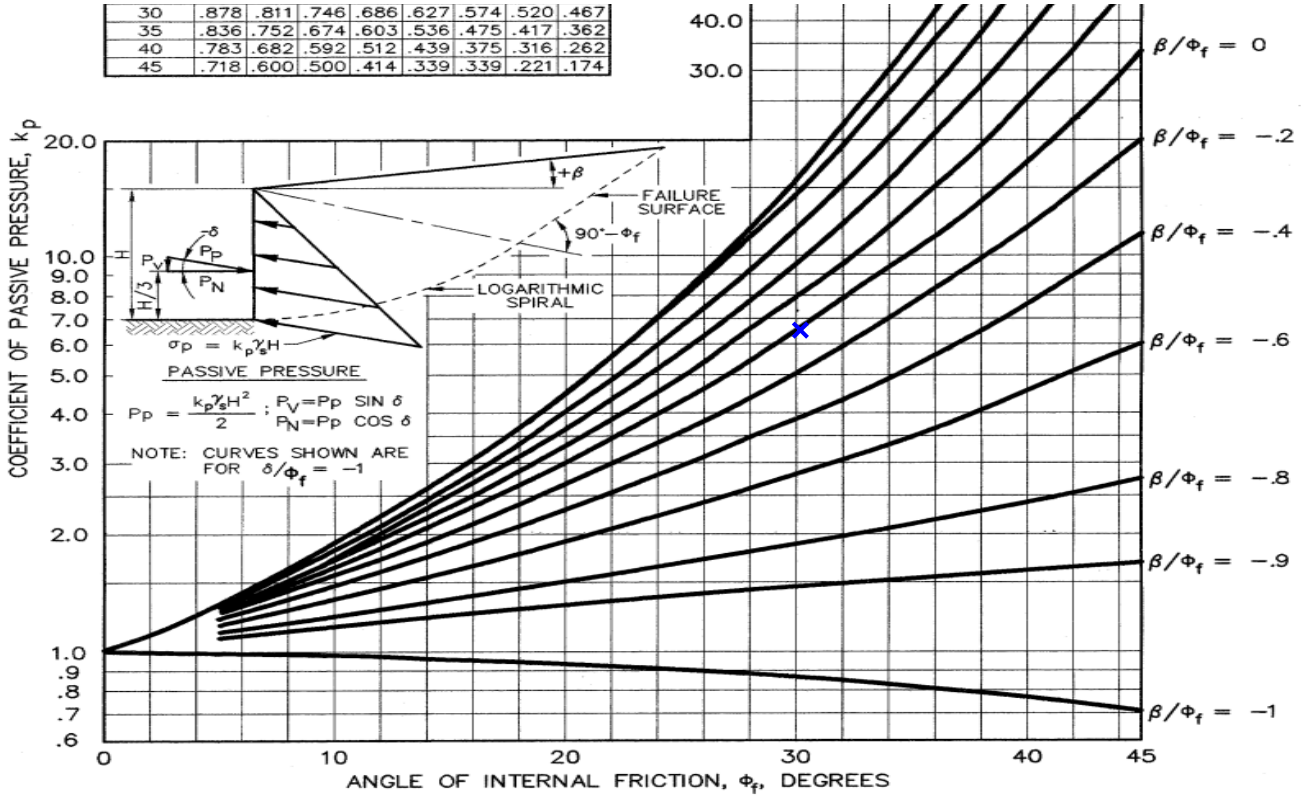


Figure 3.11.5.4-2—Computational Procedures for Passive Earth Pressures for Vertical Wall with Sloping Backfill (U.S. Department of the Navy, 1982a)

Passive Seismic	**Log-spiral & Anderson et al. (2008)**	
Total Unit Weight of Soil, γ (pcf)	70	
Effective Horizontal Acceleration, K_h (g)	0.31	
Friction Angle of Soil, ϕ'_f (°)	30	
Soil-Wall Interface Friction Angle from Normal, δ (°)	20	
Slope of Backfill from Horizontal, β (°)	0	
Skew Angle of Wall from Normal, θ_{skew} (°)	0.0	
δ/ϕ'_f ratio	0.67	
Total Passive Seismic Earth Pressure Coefficient, K_{pe}	3.877	
Total Passive Seismic Earth Pressure Coefficient with Skew Effects, $K_{pe\text{-}skewed}$	3.877	$K_{peskewed} = RskewKpe$
Dynamic Component of K_{pe}, ΔK_{pe}	-1.815	$\Delta K_{pe} = Kpe - Kp$
Dynamic Component of K_{pe} with Skew Effects, $\Delta K_{pe\text{-}skew}$	-1.815	
Total Passive Seismic Equivalent Fluid Density, γ_e (pcf)	**271.4**	$\gamma_e = \gamma_m K_{pe}$ $\Delta\gamma_e = \gamma_m \Delta K_{pe}$
Dynamic Component of Passive Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**-127.0**	(Skew effects included in results if applicable)

References:
1. Anderson et al. (2008) and U.S Department of the Navy (1982) from American Association of State Highway and Transportation Officials [AASHTO]. (2017). AASHTO LRFD Bridge Design Specifications, U.S. Customary Units. Washington, D.C.
Section A11.4 p. 11-115 to p. 11-119
2. Rollins, K. M., and Jessee, S. J. (2013). "Passive Force-Deflection Curves for Skewed Abutments." Journal of Bridge Engineering, 18(10), 1086–1094.

Submerged Dynamic Component of Passive Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf) **-13.8** (Skew effects included in results if applicable)

Graphical Solution for Log-Spiral Passive Seismic Earth Pressure Coefficient:

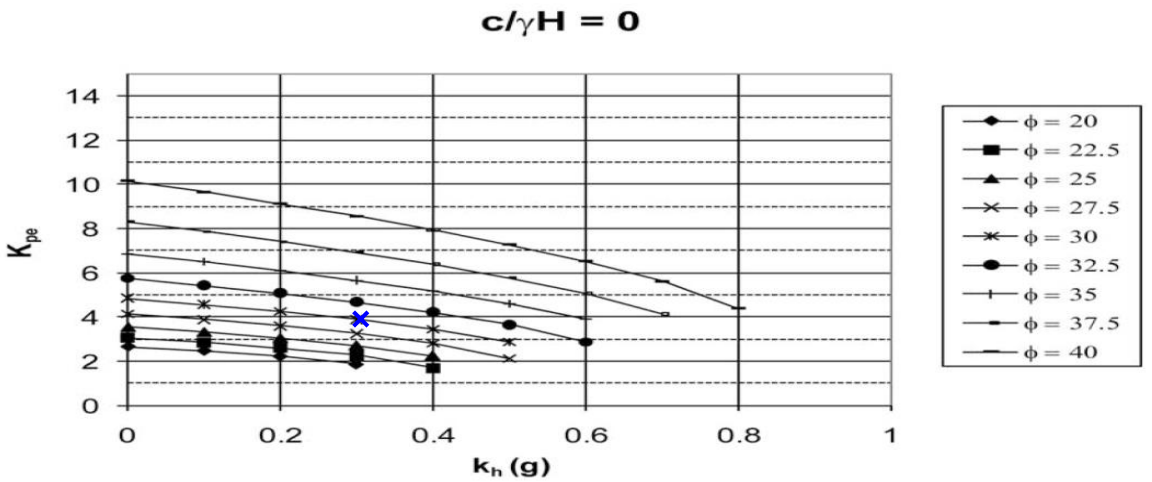


Figure A11.4-2—Seismic Passive Earth Pressure Coefficient Based on Log Spiral Procedure for $c/\gamma H = 0$ and 0.05 (c = soil cohesion, γ = soil unit weight, and H = height or depth of wall over which the passive resistance acts)

Note: $k_h = A_s = k_{ho}$ for wall heights greater than 20 ft.

Lateral Earth Pressure

Client	SLC Department of Public Utilities
Project name	SLC WRF Influent Force Main Pipeline - earth pressures from native
Project Number	60664196
Date	11/29/2021

Wall Design Parameters

Total Unit Weight of Soil for Active and At-Rest Calculations, γ (pcf)	125
Total Unit Weight of Soil for Passive Calculations, γ (pcf)	105
Friction Angle of Soil, ϕ' (°)	26
Soil-Wall Interface Friction Angle from Normal, δ' (°)	13.0
Slope of Backfill from Horizontal, α (°)	0
Backslope of Wall from Vertical, θ (°)	0
Free Field PGA	0.62
Horizontal Seismic Coefficient, K_h	0.31
Vertical Seismic Coefficient, K_v	0

At-Rest

Mayne and Kulhawy (1982)

Reference: Mayne & Kulhawy (1982) from Das, B. M. and Sobhan, K. (2014). Principles of Geotechnical Engineering. Cengage Learning, Stamford, CT. p. 494-495

Total Unit Weight of Soil, γ (pcf)	125
Friction Angle of Soil, ϕ' (°)	26
Over Consolidation Ration (OCR)	2.0
At-Rest Earth Pressure Coefficient, K_0	0.76
At-Rest Equivalent Fluid Density, γ_e (pcf)	**95.1**
Submerged At-Rest Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**47.6**

$$K_0 = (1 - \sin\varphi)(\mathrm{OCR})^{\sin\varphi}$$

$$\gamma_e = \gamma_m K_0 \qquad \gamma_{e_{(sub)}} = (\gamma - \gamma_{water})K_0$$

At-Rest Seismic

Mikola & Sitar (2013)

Free Field PGA	0.62
Total Unit Weight of Soil, γ (pcf)	125
Dynamic Component of At-Rest Seismic Earth Pressure Coefficient, ΔK_{0e}	0.41
Total Seismic At-Rest Earth Pressure Coefficient, K_{0e}	1.17
Total At-Rest Seismic Equivalent Fluid Density, γ_e (pcf)	**146.8**
Dynamic Component of At-Rest Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**51.7**
Submerged Dynamic Component of At-Rest Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf)	**25.9**

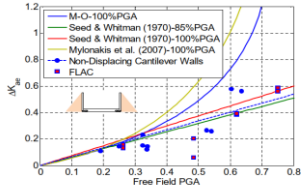


Figure 6.18. Dynamic earth pressure coefficient as a function of PGA for non-displacing U- shaped cantilever walls with medium dense sand backfill.

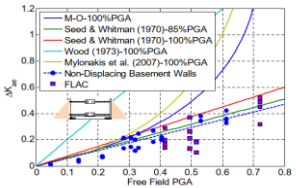


Figure 6.16. Dynamic earth pressure coefficient as a function of PGA for non-displacing basement structures with medium dense sand backfill.

$$\gamma_e = \gamma_m K_{0e} \qquad \Delta\gamma_e = \gamma_m \Delta K_{0e}$$

Active

Coulomb (1776)

Reference: Coulomb (1776) from Das, B. M. and Sobhan, K. (2014). Principles of Geotechnical Engineering. Cengage Learning, Stamford, CT. p. 518-519; See Figure 13.19 p. 518.

Total Unit Weight of Soil, γ (pcf)	125
Friction Angle of Soil, ϕ' (°)	26
Soil-Wall Interface Friction Angle from Normal, δ' (°)	13
Slope of Backfill from Horizontal, α (°)	0
Backslope of Wall from Vertical, θ (°)	0
Active Earth Pressure Coefficient, K_a	0.35
Active Equivalent Fluid Density, γ_e (pcf)	**44.2**
Submerged Active Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**22.1**

$$K_a = \frac{\cos^2(\varphi' - \theta)}{\cos^2\theta\,\cos(\delta' + \theta)\left[1 + \sqrt{\frac{\sin(\delta' + \varphi')\sin(\varphi' - \alpha)}{\cos(\delta' + \theta)\cos(\theta - \alpha)}}\right]^2}$$

$$\gamma_e = \gamma_m K_a \qquad \gamma_{e_{(sub)}} = (\gamma - \gamma_{water})Ka$$

Active Seismic

	Mononobe-Okabe
Total Unit Weight of Soil, γ (pcf)	125
Friction Angle of Soil, ϕ' (°)	26
Soil-Wall Interface Friction Angle from Normal, δ' (°)	13
Slope of Backfill from Horizontal, β (°)	0
Backslope of Wall from Vertical, θ (°)	0
Horizontal Seismic Coefficient, K_h	0.31
Vertical Seismic Coefficient, K_v	0.0
Seismic Inertia Angle, Ψ (°)	17.22
Static Active Lateral Earth Pressure Coefficient, K_a	0.35
Total Seismic Active Earth Pressure Coefficient, K_{ae}	0.666
Dynamic Component of K_{ae}, ΔK_{ae}	0.312
Total Active Seismic Equivalent Fluid Density, γ_e (pcf)	**83.2**
Dynamic Component of Active Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**39.1**
Submerged Dynamic Component of Active Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf)	**19.6**

Reference: Okabe (1926) & Mononobe and Matsuo (1929) from Kramer, S. L. (1996). Geotechnical Earthquake Engineering. Prentice Hall, Upper Saddle River, NJ. p. 478-480

$$\psi = \tan^{-1}\frac{K_h}{1-Kv}$$

$$K_{ae} = \frac{cos^2(\varphi-\psi-\theta)}{cos\psi\, cos^2\theta\, \cos(\psi+\theta+\delta)\left[1+\sqrt{\frac{\sin(\varphi+\delta)\sin(\varphi-\psi-\beta)}{\cos(\beta-\theta)\cos(\psi+\theta+\delta)}}\right]^2}$$

$$\Delta K_{ae} = Kae - Ka$$

$$\gamma_e = \gamma_m K_{ae} \qquad \Delta\gamma_e = \gamma_m \Delta K_{ae}$$

Passive

	Log-Spiral
Total Unit Weight of Soil, γ (pcf)	105
Friction Angle of Soil, ϕ' (°)	26
Soil-Wall Interface Friction Angle from Normal, δ' (°)	13
Slope of Backfill from Horizontal, β (°)	0
Backslope of Wall from Horizontal, θ (°)	90
$-\delta/\varphi'_f$ ratio	-0.500
β/ϕ'_f ratio	0.000
Passive Earth Pressure Coefficient from Chart, $K_{p\text{-Chart}}$	4.712
Reduction Factor, R_f	0.796
Passive Earth Pressure Coefficient, K_p	3.749
Skew Angle of Wall from Normal, θ_{skew} (°)	0.0
Reduction Factor for Skew Effects, R_{skew}	1.000
Passive Earth Pressure Coefficient with Skew Effects, $K_{p\text{-skewed}}$	3.749
Passive Equivalent Fluid Density, γ_e (pcf)	**393.7**
Submerged Passive Equivalent Fluid Density, $\gamma_{e(sub)}$ (pcf)	**159.7**

References:
1. U.S Department of the Navy (1982) from American Association of State Highway and Transportation Officials [AASHTO]. (2017). AASHTO LRFD Bridge Design Specifications, U.S. Customary Units. Washington, D.C. Section 3.11.5.4 p. 3-117 to p. 3-118
2. Rollins, K. M., and Jessee, S. J. (2013). "Passive Force-Deflection Curves for Skewed Abutments." Journal of Bridge Engineering, 18(10), 1086–1094.

$$R_{skew} = (7.79 * 10^{-5})\theta_{skew}{}^2 - 0.018\theta_{skew} + 1$$

$$K_{pskewed} = RskewKp$$

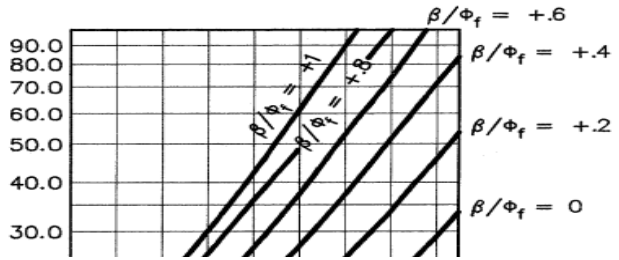
$$\gamma_e = \gamma_m K_p$$

$$\gamma_{e(sub)} = (\gamma - \gamma_{water})Kp$$

Graphical Solution for Log-Spiral Passive Earth Pressure Coefficient:

REDUCTION FACTOR (R) OF k_p FOR VARIOUS RATIOS OF $-\delta/\Phi_f$

Φ_f \ δ/Φ_f	−0.7	−0.6	−0.5	−0.4	−0.3	−0.2	−0.1	0.0
10	.978	.962	.946	.929	.912	.898	.881	.864
15	.961	.934	.907	.881	.854	.830	.803	.775
20	.939	.901	.862	.824	.787	.752	.716	.678
25	.912	.860	.808	.759	.711	.666	.620	.574
30	.878	.811	.746	.686	.627	.574	.520	.467
35	.836	.752	.674	.603	.536	.475	.417	.362
40	.783	.682	.592	.512	.439	.375	.316	.262
45	.718	.600	.500	.414	.339	.339	.221	.174



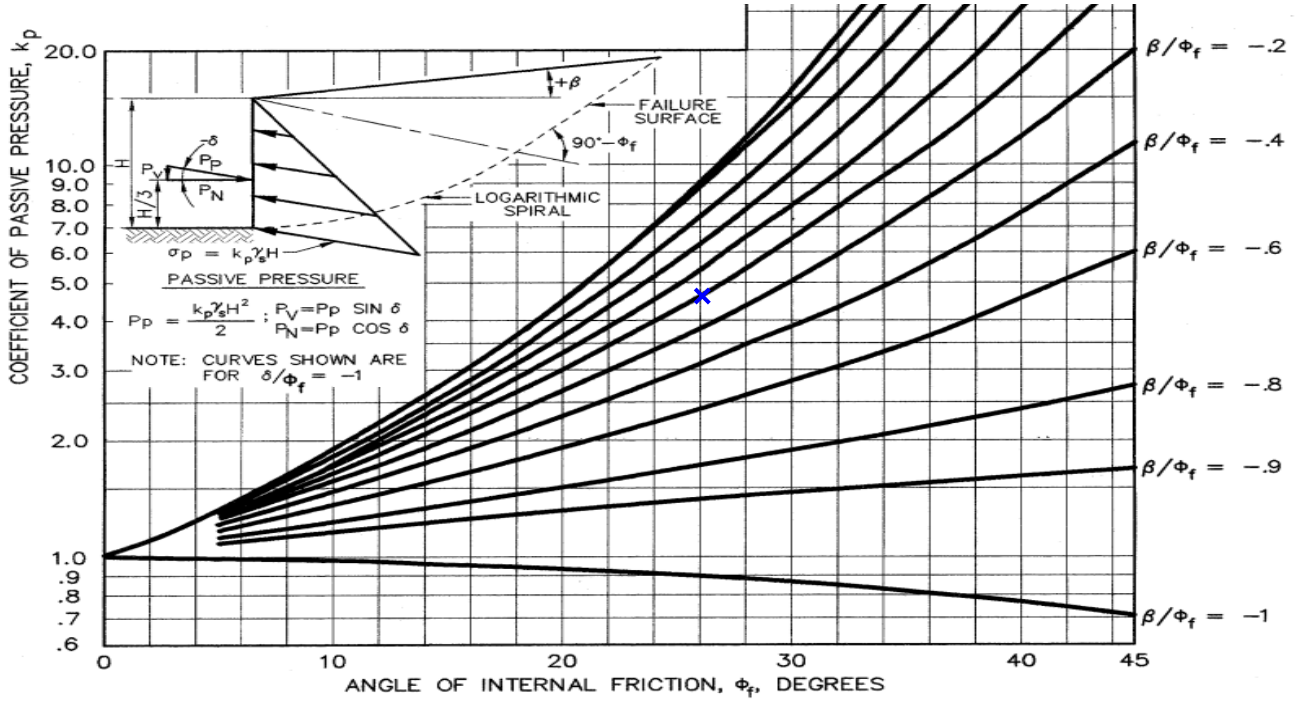


Figure 3.11.5.4-2—Computational Procedures for Passive Earth Pressures for Vertical Wall with Sloping Backfill (U.S. Department of the Navy, 1982a)

Passive Seismic	**Log-spiral & Anderson et al. (2008)**	
Total Unit Weight of Soil, γ (pcf)	105	
Effective Horizontal Acceleration, K_h (g)	0.31	
Friction Angle of Soil, ϕ'_f (°)	26	
Soil-Wall Interface Friction Angle from Normal, δ (°)	17	
Slope of Backfill from Horizontal, β (°)	0	
Skew Angle of Wall from Normal, θ_{skew} (°)	0.0	
δ/ϕ'_f ratio	0.67	
Total Passive Seismic Earth Pressure Coefficient, K_{pe}	2.892	
Total Passive Seismic Earth Pressure Coefficient with Skew Effects, $K_{pe\text{-}skewed}$	2.892	$K_{peskewed} = RskewKpe$
Dynamic Component of K_{pe}, ΔK_{pe}	-0.858	$\Delta K_{pe} = Kpe - Kp$
Dynamic Component of K_{pe} with Skew Effects, $\Delta K_{pe\text{-}skew}$	-0.858	
Total Passive Seismic Equivalent Fluid Density, γ_e (pcf)	**303.6**	$\gamma_e = \gamma_m K_{pe}$ $\quad$ $\Delta\gamma_e = \gamma_m \Delta K_{pe}$
Dynamic Component of Passive Seismic Equivalent Fluid Density, $\Delta\gamma_e$ (pcf)	**-90.0**	(Skew effects included in results if applicable)
Submerged Dynamic Component of Passive Seismic Equivalent Fluid Density, $\Delta\gamma_{e(sub)}$ (pcf)	**-36.5**	(Skew effects included in results if applicable)

References:

1. Anderson et al. (2008) and U.S Department of the Navy (1982) from American Association of State Highway and Transportation Officials [AASHTO]. (2017). AASHTO LRFD Bridge Design Specifications, U.S. Customary Units. Washington, D.C. Section A11.4 p. 11-115 to p. 11-119
2. Rollins, K. M., and Jessee, S. J. (2013). "Passive Force-Deflection Curves for Skewed Abutments." Journal of Bridge Engineering, 18(10), 1086–1094.

Graphical Solution for Log-Spiral Passive Seismic Earth Pressure Coefficient:

$$c/\gamma H = 0$$

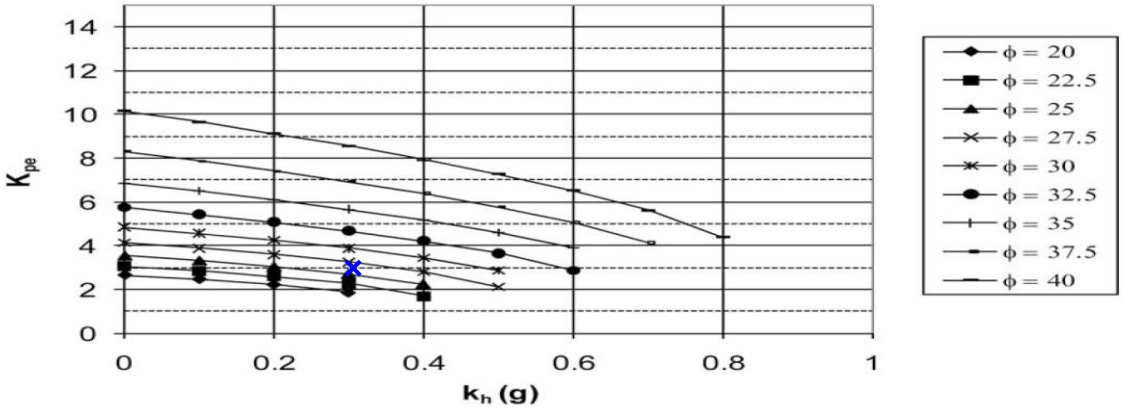


Figure A11.4-2—Seismic Passive Earth Pressure Coefficient Based on Log Spiral Procedure for $c/\gamma H = 0$ and 0.05 (c = soil cohesion, γ = soil unit weight, and H = height or depth of wall over which the passive resistance acts)

Note: $k_h = A_s = k_{ho}$ for wall heights greater than 20 ft.

Salt Lake City Water Reclamation Facility Composite Soil Constrained Modulus for Vertical Pipe Deflection Calculation

Purpose

This calculation document details the approach and methodology used to estimate the composite soil constrained modulus for vertical pipe deflection for the proposed Salt Lake City (SLC) New Water Reclamation Facility (New WRF) Influent Pumping Station (IPS) area.

Data Available

AECOM performed geotechnical explorations of subsurface conditions in the vicinity of the proposed New WRF IPS facilities. The subsurface exploration program for the area of interest was performed between July 2018 and August 2021. The details of the laboratory and field investigations are discussed in the "Salt Lake City Water Reclamation Facility Influent Pump Station Settlement Calculation" document.

Assumptions

The following assumptions were made regarding this calculation and supporting data:

- Laboratory tests were performed in accordance with the referenced American Society for Testing and Materials (ASTM) standards and are reported accurately by the subcontracted testing facility.
- Samples tested in the laboratory are representative of the soil unit from which they were obtained. Further, the results of the testing are indicative of material properties for the soil unit.
- The soil constrained modulus, M_s, may be used directly as the modulus of soil reaction, E', for calculating the pipe vertical deformation in the Iowa formula (AWWA 2013).
- The trench is 24 inches wider than the pipe outer diameter (12 inches on each side) to provide clearance for compaction.
- The embedment soil around and above the pipe will be Controlled Low Strength Material (CLSM) or free-draining granular material.
- The embedment material around the pipe will be compacted to at least 95% of the maximum dry density determined by standard proctor test ASTM D698-12 (ASTM 2012)

Methodology

The composite constrained modulus, M_s, was calculated based on the methodology proposed in AWWA 2013. The composite constrained modulus, M_s, is calculated by multiplying the stress-dependent constrained modulus of the pipe zone embedment, M_{sb}, by a soil support combining factor, which depends on the relative stiffness of the native soil and embedment soil, and trench width to pipe diameter ratio.

Calculation Procedure

The composite constrained soil modulus is calculated using the following formula

$$M_s = S_c M_{sb} \quad \text{(Eq. 1)}$$

where,

M_s = composite constrained soil modulus

S_c = soil support combining factor from Table 5-5 (AWWA 2013)

M_{sb} = constrained soil modulus of the pipe zone embedment from Table 5-4 of AWWA (AWWA 2013)

The M_{sb} depends on the soil class and vertical effective stress at the pipe springline. Class II material was selected for the embedment soil based on Table 6-1 for clean, coarse-grained soil with less than 12% fines content (AWWA 2013). The effective vertical stress is calculated assuming a unit weight of 125 pcf for the backfill material and groundwater elevation of 4,211 feet. The M_{sb} was estimated by linearly interpolating the values in Table 5-4 for calculated vertical effective stress at the springline of the pipe for class II material with relative compaction of 95%, based on standard proctor test (AWWA 2013, ASTM D698-12 2012). Alternatively, CLSM could be used as backfill material. AWWA 2013 recommends M_{sb} of 25,000 psi for calculating the long-time deflection of cement stabilized sand. However, depending on the properties of CSLM, the M_{sb} of 25,000 psi could overestimate the actual M_{sb}. Conservatively, the calculated M_{sb} for class II material is used for CSLM. The calculation could be updated if more information about CSLM material properties is provided.

To estimate the soil support combining factor, S_c, the constrained modulus of the native soil, M_{sn}, at pipe elevation is needed. The M_{sn} was estimated from Table 5-6 in the referenced AWWA (2013) document, based on the undrained shear strength, S_u, and general soil description for clay layers and based on the general soil description for granular layers. The estimation of the S_u values from field and laboratory data is discussed under separate cover. The soil description for the granular material is selected based on the estimated constrained modulus developed in other documents, and the field investigation. The S_c was estimated by linear interpolation of Table 5-5 for the calculated M_{sn} to M_{sb} ratio, M_{sn}/M_{sh}, and the calculated trench width (B_d) to pipe outer diameter (D) ratio, B_d/D, by assuming 12 inches of clearance on each side of the pipe (AWWA 2013).

Soil Profile and Pipe Elevation

Table 1 shows the preliminary pipe diameters at each elevation, which were provided by the pipeline designer.

Generally, within the elevation of interest for pipes, the native soil is composed of very soft to soft clay with a few thin (1 feet to 3.5 feet) coarse-grained sand layers. The soil profile is shown as part of the calculation in Attachment 2.

Table 1. Diameters and Invert Elevations of IPS Effluent Pipe

Pipe Diameter (in)	Invert Elevation (ft)	
	From	To
48	4208	4212

Results and Recommendations

A plot of the M_s (E') vs. elevation is shown in Attachment 1 and the detailed calculations are shown in Attachment 2.

The M_s varies from about 940 psi to 980 psi, depending on the pipe elevation and location. The lower and higher values of M_s correspond to the elevation of the pipe springline and the anticipated soil types near the springline depth. The soil profile that is used in this calculation represents the average soil condition for the IPS area. The field investigation shows some variability of the thickness and elevation of soil layers. The soil profile variability is not anticipated to have a significant effect on the overall settlement calculation. However, considering the presence of thin layers of coarse-grained silty sand and the high sensitivity of the M_s values to the soil layer type, the soil profile variability could have an effect on M_s. Accordingly, it is recommended to use relatively conservative values of M_s where there is variability in soil types near the springline elevation of each pipe (e.g., the low end of values shown in Attachment 1 for the springline depth of a pipe).

References

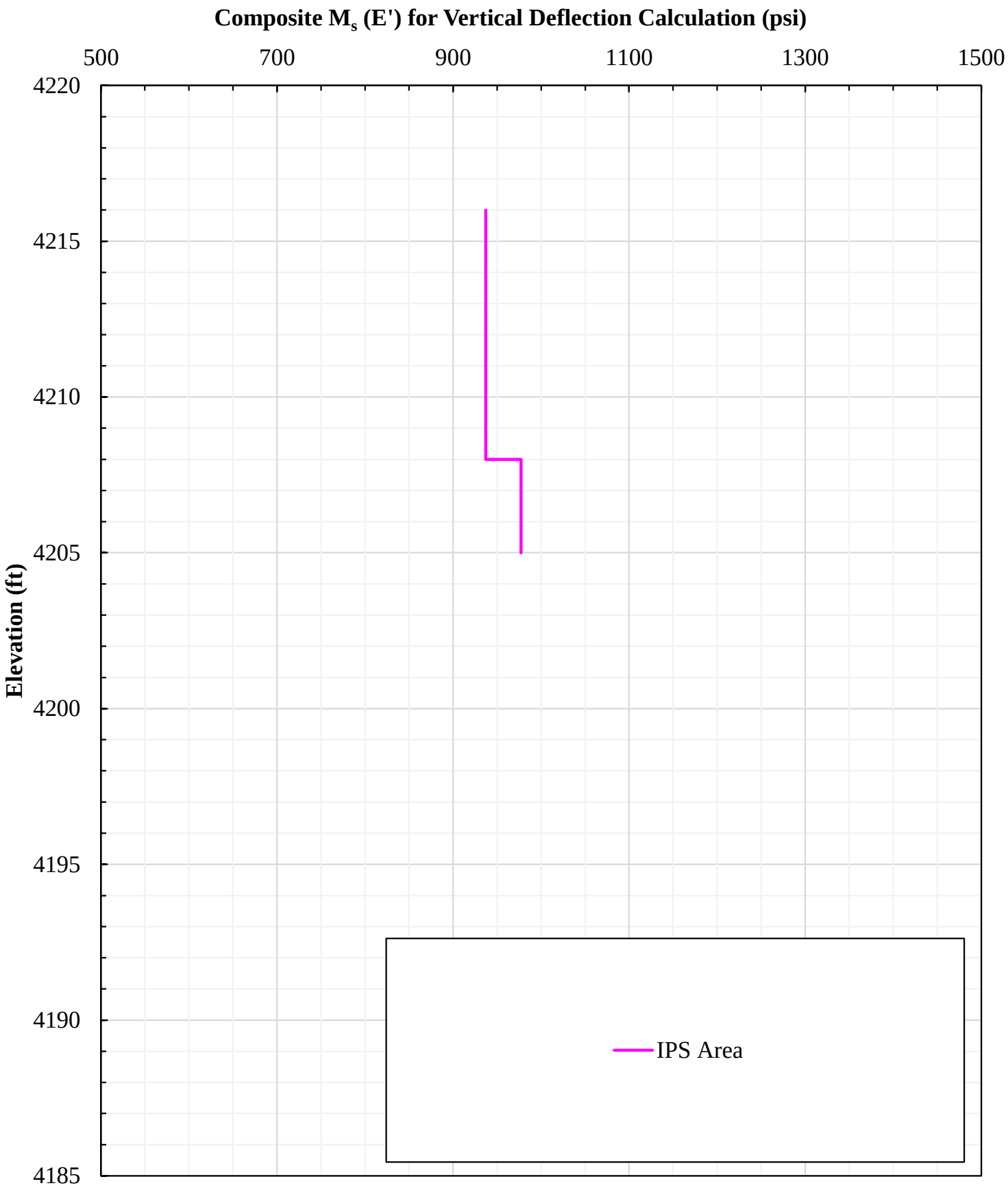
American Water Works Association. (2013). Manual of Water Supply Practices M45, Fiberglass Pipe Design, Third Edition. M45 Fiberglass Pipe Design, Third Edition, American Water Works Association.

ASTM D698-12. (2012). “Standard test methods for laboratory compaction characteristics of soil using standard effort (12 400 ft-lbf/ft3 (600 kn-m/m3)).” ASTM INTERNATIONAL, West Conshohocken, PA, 04.08, 1–13.

Attachments

Attachment 1: M_s (E’) vs. elevation plot

Attachment 2: M_s (E’) Calculation


Composite M_s (E') for Vertical Deflection Calculation (psi)
500
700
900
1100
1300
1500
4220
4215
4210
4205
4200
4195
4190
4185
Elevation (ft)
IPS Area

HDPE pipe at IPS Area

GWT Elevation: 4209 ft **Embedment Class:** Class II **Embedment Compaction:** SPD95

Sublayer No.	Soil Model	Sub Layer Thickness (ft)	Elevation at Top of Layer (ft)	Elevation at Bottom of Layer (ft)	Unit weight (pcf)	Pipe Diameter provided by structual Engineer (in)	$\sigma_v^{(1)}$ psf	$\sigma_v'^{(1)}$ psf	M_{sb} psi	Soil type	M_{sn} based on:	Description	N_{SPT}	q_u psf	M_{sn} psi	M_{sn} / M_{sb}	Clearance at pipe sringline in	B_d/D	S_c	M_s (E') psi
1	Sand/Clay	8.0	4216.0	4208.0	113	48	500	500	2,371	Cohesive	qu	--	--	800	700	0.30	12.0	1.50	0.40	937
2	Clay 1/Silt 1	3.0	4208.0	4205.0	113	48	1,188	1,032	2,773	Cohesive	qu	--	--	800	700	0.25	12.0	1.50	0.35	977

DOCUMENT 00 41 00
BID FORM

PART 1 GENERAL

1.1 **BIDDER**

A. Name: _____

B. Address: _____

_____

_____

C. Telephone number: _____

D. Email address: _____

E. Facsimile number: _____

F. Tax identification number: _____

G. Bidder holds license number _____, issued by the Utah State Department of Commerce, Division of Occupational and Professional Licensing. Bidder is licensed to practice as a _____ Contractor. The license expiration date _____.

1.2 **NOTICE**

A. Pursuant to Section 58-55-501(8), Utah Code Annotated (UCA), it is unlawful to submit a bid for any work for which a license is required under Chapter 55 of Title 58, UCA, by a person or other business entity not licensed or excepted from licensure as a contractor under Chapter 55 of Title 58, UCA. Pursuant to Section 58-55-503(1), UCA, contracts for the work may not be awarded to any person or other business entity that violates Sections 58-55-501(8) UCA, in submitting its Bid.

1.3 **CONSTRUCTION CONTRACT**

A. NEW WRF SW1 Influent Pump Station (IPS), Project 524905396.

B. The ENGINEER's estimate for this project is over $2,000,000.00.

C. This project is not CDBG funded.

D. This project does require a permit to work in the Public Way from Salt Lake City Engineering, 349 South 200 East, Suite 100. If such a permit is required, Section 6.7 (H) (1) (d) of Document 00 73 10 (Modifications to the General Conditions) shall apply.

1.4 **ADDENDA**

A. Bidder hereby acknowledges receipt of the following Addenda.

_____

(list Addenda numbers here)

1.5 **SUBMITTALS**

A. **With Bid**:

1. This Bid Form (Document 00 41 00).
2. Bid Schedule (Document 00 43 00).
3. Bid bond.
4. Mandatory Submittals (If the documents noted below are included in the Project Manual).
    a. Qualified Health Insurance Certification Form (Document 00 43 45), checking "No" will not render the bid non-responsive. That form is used by Bidder to certify whether Bidder and all subcontractors of Bidder working on the project have and will maintain an offer of qualified health insurance in compliance with Salt Lake City Code Section 3.24.115 for the duration of the contract.
    b. Work Environment Certification Form (Document 00 43 46) If the Bidder does not certify yes to each question in Document 00 43 46 the bid will be rejected as non-responsive. That form is used by Bidder to certify that Bidder and all subcontractors of Bidder working on the project have and will maintain 1) a drug and alcohol testing policy; 2) a program to recruit and/or employ veterans; 3) a job training program; 4) a safety program; and 5) a formal policy of non-discrimination in compliance with Salt Lake City Code Section 3.24.115 for the duration of the contract. See Section 3.24.115 of the Salt Lake City Code and Article 1.4 of Section 00 22 16 Supplemental Instructions.
    c. Qualifications Statement Form (Document 00 45 14).

B. Due diligence letter to Bidder: If Bidder receives a due diligence letter from OWNER after bid opening, Bidder must submit the following documents to OWNER after ENGINEER's request.

1. Document 00 43 36: Proposed Subcontractor Form.
2. Document 00 43 37: Work Under Contract Report.
3. Document 00 43 38: Bidder Status Report.
4. Other information requested and as defined in Article 3.1 and 3.4 D of Document 00 21 13.

C. **After Notice of Intent to Award**: If Bidder receives a notice of intent to award the Contract from OWNER after bid opening, Bidder must submit the following documents to OWNER.

1. Document 00 52 00: Agreement.
2. Document 00 61 13: Performance Bond.
3. Document 00 61 14: Payment Bond.
4. Document 00 62 16: Applicable Insurance Certificate.
5. Supplementary Submittals (if applicable):

a. Copy of letter from OWNER's Labor Relations Specialist certifying that Bidder has an approved utilization plan that offers economic opportunities to low and very low income persons.

b. Document 00 54 00: Agreement Supplement.

c. Document 00 54 15: Value Program Supplemental Agreement.

d. Document 00 54 16: Qualified Health Insurance Supplemental Agreement.

e. Document 00 54 17: Economic Opportunities Supplemental Agreement.

1.6 **DEFINITIONS**

A. **Bid Documents**: The Bid Documents consist of the Invitation to Bid, the Instructions to Bidders, any Supplementary Instructions to Bidders, this Bid form, any supplements (or post-bid supplements), the Bid Schedule, any data listed by and limited to the provisions in the Geotechnical Data Document, and the Bid Bond.

B. **Bid Bond**: AIA Document A310 as published by the American Institute of Architects, 1736 N. Y. Ave. N. W. Washington, D.C. 20006 or one substantially the same and acceptable to OWNER.

C. **HUD**: United States Department of Housing and Urban Development.

D. **WIFIA**: Water Infrastructure Finance and Investment Act

PART 2 COVENANTS

2.1 **BIDDER TO ENTER INTO AN AGREEMENT**

A. **In General**: Bidder agrees, if this Bid is accepted, to enter into a Construction Contract with OWNER to perform and furnish all Work specified or indicated in the Contract Documents at the Contract Time and Contract Price identified in the Agreement (Document 00 52 00).

B. **Agreement Supplement**: If it becomes necessary to further define the Work, Contract Price, Contract Time, or some other portion of the Construction Contract before signing the Agreement (Document 00 52 00), ENGINEER shall prepare an Agreement Supplement (Document 00 54 00) describing such change. OWNER shall have sole discretion in determining the necessity of preparing such a contract modification. If the Agreement Supplement is acceptable to Bidder, Bidder shall execute the Agreement Supplement before or concurrently with the execution of the Agreement (Document 00 52 00).

C. If Bidder was awarded the Construction Contract in part as a result of OWNER's Value-Based Procurement Program, Bidder shall enter into a Value Program Supplemental Agreement (Document 00 54 15) with OWNER concurrently with its execution of the Agreement (Document 00 52 00).

D. If Bidder was awarded the Construction Contact in part as a result of OWNER's Qualified Health Insurance program, Bidder shall enter into a Qualified Health Insurance Supplemental Agreement (Document 00 54 16) with OWNER concurrently with its execution of the Agreement (Document 00 52 00).

2.2 BIDDER ACCEPTS TERMS AND CONDITIONS

A. Bidder accepts all of the terms and conditions of the Bid Documents, including without limitation those dealing with the disposition of Bid security.

B. Bidder must pick up, sign, and submit, the required number of copies of the Agreement (Document 00 52 00) with the Bonds and other documents required by the Agreement within 10 days (or such longer period of time that OWNER in its discretion may allow) after the date of OWNER's Notice of Intent to Award the Construction Contract.

2.3 REPRESENTATION OF BIDDER

A. In submitting this Bid, Bidder represents, as more fully set forth in the Instructions To Bidders (Document 00 21 13), that:

1. **Nature of the Work**: Bidder has become familiar with the nature and extent of the Contract Documents, Work, site, locality, and all local conditions and Laws and Regulations that in any manner may affect cost, progress, performance, or furnishing of the Work.
2. **Surface and Subsurface Conditions**: Bidder has studied carefully all reports and drawings of subsurface conditions and drawings of physical conditions that are identified in the Geotechnical Data (Document 00 31 32) (if any).
3. **Underground Utilities**: Bidder has reviewed and checked all information and data shown or indicated on the Contract Documents with respect to existing Underground Facilities at or contiguous to the site.
4. **Bidder Investigation**: Bidder has correlated the results of all observations, examinations, investigations, explorations, tests, reports, and studies with the terms and conditions of the Contract Documents.
5. **Discrepancy Resolutions**: Bidder has given ENGINEER written notice of all conflicts, errors, or discrepancies that Bidder has discovered in the Contract Documents and acknowledges that all written resolutions thereof issued by ENGINEER before Bid opening, are acceptable to Bidder.

2.4 OWNER'S RIGHTS AT BID AWARD

A. Bidder agrees that OWNER has the right to reject this Bid or to award the Work or any part thereof to the undersigned at the prices stipulated. Bidder agrees to make no claim for damages for such rejection or award.

B. If the Bid is rejected, then the Bid security shall be returned to Bidder.

C. If the Bid is accepted, OWNER shall notify Bidder of OWNER's intent to award the Construction Contract to Bidder. Bidder shall have 10 days (or such longer period of time that OWNER in its discretion may allow) to sign and return the Agreement (Document 00 52 00) to OWNER. If Bidder fails to sign the Agreement, the Bid security, at OWNER's option, shall be claimed and cashed and the amount thereof paid to OWNER as liquidated damages for the failure of Bidder to comply with the terms of the Bid.

D. Bidder agrees that the Bid may be rejected if the submittals listed in this Document or the Notice of Intent to Award are not submitted within the time listed in the Notice of Intent to Award (or described in paragraph 2.4C hereof).

2.5 **NON-COLLUSION; ETHICS**

A. Bidder represents that the Bid is genuine. The Bid is not made in the interest of or on behalf of any undisclosed person, firm, or corporation.

B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid.

C. Bidder has not solicited or induced any person, firm, or corporation to refrain from bidding.

D. Bidder has not sought by collusion to obtain for itself any other advantage over any separate Bidder or over OWNER.

E. **REPRESENTATION REGARDING ETHICAL STANDARDS FOR CITY OFFICERS AND EMPLOYEES AND FORMER CITY OFFICERS AND EMPLOYEES**

Bidder represents that it has not:

1. **Provided an illegal gift or payoff to a City officer or employee or former City officer or employee, or his or her relative or business entity.**
2. **Retained any person to solicit or secure this contract upon an agreement or understanding for a commission, percentage, or brokerage or contingent fee, other than bona fide employees or bona fide commercial selling agencies for the purpose of securing business.**
3. **Knowingly breached any of the ethical standards set forth in the City's conflict of interest ordinance, Chapter 2.44, Salt Lake City Code; or**
4. **Knowingly influenced, and hereby promises that it will not knowingly influence, a City officer or employee or former City officer or employee to breach any of the ethical standards set forth in the City's conflict of interest ordinance, Chapter 2.44, Salt Lake City Code.**

2.6 **BID PRICING**

A. Bidder will complete the Work for the prices listed in the Bid Schedule (Document 00 43 00). Bidder agrees that quantities for Unit Price Work are not guaranteed. (Refer to Article 11.7 of the General Conditions (Document 00 72 00).

2.7 **SUBSTANTIAL COMPLETION, PROJECT COMPLETION, AND LIQUIDATED DAMAGES**

A. Bidder agrees that the Work will be Substantially Complete and ready for Final Inspection on or before the expiration of the Contract Time indicated in the Agreement (Document 00 52 00).

B. Bidder agrees that the Work will be complete and ready for final payment in accordance with Article 14.9 of the General Conditions (Document 00 72 00) on or before the expiration of the Punch List Time indicated in the Agreement.

C. Bidder accepts the provisions of the Agreement (Document 00 52 00) as to liquidated damages in the event of failure to complete the Work on time and in accordance with the Contract Documents.

PART 3 EXECUTION

3.1 **EFFECTIVE DATE**

A. Bidder executes this Bid and declares it to be in effect as of the _____ day of _____-_____, 20 _____.

3.2 **BIDDER'S SUBSCRIPTION**

A. Bidder's Signature: _____

B. Please print Bidder's name here: _____

C. Title: _____

END OF DOCUMENT

DOCUMENT 00 43 00
BID SCHEDULE

PART 1 GENERAL

1.1 **DOCUMENT INCLUDES**

A. Price schedules.

B. Measurement and payment provisions.

1.2 **CONSTRUCTION CONTRACT**

A. **New WRF SW1A Influent Pump Station (IPS)**
1200 Reclamation Road, Salt Lake City
Project No. 524905396

1.3 **REFERENCES**

A. APWA Section 01 29 00: Payment Procedures.

B. Document 00 52 00: Agreement.

PART 2 PRICE SCHEDULES

2.1 **GENERAL**

A. Number of schedules in Base Bid: One (1).

B. For progress payment procedures, see APWA Section 01 29 00.

2.2 **BASE BID**

A. Bidder shall complete all blanks in the bid schedule included in this section. Failure to do so may cause the bid to be declared non-responsive by ENGINEER.

B. The base bid for the project shall include items 1-8 and all allowances from the bid schedule.

2.3 **ALTERNATES**

A. Bidder shall complete all blanks in the bid schedule included in this section. Failure to do so may cause the bid to be declared non-responsive by ENGINEER. Refer to Section 01 23 00 for description of each alternate.

B. Prices for each alternate shall be included in the bid schedule and be selected by Owner in accordance with 01 23 00.

2.4 **ALLOWANCES**

A. Bidder shall complete all blanks in the bid schedule included in this section. Failure to do so may cause the bid to be declared non-responsive by ENGINEER. Refer to Section 01 21 00 for description of each allowance.

Item No.	Description	Quantity Unit	Unit Price	Amount ($)
Base Bid				
1	Pump Station Construction	1 Lump Sum		
2	Mobilization/Demobilization	1 Lump Sum		
3	Odor Control Construction	1 Lump Sum		
4	Electrical Building Construction	1 Lump Sum		
5	Standby Power and Fuel Construction	1 Lump Sum		
6	Ductbank Construction	1 Lump Sum		
7	1" Mill and Overlay	24,000 yd^2 Unit Price ($/$yd^2$)		
8	Site Civil	1 Lumps Sum		
Allowances				
9	Golf Netting	1 Lump Sum	$100,000	$100,000
10	Bypass Pumping	1 Lump Sum	$500,000	$500,000
11	Permitting Fees	1 Lump Sum	$30,000	$30,000
12	Hauling and Disposal of Unsuitable Materials to Brown Property	80,800 ton Unit Price ($/ton)		
13	Hauling and Disposal of Unsuitable or Impacted/Contaminated Materials to Landfill	20,200 ton Unit Price ($/ton)		
Total Base Bid (Base Bid + Allowances)				
Total Base Bid in Words				
Alternates				
14	Installation of 6th Pump	1 Lump Sum		

PART 3 MEASUREMENT AND PAYMENT

3.1 GENERAL

A. This Section defines the manner in which the Lump Sum Prices, Unit Prices, and the Allowances listed in the Bid Schedule will be used to determine measurement and payment for all Work and describes the required procedures for monthly progress payments to the Contractor.

B. Lump Sum (LS) Bid Items: Measured on a percent complete basis.

C. See payment procedures in APWA Section 01 29 00 – Payment Procedures. For lump sum items, Contractor will be required to submit a schedule of values in accordance with the specifications prior to the first pay request.

D. No initial progress payment (other than a single mobilization payment as described in Article 3.3 below) will be made prior to acceptance by the ENGINEER of the Progress Schedule, the associated Schedule of Costs (or Values), and the list of anticipated submittals.

E. No subsequent progress payment will be made prior to receipt by the ENGINEER of the monthly update of the Construction Progress Schedule, as specified in Section 01 31 13 - Coordination.

F. All Work required by the Contract, Drawings, and Specifications not otherwise used as a separate bid item, shall be considered as included in the prices of the bid, and no additional compensation will be made.

G. CONTRACTOR will take all measurements and compute all quantities.

H. CONTRACTOR will provide all equipment, workers, and survey crews as necessary to assist ENGINEER in verifying measurements.

3.2 LUMP SUM PRICES

A. Bid amounts include full compensation for all plant, labor, service, materials, products, tools, equipment, transportation, services and incidentals; erection, application or installation of the Work; overhead and profit, permits; and completing the WORK included in the Agreement, shown in the Drawings, defined in the Specifications, and stipulated herein. WORK required for which no separate Bid items is identified will be considered as a subsidiary obligation of the Contractor, and the cost therefore shall be included in the most applicable Bid item.

B. Payment for all items in the Bid Schedule will include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of Work being described, as necessary to complete the various items of the Work in accordance with the requirements of the Contract Documents, including all appurtenances thereto, and including but not limited to all costs of permits and cost of compliance with the regulations of public agencies having jurisdiction, including Safety and Health Requirements of the Utah Division of Industrial Safety and

the Occupational Safety and Health Administration of the U.S. Department of Labor (OSHA).

C. Payment for all items in the Bid Schedule will include the cost of incidental work such as but not limited to: baseline and progress schedule (01 32 17); QA/QC program; submittal processing; traffic control plan (01 55 26); project identification sign(s); safety procedure plan (00 72 00, 2.5B.7); dust control; surveying; testing; commissioning; temporary utilities during construction; coordination with utility companies for temporary and permanent utility services; locating existing utilities and other underground facilities; providing any needed coordination, assistance, and work to other utility companies in locating and relocating service laterals and mains, as needed; irrigation, surface water and drainage management (01 57 00); dewatering plan (31 23 19); shoring (31 50 00); saw cutting, removal, and disposal of any Portland cement concrete as required; pothole excavations; backfill per construction drawings; removal and disposal of waste materials; backfill material and compaction; startup and testing; dewatering; fees from the County Surveyor for monument restoration; hauling and stockpiling of materials and equipment; protection and support of existing surface and subsurface features; untreated base course at depth indicated; removal and disposal of existing curb and gutter, concrete waterway, driveway, drive approach and sidewalk; coordination with public outreach; replacement of all curb and gutter, concrete waterway, and sidewalk/driveway; installation of sewer manhole invert cover(s) and subsequent removal as directed by governing authorities; temporary asphalt concrete patch; coordination with property owners, businesses, contractors, and government agencies; all provisions required to provide and maintain full and continuous access to all properties affected by construction operations; replacement of existing facilities removed without prior approval of the ENGINEER; replacement and restoration of existing facilities damaged by the CONTRACTOR's operations; surface restoration not identified as separate pay items in bid schedule; and all other necessary work, to complete the work in place.

D. The unit or lump sum item of work, which involves excavation or trenching shall include all costs for such work. No direct payment will be made for excavation or trenching. All excavation and trenching will be unclassified as to materials which may be encountered; in addition, trenches will be unclassified as to depth. There will be no payment for over excavation and backfill unless approved in writing by ENGINEER prior to excavation.

E. All costs shall be included in the prices named in the Bid Schedule for the various items of Work. Except as otherwise provided herein, no separate payment will be made for any item that is not specifically set forth in the Bid Schedule.

3.3 SCHEDULE OF COSTS FOR PAYMENTS

A. Submit to the ENGINEER, within 5 days of acceptance of the Construction Schedule, an electronic copy of a Schedule of Costs (or Values). The Schedule of Costs shall be a form showing a detailed breakdown of quantities and prices of work and materials required to perform and complete the contract.

B. The Schedule of Costs shall provide a cost breakdown for each element detailed in the approved Construction Schedule. The total of the price breakdown must agree with the unit price bid items added. The elements listed and price breakdown shall not be front end

loaded or unbalanced, shall be subject to adjustment between the ENGINEER and the CONTRACTOR, and will be used as a basis for progress payments.

3.4 DESCRIPTION OF BID ITEMS

A. Bid Item No. 1 – Pump Station Construction

1. General Measurement and Payment:

a. Pump Station Construction shall be measured and paid for on a lump sum basis.

b. Measurement: The sum allowed for Bid Item No. 1 as set forth in the Bid Form includes all Work for and in connection with construction of the Influent Pump Station in its entirety excluding items listed in the subsequent bid items.

c. Payment shall include all labor, materials, equipment, supplies, and other work necessary for the construction of the complete pump station and all associated structures, trade work, and appurtenances as shown in the Contract Documents, and as listed in section 3.2.C above, and all other appurtenances and requirements as applicable to provide a complete and functional project.

d. Payment for Work under this Bid item will be based on the breakdown of costs for each scheduled activity in the Construction Schedule of Costs as approved and accepted by the ENGINEER and OWNER. The amount paid shall be in accordance with the actual percent complete at the time of payment for each item listed in the Schedule of Values as submitted by the CONTRACTOR and as approved and accepted by the ENGINEER.

B. Bid Item No. 2 –Mobilization/Demobilization

1. Measurement and Payment

a. Measurement: Mobilization/Demobilization will be measured and paid on a lump sum (LS) basis.

b. Payment: Payment for Mobilization & Demobilization shall consist of preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the Site, securing all insurances required to complete the work including those listed in Sections 00 72 00, 00 73 00, and 00 73 10, and for all other appurtenances, work and operations which must be performed, or costs incurred, prior to beginning the Work, and as described in Section 01 71 13.

c. Payment for mobilization/demobilization will be as follows:

1) When the Contract, proposed Description of Bid Items includes a separate item for mobilization/demobilization, payment for mobilization/ demobilization will include full compensation for the furnishing of all labor, materials, tools, equipment, administrative costs, and incidentals for mobilization/demobilization.

2) The OWNER anticipates no greater than three percent (3%) of the total Contract Sum for Bid Items #1,3,4,5,6,7 & 8 as a separate pay item for

mobilization/demobilization.

3) In the event the CONTRACTOR submits a mobilization/demobilization pay item greater than three percent (3%) of the value of Bid Items #1, 3, 4, 5, 6, 7 & 8, the OWNER will pay any excess mobilization/demobilization amount with the final Progress Payment.

d. Payment for mobilization/demobilization will be prorated as follows:

1) When the Progress Payment request is three percent (3%) or more of the original total Contract Sum (excluding all mobilization/demobilization bid items), fifty percent (50%) of the contract item price for mobilization/demobilization or one and one-half percent (1.5%) of the total Contract Sum, whichever is less, will be paid for mobilization/ demobilization.

2) When the Progress Payment request is ten percent (10%) or more of the original total Contract Sum (excluding all mobilization/demobilization bid items), seventy percent (70%) of the contract item price for mobilization/ demobilization or two percent (2%) of the total Contract Sum, whichever is less, will be paid for mobilization/demobilization.

3) When the Progress Payment request is twenty percent (20%) or more of the original total Contract Sum (excluding all mobilization/demobilization bid items), ninety percent (90%) of the contract item price for mobilization/ demobilization or two and one-half percent (2.5%) of the total Contract Sum, whichever is less, will be paid for mobilization/ demobilization.

4) When the Progress Payment request is fifty percent (50%) or more of the original total Contract Sum (excluding all mobilization/demobilization bid items), one hundred percent (100%) of the contract item price for mobilization/demobilization or three percent (3%) of the total Contract Sum, whichever is less, will be paid for mobilization/demobilization.

5) After final acceptance of the Contract, the amount, if any, of the Contract item price for mobilization/demobilization in excess of three percent (3%) of the original total Contract Sum will be included for payment in the final estimate.

e. The OWNER will not pay additional mobilization/demobilization compensation for work under a Contract Change Order. Payment for mobilization/ demobilization shall be subject to retention.

C. Bid Item No. 3 – Odor Control Construction

1. Measurement: Odor Control shall be measured and paid for on a lump sum basis and shall include the following; all underslab utilities and foundation preparation, foundation slab, odor control system, electrical, and instrumentation associated with the odor control system.

2. Payment for odor control system shall be paid for based on the percentage complete

for an operational system approved by ENGINEER and OWNER.

D. Bid Item No. 4 – Electrical Building Construction

1. Measurement: Electrical Building Construction shall be measured and paid for on a lump sum basis and shall include the following; all underslab utilities and foundation preparation, foundation slab, electrical building, all interior and exterior electrical equipment, terminations, connections, instrumentation, ancillary works associated with the electrical building.

2. Payment for Electrical Building construction shall be paid based on the percentage complete for an operational system approved by the ENGINEER and OWNER.

E. Bid Item No. 5 – Standby Power and Fuel

1. Measurement Standby Power and Fuel shall be measured and paid for on a lump sum basis and shall include the following; all underslab utilities and foundation preparation, foundation slab, generators, fueling systems, fuel storage tanks, interior and exterior electrical equipment, terminations, connections, instrumentation, and ancillary works associated with the Standby Power and Fuel System.

2. Payment for the Standby Power and Fuel System shall be paid shall be paid based on the percentage complete for an operational system approved by the ENGINEER and OWNER .

F. Bid Item No. 6 – Ductbank Construction

1. Measurement: Ductbank construction will be measured and paid on a lump sum (LS) basis and consist of construction of the ductbank between the existing ductbank at the new SLCWRF facility and Influent Pump Station Electrical Building including all associated terminations and cable.

2. Payment: Payment for Ductbank Construction shall be paid based on the percentage complete of installation of ductbank, including compacted backfilling over completed ductbank.

G. Bid Item No. 7 – 1” Mill and Overlay

1. Measurement: 1” Mill and Overlay shall be measured and paid based on actual quantities of asphalt milled and overlayed in accordance with APWA plan 253.2, APWA 32 01 16.71 and related sections.

2. Payment: 1” Mill and Overlay shall be paid based on the unit rate bid by the CONTRACTOR to mill and overlay 1” of asphalt pavement for areas of existing roadways damaged during construction. ENGINEER has estimated a total quantity of 24,000 yd^2 of asphalt will require milling and overlay to repair streets damaged by construction activities.

H. Bid Item No. 8 – Site Civil

1. Measurement: Site Civil work shall be measured and paid for on a lump sum basis and shall include the following; all underground piping, ductbanks, and conduits up to the edge of structures, excavation, backfill, compaction, paving, grading,

curb/gutter, tie-ins, and ancillary works associated with providing all site civil and utilities.

2. Payment shall be made for Site Civil paid based on the percentage complete of civil site improvements approved by ENGINEER and OWNER.

I. Bid Item No. 9 – Golf Netting Allowance

1. Measurement: Shall be measured based on actual quantities of netting installed.
2. Payment for golf course netting shall be paid based on the actual cost incurred by the CONTRACTOR to put up new netting around the pump station site. Payment shall be made upon receipt of invoices. The lump sum amount shown on the bid schedule is an estimate for bidding purposes only.

J. Bid Item No. 10 – Bypass Pumping Allowance

1. Measurement: Allowance payment to CONTRACTOR during implementation of the work required to assist the OWNER in designing, implementing, and operating a temporary bypass pumping system to allow construction of the connections to the existing facilities.

2. Measurement: Prior to commencing this WORK, CONTRACTOR, OWNER and ENGINEER shall meet in a pre-activity conference to define the WORK required. CONTRACTOR shall then prepare a schedule of values for the requested work and submit it to the ENGINEER/OWNER for review and approval, prior to starting work. Schedule of values shall include all requested WORK and shall represent the full reimbursement for the requested WORK.

3. Payment for Bypass Pumping shall be made based upon advanced written approval from the OWNER of the submitted Schedule of Values based upon WORK completed, submittal of receipts, or other documentation of actual costs and/or completion of the Work and acceptance by ENGINEER and OWNER. The lump sum amount shown on the bid schedule is an estimate for bidding purposes only.

K. Bid Item No. 11 – Permitting Fees Allowance

1. Measurement: Permitting Fees shall be measured and paid on the actual cost incurred by the CONTRACTOR to obtain the required permits.

2. Payment: Permitting Fees shall be paid based on the actual cost incurred by the CONTRACTOR to obtain the required permits. Payment shall be made upon receipt of the associated permit and submittal of receipts/ payment documentation. The lump sum amount shown on the bid schedule is an estimate for bidding purposes only.

L. Bid Item No. 12 – Hauling and Disposal of Unsuitable Materials to Brown Property Allowance

1. Measurement: Hauling and Disposal of Unsuitable Materials to Brown Property shall be measured and paid based on actual quantities of Unsuitable Materials hauled to the Brown Property.

2. Payment: Hauling and Disposal of Unsuitable Materials to Brown Property shall be paid based on the unit rate bid by the CONTRACTOR to haul and dispose of the material.

Payment shall be made upon receipt of the haul tickets. ENGINEER has estimated a total quantity of 80,800 ton of material will be unsuitable and require hauling.

M. Bid Item No. 13 – Hauling and Disposal of Unsuitable or Impacted/Contaminated Materials to Landfill

1. Measurement: Hauling and Disposal of Unsuitable or Impacted/Contaminated Materials to Landfill shall be measured and paid based on actual quantities of materials hauled to the Landfill.
2. Payment: Hauling and Testing of Unsuitable Materials to Landfill shall be paid based on the unit rate bid by the CONTRACTOR to haul, test, and tip the material. Payment shall be made upon receipt of the haul tickets. ENGINEER has estimated a total quantity of 20,200 ton of material will be unsuitable and require hauling.

N. Bid Item No. 14 – Installation of 6^{th} Pump Alternate

1. Measurement: Installation of 6^{th} Pump will be measured and paid on a lump sum (LS) basis.
2. Payment: Payment for Installation of 6^{th} Pump shall be paid based on schedule of values on percentage of work complete.

END OF DOCUMENT

DOCUMENT 00 43 36
PROPOSED SUBCONTRACTOR FORM

PART 1 GENERAL

1.1 **BIDDER**

A. Name: _____

Address: _____

_____

_____

B. Telephone Number: _____

1.2 **CONSTRUCTION CONTRACT**

A. New WRF SW1 Influent Pump Station (IPS)
1200 Reclamation Road, Salt Lake City
Project No. 524905396

PART 2 REPORT

2.1 **SUBCONTRACTOR AND SUPPLIER REPORT**

A. Failure of Bidder to specify a Subcontractor for any portion of the Work constitutes an agreement by Bidder that Bidder is fully qualified to perform that portion of work and that Bidder shall perform that portion. See Instructions to Bidders (Document 00 21 13, paragraph 3.4B for additional information concerning the subcontractors and the nature and extent of any work that must be listed on this form.

B. Bidder will be fully responsible to OWNER for the acts and omissions of Subcontractors and Suppliers and of persons either directly or indirectly employed by them, as Bidder is for the acts and omissions of persons employed by Bidder directly.

C. Nothing contained in the Contract Documents shall create any contractual relationship between any Subcontractor or Supplier and OWNER. Bidder agrees that each subcontract with Bidder's Subcontractor will disclaim any third party or direct relationship between OWNER and any Subcontractor or Supplier.

D. The names and addresses of the Subcontractors and Manufacturers who will work under the terms of the Contract Documents and the estimated dollar amount of each subcontract, as appropriate, are set forth in the following tables.

SUBCONTRACTORS		
Name	**Nature and Extent of Work to be Subcontracted**	**Amount**
1.		
2.		
3.		
4.		
5.		
Total $ _____ Percent of Total Contract _____%		
SUPPLIERS		
Name	**Nature and Extent of Work to be Supplied**	**Amount**
1.		
2.		
3.		
4.		
5.		

PART 3 EXECUTION

3.1 **EFFECTIVE DATE**

A. Bidder executes this Subcontractor and Supplier report and declares it to be a supplement to the Bid (Document 00 41 00) and in effect as of _____, 20___

3.2 **BIDDER'S SUBSCRIPTION**

A. Bidder's signature: _____

B. Please print Bidder's name here: _____

C. Title: _____

END OF DOCUMENT

DOCUMENT 00 43 37
WORK UNDER CONTRACT REPORT

PART 1 GENERAL

1.1 **BIDDER**

A. Name: _____

Address: _____

_____

_____

B. Telephone Number: _____

1.2 **CONSTRUCTION CONTRACT**

A. New WRF SW1 Influent Pump Station (IPS)

1200 Reclamation Road, Salt Lake City

Project No. 524905396

PART 2 REPORT

2.1 **STATUS OF WORK UNDER CONTRACT**

A. The completion and submission to OWNER of the following table by Bidder is required within 7 calendar days after ENGINEER's request per Article 3.1 of the Instructions to Bidders (Document 00 21 13). OWNER may declare Bidder non-responsive if this report is not submitted on time.

B. The successful Bidder is required to notify OWNER in writing of any new contracts awarded before the execution of the Construction Contract.

STATUS OF WORK UNDER CONTRACT

	Description of Contract And for Whom Performed	Date of Award	Amount of Contract	Contract Completion Date	Percent Complete	Scheduled Completion Date	Dollar Amount Outstanding
1							
2							
3							
4							

	Description of Contract And for Whom Performed	Date of Award	Amount of Contract	Contract Completion Date	Percent Complete	Scheduled Completion Date	Dollar Amount Outstanding
5							
6							
7							
8							
9							
10							

Total of Dollar Amount Outstanding $_____

CONTRACTOR's Bid for this Project $_____

TOTAL $_____

C. Add supplemental sheets if necessary to account for all work under contract.

PART 3 EXECUTION

3.1 EFFECTIVE DATE

A. Bidder executes this Work Under Contract Report and declares it to be a supplement to the Bid (Document 00 41 00) and in effect as of _____, 20____.

3.2 BIDDER'S SUBSCRIPTION

A. Bidder's signature: _____

B. Please print Bidder's name here: _____

C. Title: _____

END OF DOCUMENT

DOCUMENT 00 43 38
BIDDER STATUS REPORT

PART 1 GENERAL

1.1 **BIDDER**

A. Name: _____

B. Address: _____

_____

_____

C. Telephone number: _____

1.2 **CONSTRUCTION CONTRACT**

A. New WRF SW1 Influent Pump Station (IPS)
1200 Reclamation Road, Salt Lake City
Project No. 524905396

PART 2 REPORT

2.1 **BIDDER STATUS REPORT**

A. Bidder affirms that the following information is true and correct.

1. Number of employees: _____
2. Bidder's firm is: (check all of the following that are applicable)

[___] Independently owned and operated.

[___] An affiliate of*

[___] A subsidiary of*

[___] A division of*

[___] A business with gross revenue in excess of $_____

[___] A business with gross revenue below $ _____

* PARENT COMPANY:

Name: _____

Address: _____

Telephone Number: _____

Facsimile Number: _____

PART 3 EXECUTION

3.1 **EFFECTIVE DATE**

A. Bidder executes this status report and declares it to be a supplement to the Bid Form (Document 00 41 00) and in effect as of _____, 20 ____.

3.2 **BIDDER'S SUBSCRIPTION**

A. Bidder's Signature: _____

B. Please print Bidder's name here: _____

C. Title: _____

END OF DOCUMENT

DOCUMENT 00 43 45
QUALIFIED HEALTH INSURANCE CERTIFICATION FORM

PART 1 GENERAL

1.1 **BIDDER**

A. Name: _____

B. Address: _____

_____

_____

C. Telephone number: _____

1.2 **CONSTRUCTION CONTRACT**

A. New WRF SW1 Influent Pump Station (IPS)

1200 Reclamation Road, Salt Lake City

Project No. 524905396

1.3 **CERTIFICATION**

A. Bidder, on behalf of Bidder and every subcontractor under Bidder, if any, affirms that the following information is true and correct as of the time of submitting its bid.

1. Bidder and every subcontractor, if any, provides and will maintain Qualified Health Insurance Coverage Yes _____ No _____

initial initial

as defined in Section 3.24.115 of the Salt Lake City Code means the same as that term defined in Section 26-40-115, Utah Code Annotated, as amended, or its successor:

B. Qualified Health Insurance Coverage as defined in Section 3.24.115:

1. A health benefit plan and employer contribution level with a combined actuarial value at least actuarially equivalent to the combined actuarial value of the benchmark plan found at http://www.health.utah.gov/chip/PDF/2016Benchmark.pdf determined by the Children's Health Insurance Program under Utah Code Section 26-40-106(1) and a contribution level at which the employer pays at least 50% of the premium for the employee and the dependents of the employee who reside or work in Utah; or
2. A federally qualified high deductible health plan that at a minimum:
   a. Has a deductible that is :
      i. The lowest deductible permitted for a federally qualified high deductible health plan; or
      ii. A deductible that is higher than the lowest deductible permitted for a federally qualified high deductible health plan, but includes an employer contribution to a health savings account in a dollar amount at least equal to the dollar amount difference between the lowest deductible permitted for a federally qualified high deductible plan and the deductible for the employer offered

federally qualified high deductible plan;

b. Has an out-of-pocket maximum that does not exceed three times the amount of the annual deductible; and

c. Provides that the employer pays 60% of the premium for the employee and the dependents of the employee who work or reside in Utah.

PART 3 EXECUTION

3.1 EFFECTIVE DATE

A. Bidder executes this form, a supplement to the Bid Form (Document 00 41 00), and declares it to be true and correct and in effect as of _____, 20 ____.

3.2 BIDDER'S SUBSCRIPTION

A. Bidder's signature: _____

B. Please print Bidder's name here: _____

C. Title: _____

END OF DOCUMENT

DOCUMENT 00 43 46
WORK ENVIRONMENT CERTIFICATION FORM

PART 1 GENERAL

1.1 **BIDDER**

A. Name: _____

B. Address: _____

_____

_____

C. Telephone number: _____

1.2 **CONSTRUCTION CONTRACT**

A. New WRF SW1 Influent Pump Station (IPS)

1200 Reclamation Road, Salt Lake City

Project No. 524905396

1.3 **AFFIDAVIT**

A. Bidder, on behalf of Bidder and every subcontractor under Bidder, if any, affirms that the following information is true and correct.

1. Bidder and every subcontractor, if any, provides and will maintain the following as defined in Section 3.24.115 of the Salt Lake City Code for the duration of the contract.

a.	A drug and alcohol testing policy during the period of the contract.	Yes _____ Initial No _____ Initial
b.	A program to actively recruit and/or employ veterans.	Yes _____ Initial No _____ Initial
c.	A job training program.	Yes _____ Initial No _____ Initial

d.	A safety program.	Yes _____ Initial No _____ Initial
e.	A formal policy of non-discrimination consistent with federal, state, and local law.	Yes _____ Initial No _____ Initial

PART 3 EXECUTION

3.1 EFFECTIVE DATE

A. BIDDER executes this form and declares it to be true and correct and in effect as of _____, 20 ____.

3.2 BIDDER'S SUBSCRIPTION

A. BIDDER's signature: _____

B. Please print BIDDER's name here: _____

C. Title: _____

END OF DOCUMENT

DOCUMENT 00 45 14
QUALIFICATIONS STATEMENT

ARTICLE 1 — GENERAL INFORMATION

1.01 Provide contact information for the Contractor:

Legal Name of Contractor:			
Corporate Office Information			
Contact Name:		Phone number:	
Email Address:			
Address of corporate office:			
Local Office Information			
Contact Name:		Phone number:	
Email Address:			
Address of local office:			

1.02 Provide information on the Contractor's organizational structure:

Form of Business:	☐ Sole Proprietorship ☐ Partnership ☐ Corporation		
☐ Limited Liability Company ☐ Joint Venture comprised of the following companies:			
	1.		
	2.		
	3.		
Provide a separate Qualification Statement for each Joint Venturer if applicable.			
Date Business was formed:		State in which Business was formed:	
Is this Contractor licensed to operate in Utah for the work as defined in the contract documents?		☐ Yes ☐ No ☐ Pending	

1.03 Identify all businesses that own Contractor in whole or in part (25 percent or greater), or that are wholly or partly (25 percent or greater) owned by Contractor:

Name of business:		Affiliation:	
Address:			
Name of business:		Affiliation:	
Address:			
Name of business:		Affiliation:	
Address:			

ARTICLE 2 — CONSTRUCTION EXPERIENCE

2.01 Provide information that will identify the overall size and capacity of the Contractor:

Average number of current full-time employees:	
Estimate of revenue for the current year:	
Estimate of revenue for the previous year:	

2.02 Provide information regarding the Contractor's previous contracting experience.

Years of experience with projects like the proposed project:				
As a general contractor:		As a joint venturer:		
Has Contractor, or a predecessor in interest, or an affiliate identified in Paragraph 1.03 done any of the following:				
Been disqualified as a bidder by any local, state, or federal agency within the last 5 years? ☐ Yes ☐ No				
Been barred from contracting by any local, state, or federal agency within the last 5 years? ☐ Yes ☐ No				
Been released from a bid in the past 5 years? ☐ Yes ☐ No				
Defaulted on a project or failed to complete any contract awarded to it? ☐ Yes ☐ No				
Refused to construct or refused to provide materials defined in the contract documents or in a change order? ☐ Yes ☐ No				
Been a party to any currently pending litigation or arbitration? ☐ Yes ☐ No				
If yes to any of the above, provide full details in a separate attachment with bid.				
Contractor's OSHA Recordable Lost Time Incident Rates:				
Contractor's most recent (NCCI) Workers Compensation Experience Modification Rate (EMR):				
Available Bonding Capacity at time of bidding:				

2.03 List a minimum of 2 and a maximum of 6 projects completed in the last 10 years in Schedule A and provide indicated information to demonstrate the Contractor's experience with projects similar in type and cost of construction to the Project. Bidder must demonstrate successful completion during the last 10 years of at least 1 project comparable in nature and scope to this project and one project with a dollar value of at least 50 percent of the value bid for the Project. Similar projects would include projects that include complicated pump stations, water/wastewater treatment plant construction, or complicated deep excavation concrete structures.

2.04 In Schedule B, provide information on key individuals whom Contractor intends to assign to the Project. Key individuals include the Project Manager and Project Superintendent, at a minimum.

ARTICLE 3 — REQUIRED ATTACHMENTS

3.01 Provide the Statement of Qualifications with the Bid. Provide the following information with the Statement of Qualifications:

A. If Contractor is a Joint Venture, separate Qualifications Statements for each Joint Venturer, as required in paragraph 1.02.

B. Completed tables within this specification.

C. Attachments providing additional information as specified herein.

D. Schedule A (Previous Experience with Similar Projects) as specified in this Document.

E. Schedule B (Key Individuals) as specified in this Document.

This **Statement of Qualifications** is offered by:

Contractor: _____
(typed or printed name of organization)

By: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(date signed)

(If Contractor is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)

Attest: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address for giving notices:

_____

_____

_____

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

_____

_____

_____

Phone: _____

Email: _____

Schedule A—Previous Experience with Similar Projects

Name of Organization					
Project Owner		Project Name			
General Description of Project					
Project Cost		Date Project Completed			
Liquidated Damages Amount ($):					
Key Project	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer/Engineer					
Construction Manager					

Name of Organization					
Project Owner		Project Name			
General Description of Project					
Project Cost		Date Project Completed			
Liquidated Damages Amount ($):					
Key Project	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer/Engineer					
Construction Manager					

Schedule A—Previous Experience with Similar Projects

Name of Organization					
Project Owner		Project Name			
General Description of Project					
Project Cost		Date Project Completed			
Liquidated Damages Amount ($):					
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Name of Organization					
Project Owner		Project Name			
General Description of Project					
Project Cost		Date Project Completed			
Liquidated Damages Amount ($):					
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Schedule A—Previous Experience with Similar Projects

Name of Organization					
Project Owner		Project Name			
General Description of Project					
Project Cost		Date Project Completed			
Liquidated Damages Amount ($):					
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Name of Organization					
Project Owner		Project Name			
General Description of Project					
Project Cost		Date Project Completed			
Liquidated Damages Amount ($):					
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Schedule B—Key Individuals

Project Manager			
Name of individual			
Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

Project Superintendent			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

END OF DOCUMENT

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DOCUMENT 00 52 00
AGREEMENT

This Agreement is dated as of the date that the City Recorder attests the applicable City signature, which date shall be the recordation date, and is between Salt Lake City Corporation, a Utah municipal corporation, 1530 S. West Temple, Salt Lake City, Utah 84115-5223 (OWNER or City) and the following entity (CONTRACTOR)

Name: _____

Address: _____

_____

_____

Telephone number: _____

Facsimile number: _____

For valuable consideration, the receipt of which the parties acknowledge, OWNER and CONTRACTOR agree to the following.

PART 1 GENERAL

1.1 DEFINITIONS

A. Words used in this Agreement, in any Qualified Health Insurance Supplemental Agreement (Document 00 54 16), in any Value Program Supplemental Agreement (Document 00 54 15), and in any Supplemental Agreement (Document 00 54 00) related hereto that are defined in Document 00 72 00 in the current Edition of the Manual of Standard Specifications published by the Utah Chapter of the American Public Works Association shall have meaning as defined therein.

1.2 WORK

A. CONTRACTOR shall provide the construction and services specified in the Drawing and Specifications in the Construction Contract known as:

New WRF SW1 Influent Pump Station (IPS)

1200 Reclamation Road, Salt Lake City

Project No. 524905396

B. CONTRACTOR shall comply with its obligations under the Contract Documents.

1.3 ENGINEER

A. **JASON BROWN, P.E.** is OWNER's representative and agent who has the rights, authority, and duties assigned to ENGINEER in the Contract Documents.

1.4 ASSIGNMENT NOT BINDING WITHOUT WRITTEN CONSENT

A. No assignment of any right or interest in the Construction Contract shall be made without written consent of OWNER and CONTRACTOR. No assignment will release or discharge OWNER or CONTRACTOR from any duty or responsibility under the

Construction Contract unless specifically stated to the contrary in any written consent to an assignment.

B. CONTRACTOR shall make no assignment of money that is due without OWNER's written consent (except to the extent that the effect of this restriction may be limited by Law or Regulation).

1.5 **BINDING TERMS**

A. OWNER and CONTRACTOR each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Construction Contract.

1.6 **REPRESENTATION REGARDING ETHICAL STANDARDS FOR CITY OFFICERS AND EMPLOYEES AND FORMER CITY OFFICERS AND EMPLOYEES**

A. CONTRACTOR represents that it has not:

1. Provided an illegal gift or payoff to a City officer or employee or former City officer or employee, or his or her relative or business entity.

2. Retained any person to solicit or secure this contract upon an agreement or understanding for a commission, percentage, or brokerage or contingent fee, other than bona fide employees or bona fide commercial selling agencies for the propose of securing business.

3. Knowingly breached any of the ethical standards set forth in City's conflict of interest ordinance, Chapter 2.44, Salt Lake City Code; or

4. Knowingly influenced, and hereby promises that it will not knowingly influence, a City officer or employee or former City officer or employee to breach any of the ethical standards set forth in City's conflict of interest ordinance, Chapter 2.44, Salt Lake City Code.

PART 2 TIME AND MONEY CONSIDERATIONS

2.1 **CONTRACT PRICE**

A. The Contract Price includes the cost of the Work specified in the Contract Documents, plus the cost of all bonds, insurance, permits, and fees, and all charges, expenses, and assessments of whatever kind or character.

B. The Schedules of Prices awarded from the Bid Schedule (Document 00 43 00) are as follows.

1. _____

2. _____

3. _____

4. _____

C. An Agreement Supplement (Document 00 54 00) [___] is, [_X_] is not attached to this Agreement.

D. A Qualified Health Insurance Supplemental Agreement (Document 00 54 16) [__] is, [_X__] is not attached to this Agreement.

E. A Value Program Supplemental Agreement (Document 00 54 15) [___] is [_X_] is not attached to this Agreement.

F. Based upon the above-awarded schedules and the Agreement Supplement (if any), the Contract Price awarded is: _____ _____ dollars and _____ cents ($_____).

2.2 **CONTRACT TIME**

A. Contract Time shall:

1. Work shall be substantially complete by **March 19, 2026.**

B. Any time specified in work sequences in the Summary of Work (Section 01 11 00) shall be a part of the Contract Time.

2.3 **PUNCH LIST TIME**

A. CONTRACTOR shall complete all Work within _30_ days after CONTRACTOR receives ENGINEER's Final Inspection Punch List unless ENGINEER grants additional time in writing or an exception has been specified in the Contract Documents.

B. Permitting CONTRACTOR to continue and finish the Work or any part of the Work after the time fixed for its completion, or after the date to which the time for completion may have been extended, whether or not a new completion date is established, shall in no way operate as a waiver on the part of OWNER of any of OWNER's rights.

2.4 **LIQUIDATED DAMAGES**

A. CONTRACTOR agrees that OWNER will suffer damage or financial loss if the Work is not completed within the Contract Time, if sequenced work is not completed on time, or if public services are interrupted. CONTRACTOR and OWNER agree that the exact amount of damage or loss is difficult to determine.

B. OWNER shall be entitled to deduct and retain liquidated damages out of any money that may be due or become due CONTRACTOR. To the extent liquidated damages exceed any amounts due CONTRACTOR, CONTRACTOR shall be liable for such amounts and shall return such amounts to OWNER.

C. Instead of requiring proof of damage or specific financial loss, CONTRACTOR shall pay the following sums to OWNER as liquidated damages and not as a penalty. Such liquidated damages shall relate only to the additional administrative costs and expenses incurred by OWNER and shall not prevent OWNER from pursuing other remedies or collecting actual damages for damage or loss other than administrative costs and expenses.

1. **Late Completion**: **five thousand dollars** and _zero_ cents ($**5000.00)** for each day or part thereof that expires after the Contract Time until the Work is Substantially Complete as provided in Article 14.5 of the General Conditions (Document 00 72 00).

2. **Late Punch List Time Completion**: 50 percent of the amount specified for Late Contract Time Completion for each day or part thereof that the Work remains incomplete after the Punch List Time. The Punch List shall be considered received by

CONTRACTOR on the day it is transmitted by facsimile, email, or hand delivery or the day it is received by registered or certified mail.

4. **Survey Monuments**: $1,000.00 if a land survey monument is disturbed or moved and ENGINEER's surveyor has not referenced the survey monument for resetting.
5. **Interruption of Public Services**: No interruption of public services shall be caused by CONTRACTOR, its agents, or employees, without ENGINEER's prior written approval.

2.5 **RETAINAGE**

A. **Retainage is at OWNER's Option**: OWNER may, in its sole discretion, retain and withhold up to five percent of any payment due to CONTRACTOR under the Construction Contract, but the total retention may not exceed five percent of the total Contract Price. If, in ENGINEER's opinion, the Work is proceeding in accordance with CONTRACTOR's approved progress schedule, and all progress schedule submittals are current and up to date, and all required payrolls, Shop Drawings, and miscellaneous submittals are current and up to date, OWNER may choose not to withhold retainage.

1. **Payments**: At any time after 50 percent of the Work has been completed and if $50,000 or more has been retained, OWNER may make any of the remaining progress payments in full if, in OWNER's sole discretion, the Work is progressing satisfactorily. While CONTRACTOR is carrying on the Work, OWNER may pay monthly the balance not retained as aforesaid, after deducting all previous payments and all sums to be kept or retained under the provisions of the Construction Contract. No such payment shall be required to be made when, in the judgment of ENGINEER, the Work is not proceeding in accordance with the Contract Documents or when in ENGINEER's judgment the total value of the Work done since the last estimate amounts to less than $300. No such payment shall be construed to be an acceptance of any defective or improper Work or materials.
2. **Reducing the Retainage**: As the Work nears completion and solely at ENGINEER's discretion, OWNER may reduce the retainage to an amount more in line with the Work actually remaining.

B. **Interest**: Any money retained by OWNER shall be placed in an interest-bearing account held by OWNER as of the date such money would have otherwise been payable. The interest accrued thereon shall be for the benefit of CONTRACTOR.

C. **Release of Retainage and Interest**: Any retained moneys and any accrued interest thereon shall be released to CONTRACTOR pursuant to a billing statement from CONTRACTOR within 45 days after the later of: (1) the date that OWNER receives the billing statement from CONTRACTOR; (2) the date that a certificate of occupancy or final acceptance notice is issued to CONTRACTOR or OWNER; (3) the date that OWNER does not issue a certificate of occupancy but permits partial or complete occupancy of a newly constructed or remodeled building at the Project; or (4) the date that CONTRACTOR accepts the final pay quantities.

D. Other Retainage: Notwithstanding paragraph 2.5A: (1) if CONTRACTOR is in default or breach of the terms and conditions of the Construction Contract, OWNER may withhold from payment for as long as reasonably necessary an amount necessary to cure the breach

or default of CONTRACTOR; or (2) if the Project or a portion of the Project has been substantially completed, OWNER may retain until completion up to twice the fair market value of the Work of CONTRACTOR that has not been completed in accordance with the Construction Contract.

2.6 PAYMENT PROCEDURES

A. **Progress Payments**: CONTRACTOR shall submit Applications for Payment in accordance with Part 14 of the General Conditions (Document 00 72 00). Payment shall not become due or payable for any contract item not provided or installed by CONTRACTOR. As work is performed, OWNER shall pay money due to CONTRACTOR.

1. **Withholding Payment**: OWNER reserves the right to withhold payment from CONTRACTOR for non-compliance with any provision of the Contract Documents.
2. **Price Adjustments**: OWNER will consider making partial payment to CONTRACTOR for certain non-conforming work in advance of any negotiated settlement reached between CONTRACTOR and OWNER, provided CONTRACTOR requests in writing that this be done. CONTRACTOR agrees that any such payments made by OWNER are "payments in advance" and that any money that becomes due when the final settlement is negotiated will not constitute payments "withheld" or "retained" under State law.
3. **Pay Applications** must be submitted to ENGINEER through SLCDPU Engineering's Project Central SharePoint site. Access and use instructions are provided at the end of section 01 33 00 and must include, at a minimum, the following;
    a. Updated schedule;
    b. Schedule of values.

B. **Final Payment**: After completion of all Work and Punch List items, OWNER shall pay the Contract Price due after deducting all previous payments, unit price quantity adjustments, penalties, liquidated damages, and other amounts to be retained. All prior progress payments shall be subject to correction in the final payment. The final payment shall not be due and payable until 30 days after approval of the request for final payment by OWNER's finance department.

1. **Submittal**: Final payment shall not be made until CONTRACTOR has delivered and ENGINEER has accepted all submittals specified in Article 14.8 of the General Conditions (Document 00 72 00).
2. **OWNER Released From Claims**: The payment and acceptance of the final Contract Price due and the adjustment and payment for any Work done in accordance with any alterations of the same shall release OWNER from any and all claims of CONTRACTOR on account of Work performed under the Contract Documents or any Modification thereof, except for those claims specifically agreed to by OWNER as reserved and unresolved.

2.7 EXTRA WORK

A. No money will be paid to CONTRACTOR for any additions, deletions, or revisions in the Work as stipulated in Article 10.1 of the General Conditions (Document 00 72 00), unless

a Contract Modification for such has been made in writing and executed by OWNER and CONTRACTOR.

PART 3 EXECUTION

3.1 **EFFECTIVE DATE**

A. OWNER and CONTRACTOR executed this Agreement and declare the Effective Date of the Construction Contract to be the same as the recordation date.

3.2 **CONTRACTOR'S SUBSCRIPTION AND ACKNOWLEDGEMENT**

A. Name of organization: _____

B. Type of organization: _____

(Corporation, partnership, limited liability company, individual, etc.)

C. CONTRACTOR's Utah license number: _____

D. CONTRACTOR's signature: _____

E. Please print name here: _____

F. Title: _____

G. **Business Entity Acknowledgement**:

STATE OF UTAH)
: ss.
COUNTY OF SALT LAKE)

The foregoing instrument was acknowledged before me this _____ day of _____, 20__, by _____, the _____ of
[*Name of signer*] [*Title of signer*]
_____, a_____.
[*Name of entity*] [State where organized and type *of entity*]

_____
Notary's signature

_____
Residing in

_____
My commission expires: Notary's seal

H. **Signature Authority**: At the request of OWNER, evidence satisfactory to OWNER shall be submitted that shows that the person executing this Agreement has the required authority to execute this Agreement. For a corporation such evidence will be in the bylaws or a resolution of the board of directors. For a limited liability company such evidence will be in the operating agreement.

3.3 **OWNER'S SUBSCRIPTION AND ATTESTATION**

A. Approval as to form: _____
(OWNER's attorney)

B. Approval as to budget: _____
(OWNER's financial officer)

C. OWNER's signature: _____

D. Name and Title: _____

E. Attest: _____
(Signature of City recorder or City recorder designee)

END OF DOCUMENT

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DOCUMENT 00 61 13
PERFORMANCE BOND

PART 1 GENERAL

1.1 **BOND**

A. Number:_____.

B. Amount:_____

_____ dollars ($ _____).

1.2 **SURETY**

A. Name:_____

B. Address:_____

_____

_____

_____

C. Telephone number: _____

D. Facsimile number: _____

1.3 **CONTRACTOR**

A. Name:_____

B. Address:_____

_____

_____

_____

C. Telephone number: _____

D. Facsimile number: _____

1.4 **OWNER**

A. Salt Lake City Corporation, a Utah municipal corporation, 1530 S. West Temple, Salt Lake City, Utah 84115-5223.

1.5 **CONSTRUCTION CONTRACT**

A. New WRF SW1 Influent Pump Station (IPS)

1200 Reclamation Road, Salt Lake City

Project No. 524905396

1.6 **DEFINED TERMS**

A. Terms used in this Performance Bond which are defined in Article 1.1 of the General Conditions (Document 00 72 00) will have the meanings indicated in the General Conditions.

PART 2 COVENANTS

2.1 SURETY'S AND CONTRACTOR'S RELATIONSHIP

A. The Surety, as surety, and the CONTRACTOR, as principal, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the OWNER, as obligee, for the performance of the Construction Contract.

B. If the CONTRACTOR performs the Construction Contract, the Surety and the CONTRACTOR shall have no obligation under this Bond; otherwise this Bond shall remain in full force and effect.

2.2 NOTICE

A. Notice to the Surety, the OWNER, or the CONTRACTOR shall be sent by registered or certified mail, postage prepaid, by hand delivery, or by overnight delivery service for which a delivery receipt is required, to the address shown on this Bond.

B. Notices sent as provided in Section 2.2A shall be effective on the date on which such notice was sent.

C. Notice may be sent by facsimile. Facsimile notice shall be effective on the date of transmission provided that a confirmation establishing the successful transmission of the notice is sent by first-class mail, postage prepaid, along with a copy of the notice transmitted, no later than twenty-four (24) hours after the facsimile notice is transmitted.

D. If any notice requires a period of less than seven (7) days for response, the notice shall be sent by facsimile.

E. If the time for response to any notice expires on a Saturday, Sunday, or a legal holiday in the State of Utah, the time shall be extended to the next business day.

2.3 PROCEDURE TO INVOKE SURETY'S OBLIGATION

A. If the CONTRACTOR fails to perform any of its obligations under the Construction Contract, and such failure to perform has not been waived by the OWNER, the OWNER may notify the CONTRACTOR and the Surety, at their addresses described above, that the CONTRACTOR is in default, and may formally terminate the CONTRACTOR’s right to perform its obligations under the Construction Contract.

B. If the Construction Contract is terminated, the OWNER shall pay the unpaid Balance of the Contract Price to the Surety for completion of the Work in accordance with the terms of the Construction Contract or to a contractor selected by the Surety to perform the Work in accordance with the terms of the Construction Contract.

2.4 SURETY'S OPTIONS AT CONTRACTOR TERMINATION

A. Surety Completes the Work: The Surety may undertake to perform and complete the Work itself, through its agents, or through independent contractors.

B. Surety Obtains Bids or Proposals: The Surety may obtain bids or negotiated proposals from qualified contractors acceptable to the OWNER for a contract for performance and completion of the Work.

1. Such bids or proposals shall be prepared by the Surety for execution by the OWNER and the completion contractor selected.
2. The Surety shall secure the contract with performance and payment bonds executed by a qualified surety equivalent to this Bond and the payment bond (Document 00 61 14).
3. The Surety shall pay to the OWNER the amount of damages as described in Section 2.6 in excess of the balance of the Contract Price incurred by the OWNER resulting from the CONTRACTOR's default.

C. Surety to Pay OWNER: The Surety may determine the amount, not to exceed the amount of this Bond specified in Section 1.1B, for which the Surety believes it may be liable to pay, and tender payment therefore to the OWNER. The OWNER has sole discretion to accept payment.

2.5 PROCEDURE FOR OWNER TO DECLARE SURETY IN DEFAULT

A. The OWNER may declare the Surety to be in default pursuant to the following procedures:

1. The OWNER shall issue an additional written notice to the Surety, after declaring the CONTRACTOR in default as provided in Section 2.3, demanding that the Surety perform its obligations under this Bond; and
2. The Surety shall respond to the OWNER within 15 days after receipt of the OWNER's additional notice, either denying the claim or accepting liability and exercising its options under Section 2.4.

B. If the OWNER declines to accept the payment tendered by the Surety pursuant to Section 2.4(C), or if the Surety has denied the claim in whole or in part, the OWNER, without further notice, may pursue any remedies available to the OWNER.

2.6 SURETY'S OBLIGATIONS

A. After the OWNER has terminated the CONTRACTOR's right to complete its obligations under the Construction Contract, and if the Surety elects to complete the Work under the Construction Contract as provided in Section 2.4, then the responsibilities of the Surety to the OWNER shall not be greater than those of the CONTRACTOR under the Construction Contract, and the responsibilities of the OWNER to the Surety shall not be greater than those of the OWNER under the Construction Contract.

B. To the limit of the amount of this Bond, but subject to a commitment by the OWNER to pay all valid and proper payments made to or on behalf of the CONTRACTOR under the Construction Contract, the Surety is obligated, without duplication, for:

1. the responsibilities of the CONTRACTOR for correction of Defective Work and completion of the Work under the Construction Contract;
2. any additional legal, design professional, and delay costs resulting from the CONTRACTOR's default, and resulting from the actions or failure to act of the Surety under Section 2.4; and
3. liquidated damages that are or may become due for any reason.

2.7 **UNRELATED OBLIGATIONS OF THE CONTRACTOR**

A. The Surety shall not be liable to the OWNER for obligations of the CONTRACTOR that are unrelated to the Construction Contract, and the balance of the Contract Price shall not be reduced or changed on account of any such unrelated obligations.

B. No right of action shall accrue on this Bond to any person or entity other than the OWNER or its heirs, executors, administrators, or successors.

2.8 **SURETY WAIVES NOTICE OF ANY CHANGE**

A. Surety hereby waives notice of any change, including changes of Contract Time, Contract Price, and scope of Work, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

2.9 **VENUE**

A. Any suit or action commenced by the OWNER under this Bond shall be in a court of competent jurisdiction in Salt Lake City, Utah.

PART 3 EXECUTION

3.1 **EFFECTIVE DATE**

A. The Surety and the CONTRACTOR executed this Bond and declared it to be in effect as of the _____day of _____, 20__.

3.2 **CONTRACTOR'S SUBSCRIPTION AND ACKNOWLEDGMENT**

A. Name of organization:_____

B. Type of organization: _____

(corporation, partnership, limited liability company, individual, etc.)

C. CONTRACTOR's signature: _____

D. Print name here: _____

E. Title: _____

F. **Business Entity Acknowledgement**:

STATE OF UTAH)
: ss.
COUNTY OF SALT LAKE)

The foregoing performance bond was acknowledged before me this _____ day of _____, 20__, by _____, the
[*Name of signer*]
_____ of _____,
[*Title of signer*] [*Name of entity*]
a_____
[State where organized and type *of entity*]

_____
Notary's signature

_____
Residing in

_____
My commission expires: Notary's seal

G. **Individual Acknowledgement**:

STATE OF UTAH)
: ss.
COUNTY OF _____)

The foregoing performance bond was acknowledged before me this _____

day of _____, 20 __ by _____, an

individual.

_____
Notary's signature

_____
Residing in

_____
My commission expires: Notary's seal

H. **Signature Authority**: At the request of OWNER, CONTRACTOR shall submit to OWNER evidence satisfactory to OWNER that shows that the person executing this Bond has the required authority to execute this Bond. For a corporation such evidence will be in the bylaws or a resolution of the board of directors. For a limited liability company such evidence will be in the operating agreement.

3.3 **SURETY'S SUBSCRIPTION AND ACKNOWLEDGMENT**

A. Attach evidence of Surety's corporate authority to sign.

B. Surety's signature: _____

C. Please print name here: _____

D. Title: _____

E. Acknowledgment:

STATE OF UTAH)

:

COUNTY OF _____)

The foregoing performance bond was acknowledged before me this __ day of _____ _____, 20___ by _____,

(Name of signee)

the_____ of _____,

(Title of signee) (Name of entity)

a _____.

(State where organized and type of entity)

_____

Notary's signature

_____

Residing in

_____

My commission expires: Notary's seal

END OF DOCUMENT

DOCUMENT 00 61 14
PAYMENT BOND

PART 1 GENERAL

1.1 **BOND**

A. Number: _____

B. Amount: _____

_____ dollars ($ _____)

1.2 **SURETY**

A. Name: _____

B. Address: _____

_____

_____

_____

C. Telephone number: _____

D. Facsimile number: _____

1.3 **CONTRACTOR**

A. Name: _____

B. Address: _____

_____

_____

_____

C. Telephone number: _____

D. Facsimile number: _____

1.4 **OWNER**

A. Salt Lake City Corporation, a Utah municipal corporation, 1530 S. West Temple, Salt Lake City, Utah 84115-5223.

1.5 **CONSTRUCTION CONTRACT**

A. New WRF SW1 Influent Pump Station (IPS)

1200 Reclamation Road, Salt Lake City

Project No. 524905396

1.6 **DEFINED TERMS**

A. Terms used in this Payment Bond that are defined in Article 1.1 of the General Conditions (Document 00 72 00) will have the meanings indicated in the General Conditions.

PART 2 COVENANTS

2.1 SURETY's AND CONTRACTOR's RELATIONSHIP

A. The Surety as surety, and the CONTRACTOR, as principal, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the OWNER, as obligee, to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract.

B. If the CONTRACTOR makes payment for all labor, materials, and equipment furnished for use in the performance of the Construction Contract, the Surety and the CONTRACTOR shall have no obligation under this Bond; otherwise this Bond shall remain in full force and effect.

2.2 NOTICE

A. Notice to the Surety, the OWNER, or the CONTRACTOR shall be sent by registered or certified mail, postage prepaid, by facsimile, by hand delivery, or by overnight delivery service for which a delivery receipt is required, to the address shown on this Bond.

B. Notices sent as provided in Section 2.2A shall be effective on the date on which such notice was sent.

C. Notice may be sent by facsimile. Facsimile notice shall be effective on the date of transmission provided that a confirmation establishing the successful transmission of the notice is sent by first-class mail, postage prepaid, along with a copy of the notice transmitted, no later than twenty-four (24) hours after the facsimile notice is transmitted.

D. If any notice requires a period of less than seven (7) days for response, the notice shall be sent by facsimile.

E. If the time for response to any notice expires on a Saturday, Sunday, or a legal holiday in the State of Utah, the time shall be extended to the next business day.

2.3 CONDITIONS OF SURETY'S LIABILITY

A. With respect to the OWNER, this Bond shall be null and void if the CONTRACTOR promptly takes the following actions:

1. makes payment, directly or indirectly, for all sums due Claimants; and
2. defends, indemnifies, and saves harmless the OWNER from all claims, demands, Liens, or suits by any person or entity who furnished labor, materials, or equipment for use in the performance of the Work, provided the OWNER has tendered defense of such claims, demands, Liens, or suits to the CONTRACTOR and the Surety.

2.4 PROCEDURE TO INVOKE SURETY'S OBLIGATION

A. **Concerning Claimants who have a Direct Contract with the CONTRACTOR**: The Surety shall have no obligation to Claimants under this Bond who are employed by or have a direct contract with the CONTRACTOR until such Claimants have given notice to the Surety at the address shown on this Bond and have sent a copy, or notice thereof, to the OWNER, stating that a claim is being made under this Bond and, with substantial accuracy, stating the amount of the claim.

B. **Concerning a Claimant who does not have a Direct Contract with the CONTRACTOR**: The Surety shall have no obligation to a Claimant under this Bond who does not have a direct contract with the CONTRACTOR until such Claimant takes the following actions.

1. The Claimant furnishes written notice to the CONTRACTOR and sends a copy, or notice thereof, to the OWNER, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials were furnished or supplied or for whom the labor was done or performed;
2. The Claimant either receives a rejection in whole or in part from the CONTRACTOR, or does not receive within 15 days after furnishing the above notice any communication from the CONTRACTOR by which the CONTRACTOR indicates that the claim will be paid directly or indirectly; and
3. Not having been paid within the above 15 days, the Claimant sends a written notice to the Surety at the address described on this Bond and sends a copy, or notice thereof, to the OWNER stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to the CONTRACTOR.

2.5 **SURETY'S OPTION TO SETTLE CLAIMS**

A. When the Claimant has satisfied the conditions of Section 2.4, the Surety shall promptly and at the Surety's expense take the following actions:

1. Send an answer to the Claimant, with a copy to the OWNER, within 45 days after receipt of the claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and
2. Pay or arrange for payment of any undisputed amounts.

2.6 **SURETY'S OBLIGATION**

A. The Surety's total obligation under this Bond shall not exceed the amount of this Bond, and the amount of this Bond shall be reduced in the amount of any payments made in good faith by the Surety.

2.7 **UNRELATED OBLIGATIONS OF THE CONTRACTOR**

A. The Surety and the OWNER shall not be liable to Claimants or others for obligations of the CONTRACTOR that are unrelated to the Construction Contract.

B. The OWNER shall not be liable for payment of any damages, costs, or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

2.8 **SURETY WAIVES NOTICE OF ANY CHANGE**

A. Surety hereby waives notice of any change to the Construction Contract including changes of Contract Time, Contract Price, and Scope of Work, or to related subcontracts, purchase orders, or other obligations.

2.9 **VENUE**

A. Any suit or action commenced by a Claimant under this Bond shall be in a court of competent jurisdiction in Salt Lake City, Utah.

2.10 **COPIES OF THIS BOND**

A. Upon request by any person or entity appearing to be a potential beneficiary of this Bond, the CONTRACTOR or the OWNER shall promptly furnish a copy of this Bond or shall permit a copy to be made.

PART 3 EXECUTION

3.1 **EFFECTIVE DATE**

A. The Surety and the CONTRACTOR executed this Bond and declared it to be in effect as of the _____day of _____, 20__.

3.2 **CONTRACTOR'S SUBSCRIPTION AND ACKNOWLEDGMENT**

A. Name of organization:_____

B. Type of organization: _____

(corporation, partnership, limited liability company, individual, etc.)

C. CONTRACTOR's signature: _____

D. Please print name here: _____

E. Title: _____

F. **Business Entity Acknowledgement**:

STATE OF UTAH)
: ss.
COUNTY OF _____)

The foregoing payment bond was acknowledged before me this _____ day of _____, 20__, by _____, the
[*Name of signer*]
_____ of _____,
[*Title of signer*] [*Name of entity*]
a_____
[State where organized and type *of entity*]

_____
Notary's signature

_____
Residing in

_____
My commission expires: Notary's seal

G. **Individual Acknowledgement:**

STATE OF UTAH)
: ss.
COUNTY OF _____)

The foregoing payment bond was acknowledged before me this _____ day of _

_____, 20 __ by _____, an individual.

_____
Notary's signature

_____
Residing in

_____
My commission expires: Notary's seal

H. **Signature Authority**: At the request of OWNER, CONTRACTOR shall submit to OWNER evidence satisfactory to OWNER that shows that the person executing this Bond has the required authority to execute this Bond. For a corporation such evidence will be in the bylaws or a resolution of the board of directors. For a limited liability company such evidence will be in the operating agreement.

3.3 **SURETY'S SUBSCRIPTION AND ACKNOWLEDGMENT**

A. Attach evidence of Surety's corporate authority to sign.

B. Surety's signature: _____

C. Print name here: _____

D. Title: _____

E. Acknowledgment:

STATE OF UTAH)

:

COUNTY OF _____)

The foregoing payment bond was acknowledged before me this ____ day of _____ _____, 20___ by _____,

(Name of signee)

the_____ of _____,

(Title of signee) (Name of entity)

a _____.

(State where organized and type of entity)

_____

Notary's signature

_____

Residing in

_____

My commission expires: Notary's seal

END OF DOCUMENT

DOCUMENT 00 62 11
SUBMITTAL TRANSMITTAL FORM

PART 1 GENERAL

1.1 SUMMARY

A. Form is self-transmittal. Letter of transmittal is not required.

B. All submittals must be submitted utilizing the OWNERS construction management software. A link will be provided in the letter of intent to award.

C. ENGINEER's review of submittals does not release or relieve CONTRACTOR from complying with all requirements of the Contract Documents.

1.2 ENGINEER'S FORM

A. An example of the ENGINEER's form is as follows:

SUBMITTAL REVIEW

[ ] NO EXCEPTIONS TAKEN [ ] REJECTED

[ ] MAKE CORRECTIONS NOTED [ ] RESUBMIT

[ ] SUBMIT SPECIFIED ITEM [ ] DO NOT RESUBMIT

This review is for general conformance with the design concepts of the Work and general compliance with the Contract Documents and does not constitute an approval or variance. Corrections or comments, or the failure to make them, on this review does not relieve the CONTRACTOR from full contract compliance.

The CONTRACTOR is responsible for compliance with all contract provisions, dimensions, sizes, capacities, fabrication and construction techniques, installation, coordinating work with others, and performing the Work in a safe and satisfactory manner.

Date: _____ By: _____

SALT LAKE CITY PUBLIC UTILITES ENGINEERING

B. Meaning of ENGINEER's form:

1. No Exceptions Taken: Submittals have been reviewed and no corrections were noted.
2. Make Corrections Noted: Submittals that have only minor discrepancies. Resubmission will not be required unless the stamp is marked "Resubmit".
3. Submit Specified Item: Submittals that are incomplete or require more than minor corrections will be annotated to indicate necessary corrections. Resubmit the part of the submittal showing the corrections.
4. Rejected: Submittals that are fundamentally in error, cover wrong equipment or construction, or require extensive corrections.
5. Resubmit: Submittals that require resubmission. Make corrections required, note any changes by dating the revisions to correspond with the change require date, and resubmit the corrected material.
6. Do Not Resubmit: Submittals that are not necessary to resubmit.

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SUBMITTAL TRANSMITTAL FORM

DATE

[ ] NEW SUBMITTAL
[ ] RESUBMITTAL

Section I REQUEST FOR APPROVAL OF THE FOLLOWING ITEMS (This section will be initiated by the CONTRACTOR)

TO	FROM	TRANSMITTAL No.
		PREVIOUS TRANSMITTAL No.
SPECIFICATION SECTION NUMBER (See instructions)	CONTRACT TITLE	CONTRACT No.

SUBMITTAL ITEM No. a.	DESCRIPTION OF ITEM SUBMITTED (Type, size, model number, etc.) b.	SAMPLE OR CERTIFICATE (See instructions) c.	NO. OF COPIES d.	CONTRACT REFERENCE DOCUMENT		VARIATION (See instructions) g.
				SPEC. PARA. No. e.	DRAWING SHEET No. f.	

REMARKS

I certify that the above submitted items have been reviewed in detail and are correct and conform with the contract Drawings and specifications except as otherwise noted.

_____

NAME AND SIGNATURE OF CONTRACTOR

FORM 00 62 11.1 (Read Instructions on the reverse side prior to initiating this form)

INSTRUCTIONS

1. TRANSMITTAL No: Number each transmittal consecutively in the space entitled "Transmittal No.". This number will identify each submittal.
2. PREVIOUS TRANSMITTAL No: Mark the box for re-submittal and insert the transmittal number of last submission as well as the new submittal number in the spaces provided. Each re-submittal will become a new transmittal.
3. SPECIFICATION SECTION NUMBER: Cover only one specification section with each transmittal.
4. Column "a": For each entry on this form, the "SUBMITTAL ITEM No." will be the same SUBMITTAL ITEM No. indicated on the Submittal Register (Form 01 33 00).
5. Column "c": When a sample of material or Manufacturer's Certificate of Compliance is transmitted, indicate "Sample" or "Certificate".
6. Column "g": CONTRACTOR will place a check mark in the "Variation" column when a submittal is not in accordance with the plans and specifications – also, a written statement to that effect shall be included in the space provided for "Remarks" or on a separate page.
7. ENGINEER shall return a Submittal Review Response form.

END OF SECTION

DOCUMENT 00 62 16
CERTIFICATE OF INSURANCE

PART 1 GENERAL

1.1 PROCEDURE

A. For filing purposes, add Certificates of Insurance to the Contract Documents following this page.

END OF DOCUMENT

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SECTION 00 65 00

CERTIFICATE OF SUBSTANTIAL COMPLETION (EJCDC C-625)

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SECTION 00 65 00

CERTIFICATE OF SUBSTANTIAL COMPLETION (EJCDC C-625)

Certificate of Substantial Completion

Project:	
Owner:	Owner's Contract No.:
Contract:	Engineer's Project No.:

This [tentative] [definitive] Certificate of Substantial Completion applies to:

☐ All Work under the Contract Documents: ☐ The following specified portions of the Work:

Date of Substantial Completion

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Project or portion thereof designated above is hereby declared and is also the date of commencement of applicable warranties required by the Contract Documents, except as stated below.

A [tentative] [definitive] list of items to be completed or corrected is attached hereto. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance and warranties shall be as provided in the Contract Documents except as amended as follows:

☐ Amended Responsibilities ☐ Not Amended

Owner's Amended Responsibilities:

Contractor's Amended Responsibilities:

The following documents are attached to and made part of this Certificate:

This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract Documents.

Executed by Engineer	Date
Accepted by Contractor	Date
Accepted by Owner	Date

SECTION 00 73 00
SPECIAL PROVISIONS

The following special provisions apply to all technical sections for the work in this Project Manual.

1. **WARRANTY**
   A. The following warranty conditions shall apply for all products unless otherwise modified in the individual specifications:
      1. A written material warranty guarantee of **1 year** minimum shall be provided by the manufacturer against any breakdown of the material effectiveness of the structural repair elements. CONTRACTOR shall submit a warranty document certifying the material is protected against defects for the entire length of the warranty period.
      2. A written workmanship warranty guarantee of **1 year** minimum shall be provided by the CONTRACTOR against any shortcomings of the workmanship. CONTRACTOR shall submit a warranty document certifying the workmanship is protected against defects for the entire length of the warranty period.
      3. A warranty inspection may be conducted in the 11th month or anytime following the final acceptance of the work. At their option, the CONTRACTOR and a representative of the manufacturer may participate in the inspection. Inspection shall be conducted by OWNER. All deficiencies shall be repaired at CONTRACTOR 's expense in a manner mutually agreed by OWNER and CONTRACTOR.
2. **CONTRACTOR'S RESPONSIBILITIES**
   A. Locate and designate all existing manholes and new manhole or structure access points as necessary for the Work. Where existing manholes are to be used for installation of rehabilitation methods, enlarge existing openings into the pipe as required to install the products and provide for the removal and replacement of manhole cones, grade rings, ring and covers as required. Condition of existing manholes may require complete replacement at access points. Some manholes have been noted as offset manholes. If an offset manhole is used as an access point, the manhole shall be removed and replaced with a new manhole.
   B. OWNER or ENGINEER shall determine if condition of surrounding pipe warrants replacement. Where new structures are necessary or existing structures will be modified or otherwise disturbed, provide a stamped design and installation plan from a Professional Engineer registered in the state of Utah. Provide for installation of new or modified structures and complete restoration of all areas disturbed by CONTRACTOR operations.
   C. All manhole work including enlarging of access points, manhole repair, and new manhole installation shall be as indicated on the Drawings. All work designs, plans and proposals are to be submitted to the OWNER or ENGINEER for review and approval. All work will be in accordance with the APWA Standard Plans and Specifications and as required and approved by the OWNER or ENGINEER.
   D. The CONTRACTOR shall obtain access to water hydrants for cleaning, installation and other work items requiring water. CONTRACTOR shall comply with all connection and

use requirements. The CONTRACTOR shall obtain a fire hydrant meter from Salt Lake City Public Utilities and pay a refundable one thousand dollar ($1000.00) deposit. There shall be no charge for water used through the fire hydrant meter for the project.

E. Provide Blue Stakes locating and marking of all existing utilities in areas where excavation is to be performed prior to beginning any excavation. CONTRACTOR to field locate and mark limits of any excavation work required. Utilities are shown on the Drawings for informational purposes only. The indication of utilities in the Drawings shall not be construed by the CONTRACTOR to mean that all utilities are shown in the Drawings, or that those shown are in the exact location.

F. Provide for protection of all existing facilities and restoration of all areas disturbed by the CONTRACTOR operations as specified. If utilities relocation is required, CONTRACTOR shall coordinate with utility owner to relocate utility under provisions of the Salt Lake City Utility franchise agreements.

3. **TRAFFIC CONTROL**

A. The Contractor shall follow all traffic control guidelines as specified in the Traffic Control section.

4. **FIELD VERIFICATION OF DIMENSIONS**

A. The existing sewer may have deteriorated due to hydrogen sulfide corrosion. The CONTRACTOR shall verify the actual diameter before ordering or manufacturing any products to be used during connection Work. The CONTRACTOR is responsible for field verifying the inside dimensions of the sewer prior to ordering, preparing, or installing any rehabilitation materials. A mandrel test shall be performed as specified in the individual rehabilitation sections.

B. The manhole depths, manhole locations, and pipeline lengths indicated on the drawings are approximate. CONTRACTOR shall verify all dimensions before ordering or manufacturing any products to be used during the rehabilitation work.

5. **PHOTOGRAPHS AND DVD RECORDING**

A. Prior to start of construction, photographs and video recording shall be taken by the Contractor where excavations or entry onto private property are required during construction to show utility crossings, installation of bypass piping, excavations, installation of lining system, and repair or construction of manholes or access structures. The Contractor shall include all existing structures, vegetation, and general conditions of the work site.

B. The video recording shall be high quality video .MP4 format with a minimum of 720p resolution on a digital media (flash drive or portable hard drive) formatted to be compatible with PC systems. The .MP4 file should contain an audio track that narrates the progression of the camera through the site. Photographs shall be digital (10.0 mega pixel minimum) of foundations, driveways and other areas of potential damage.

C. After completion of the construction and restoration, photographs and video recordings shall be taken by the CONTRACTOR from the same points in the same direction as the pre-construction examination.

D. video recordings and photographs shall be submitted to the OWNER or ENGINEER

within seven (7) days prior to substantial completion and prior to acceptance of the work by the OWNER or ENGINEER.

6. **PRE-CONSTRUCTION SUBMITTALS**

A. The following shall be submitted for review prior to the start of construction:

1. Items listed in the individual sections.
2. Access points and pit locations and dimensions, as required. Limits on locations for access points are indicated on the Drawings. Access points outside these limits shall require review and approval by the OWNER or ENGINEER for each deviated location.
3. Access structure details, as required. Drawings shall be stamped by a Professional Engineer registered in the State of Utah and include the following:
    a. Dimensions
    b. Reinforcement
    c. Locations
4. Groundwater management plan and a State of Utah groundwater permit application.
5. Traffic Control plan submittal as specified.
6. Safety plan with a list of hazards and mitigation methods.
7. Quality Control and testing plan.
8. Site Security Plan

B. Each submittal shall cover items from only one section of the specification unless the item consists of components from several sources. CONTRACTOR shall submit a complete initial submittal including all components. When an item consists of components from several sources, CONTRACTOR 's initial submittal shall be complete including all components.

C. All submittals, regardless of origin, shall be approved by CONTRACTOR and clearly identified with the name and number of this Contract, CONTRACTOR 's name, and references to applicable specification paragraphs and Contract Drawings. Each copy of all submittals, regardless of origin, shall be stamped or affixed with an approval statement of CONTRACTOR. Each submittal shall indicate the intended use of the item in the Work. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. The current revision, issue number, and date shall be indicated on drawings and other descriptive data.

D. CONTRACTOR shall be solely responsible for the completeness of each submittal. CONTRACTOR 's stamp or affixed approval statement of a submittal, per the Submittal Transmittal Form, is a representation to OWNER or ENGINEER that CONTRACTOR accepts sole responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, and that CONTRACTOR has reviewed and coordinated each submittal with the requirements of the Work and the Contract Documents.

E. All deviations from the Contract Documents shall be identified as deviations on each submittal. Such submittals shall, as pertinent to the deviation, indicate essential details of all changes proposed by CONTRACTOR (including modifications to piping other facilities that may be a result of the deviation).

F. OWNER or ENGINEER's review of submittals covers only general conformity to the Drawings and Specifications, external connections, and dimensions that affect the layout; it does not indicate thorough review of all dimensions, quantities, and details of the material, equipment, device, or item covered. OWNER or ENGINEER's review shall not relieve CONTRACTOR of sole responsibility for errors, omissions, or deviations in the drawings and data, nor of CONTRACTOR 's sole responsibility for compliance with the Contract Documents.

H. OWNER or ENGINEER's submittal review period shall be 28 consecutive calendar days and shall commence on the first calendar day following receipt of the submittal or resubmittal in OWNER or ENGINEER's office. The time required to mail the submittal or resubmittal back to CONTRACTOR shall not be considered a part of the submittal review period.

I. CONTRACTOR shall accept full responsibility for the completeness of each resubmittal. CONTRACTOR shall verify that all corrected data and additional information previously requested by OWNER or ENGINEER are provided on the resubmittal.

J. When corrected copies are resubmitted, CONTRACTOR shall direct specific attention to all revisions in writing and shall list separately any revisions made other than those called for by OWNER or ENGINEER on previous submittals. Requirements specified for initial submittals shall also apply to resubmittals. Resubmittals shall bear the number of the first submittal followed by a letter (A, B, etc.) or a unique identification that indicates the initial submittal and correct sequence of each resubmittal

8. PERMITS REQUIRED

A. All permits required for this project will be paid at cost.

B. Supplement the permit list given in the General Conditions Article 6.7 and additional permits listed in 00 73 10 Modifications to the General Conditions, the following permits are required:

1. Traffic Control—Traffic Control plan approval required to get the Public Way permit.
2. Public Way Excavation—Fee permit issued by UDOT based on the amount of excavation completed in the public right-of-way.
3. Noise—No-cost permit issued by Salt Lake Valley Health Department (SLVHD), 788 E. Woodoak Lane, Murray, Utah 84107.
    a. The requirements of the SLVHD noise permit is built around keeping noise in residential neighborhoods no more than 10 dB(A) above ambient between 7:00 AM to 10:00 PM and no more than 5 dB(A) above ambient outside those hours (nighttime). A waiver may be applied for to work outside the SLVHD specified regular working hours of 7:00 AM to 10:00 PM.

9. WORKING HOURS

A. The work hours need to be controlled as much as possible to minimize disturbances to adjacent residences. The OWNER or ENGINEER may permit Work outside normal project work hours but the CONTRACTOR shall still comply with appropriate noise, safety, environmental, odor and other requirements.

B. CONTRACTOR may conduct nighttime work as allowed by prior schedule approval 2-weeks in advance by OWNER or ENGINEER and subject to local neighborhood coordination. Nighttime work will be limited to times when continuous operations are required for specific construction activities and not for CONTRACTOR convenience.

10. ACCESS AND USE OF THE OWNER's SHAREPOINT WEBSITE

1. The CONTRACTOR shall utilize the OWNER's SharePoint website for all written CONTRACTOR correspondence, submittals, transmittals, pay applications, schedule updates, or other communication where feasible. CONTRACTOR shall utilize OWNER-established SharePoint workflows as directed.
2. The CONTRACTOR shall request access to the OWNER's SharePoint website through the Project Manager, by providing the name, employer, e-mail address and phone number of each individual for which access is requested.
3. All SharePoint workflow functions require one (1) individual to be designated as the point of contact to receive workflow e-mail alerts from the system. The CONTRACTOR shall designate one individual as the point of contact for these workflows at the time access is requested. The point of contact can be changed upon the request from the CONTRACTOR at any time during the execution of the project.
4. The OWNER will determine the level of access to the SharePoint website that will be granted to each individual.
5. The OWNER and or OWNER's Representative shall provide SharePoint training to the CONTRACTOR(s).
6. The OWNER shall provide instruction sheets for the electronic workflows executed through the SharePoint site.
7. CONTRACTOR is required to have access to computer hardware and software that is compatible with the OWNER's SharePoint system, capable of running automated process workflows, and supporting electronic signatures. Minimum system requirements include:
    a. Windows 7 or higher.
    b. Microsoft Internet Explorer version 8 or higher (Google Chrome preferred).
    c. Microsoft Office 2010 or higher.
    d. Latest version of Adobe Acrobat (at a minimum Reader, Standard or Professional for editing).

e. Broadband internet connection.

f. Open access to https://slcut.sharepoint.com

8. CONTRACTOR shall verify current system requirements at start of contract and may need to adjust requirements during the contract period to accommodate upgrades or changes to the SLCDPU's system.

END OF SECTION

DOCUMENT 00 73 10
MODIFICATIONS TO THE GENERAL CONDITIONS

(Supplementary Conditions)

This document changes provisions specified in the General Conditions (Document 00 72 00) in the Manual of Standard Specifications published by the Utah Chapter of the American Public Works Association.

Add the following paragraphs to Article 1.1A

61. **COVID-19:** The 2019 novel coronavirus and the disease it causes are collectively referred to herein as COVID-19.

62. **COVID-19 Proclamations:** Captures the orders, directives and guidance concerning COVID-19 that have been issued, and which may be issued, by public bodies with jurisdiction over the project.

Add the following paragraphs to Article 2.2

2.2 **COPIES OF DOCUMENTS**

B. OWNER shall not furnish to CONTRACTOR published Contract Documents that include the current edition of the Manual of Standard Plans and the Manual of Standard Specifications. The CONTRACTOR shall purchase such documents separately.

C. Copies of all Contract Documents including the current edition of the Manual of Standard Plans and the Manual of Standard Specifications shall be provided on site by the CONTRACTOR.

Modify paragraph 2.5C

2.5 **BEFORE STARTING CONSTRUCTION**

C. Field Office: The CONTRACTOR shall establish and maintain a field office in such a location that ENGINEER may always contact CONTRACTOR for transmittal of Plans and instructions and, for dissemination of Project information. CONTRACTOR shall provide and maintain a telephone in the field office during performance of the Work.

Modify Article 5.1

5.1 **PERFORMANCE, PAYMENT AND OTHER BONDS**

A. Before OWNER executes the Agreement, CONTRACTOR shall file with OWNER a good and sufficient Performance Bond (using OWNER's Document 00 61 13) and a Payment Bond (using OWNER's Document 00 61 14), each in the sum of not less than 100 percent of the Contract Price.

B. The Bonds shall be executed by CONTRACTOR and issued by a company duly and regularly authorized to do a general surety business in the State of Utah and either (i) named in the current U.S. Treasury Department's listing of approved sureties (Department Circular 570) (as amended), or (ii) with a current "A-" rating and a financial size category rating of at least a "VII" or better in A.M. Best Co., Inc.'s Best Insurance Reports, Property and Casualty Edition.

C. The Performance Bond shall guarantee the faithful performance of the Construction Contract by CONTRACTOR and the Payment Bond shall guarantee the payment of labor and materials. The Bonds shall inure by their terms to the benefit of OWNER. Neither this nor any other provision requiring a Performance Bond shall be construed to create any rights in any third party Claimant as against OWNER for performance of the Work under the Construction Contract.

D. If the surety on any Bond furnished by CONTRACTOR is subject to any proceeding under the Bankruptcy Code (Title 11, United States Code) or becomes insolvent or its right to do business is terminated in the State of Utah or it ceases to meet the requirements of this Article, CONTRACTOR shall, within 15 days thereafter, substitute another Bond and surety, both of which must be acceptable to OWNER.

Modify Article 5.2

5.2 **INSURANCE**

A. **In General**:

1. Any insurance coverage required herein that is written on a "claims made" form rather than on an "occurrence" form shall (i) provide full prior acts coverage or have a retroactive date effective before the date of the Agreement, and (ii) be maintained for a period of at least three (3) years following the end of the term of the Agreement or contain a comparable "extended discovery" clause. Evidence of current extended discovery coverage and the purchase options available upon policy termination shall be provided to OWNER.
2. All policies of insurance shall be issued by insurance companies licensed to do business in the state of Utah and either:
   a. Currently rated A- or better by A.M. Best Company;

      -OR-

   b. Listed in the United States Treasury Department's current Listing of Approved Sureties (Department Circular 570), as amended.
3. CONTRACTOR shall furnish certificates of insurance, acceptable to OWNER, verifying the foregoing matters concurrent with the execution hereof and thereafter as required.

4. In the event any work is subcontracted, CONTRACTOR shall require its subcontractor, at no cost to OWNER, to secure and maintain all minimum insurance coverages required of CONTRACTOR hereunder.

    a. This project involves the creation of following elements of work that require the stamp of a professional engineer. CONTRACTOR shall obtain and submit to OWNER insurance certificates evidencing that the subcontractor or supplier has professional liability insurance coverage meeting the requirements in the Agreement and the limits identified in Article 5.2 B.5.

5. All required certificates and policies shall provide that coverage thereunder shall not be canceled or modified without providing, in a manner approved by the OWNER**'s** Attorney, 30 days prior written notice to OWNER.

B. **Required Insurance Policies**: CONTRACTOR, at its own cost, shall secure and maintain during the term of this Agreement, including all renewal terms, the following minimum insurance coverage:

1. Worker's compensation and employer's liability insurance sufficient to cover all of CONTRACTOR's employees pursuant to Utah law, unless a waiver of coverage is allowed and acquired pursuant to Utah law. In the event any work is subcontracted, CONTRACTOR shall require its subcontractor(s) similarly to provide worker's compensation insurance for all of the latter's employees, unless a waiver of coverage is allowed and acquired pursuant to Utah law.
2. Commercial general liability (CGL) insurance with Salt Lake City Corporation as an additional insured on a primary and non-contributory basis in comparison to all other insurance including OWNER's own policy or policies of insurance, in the minimum amount of $2,000,000 per occurrence with a $3,000,000 general aggregate and $3,000,000 products completed operations aggregate. These limits can be covered either under a CGL insurance policy alone, or a combination of a CGL insurance policy and an umbrella insurance policy and/or a CGL insurance policy and an excess insurance policy. The policy shall protect OWNER, CONTRACTOR, and any subcontractor from claims for damages for personal injury, including accidental death, and from claims for property damage that may arise from Contractor's operations under this Agreement, whether performed by Contractor itself, any subcontractor, or anyone directly or indirectly employed by either of them. Such insurance shall provide coverage for premises operations, acts of independent contractors, products and completed operations.
3. Commercial automobile liability insurance that provides coverage for owned, hired, and non-owned automobiles used in connection with this Agreement in the minimum amount of a combined single limit of $1,000,000 or $500,000 liability per person, $1,000,000 liability per accident, and $250,000 property damage. These limits can be reached either with a commercial automobile liability insurance policy alone, or with a combination of a commercial automobile liability insurance policy and an umbrella insurance policy and/or a commercial automobile liability insurance policy and an

excess insurance policy. If the policy only covers certain vehicles or types of vehicles, such as scheduled autos or only hired and non-owned autos, Contractor shall only use those vehicles that are covered by its policy in connection with any work performed under this Agreement.

4. Builder's Risk: Builder's risk insurance with a policy limit equal to the total amount of the Contract Price. The policy shall be written on an "All Risk" coverage basis with OWNER as a "named insured" and "loss payee".
5. Professional liability insurance in the minimum amount of $2,000,000 per claim made with a $2,000,000 annual aggregate limit. If CONTRACTOR is not eligible to obtain such insurance, CONTRACTOR's obligation is satisfied if a subcontractor (or supplier) provides such insurance.
6. Pollution liability insurance, with OWNER as an additional insured, in the minimum amount of $2,000,000 per occurrence with a $3,000,000 annual aggregate limit.

Remove Article 6.4 in its entirety.

6.4 SUBSTITUES OR "OR-EQUAL" ITEMS

Add the following paragraphs to Article 6.7

6.7 **PERMITS**

H. Salt Lake City Permits: In addition to any other permits required for the Work, CONTRACTOR shall obtain permits from Salt Lake City Corporation for Work on the Project.

1. OWNER-Paid Permits: CONTRACTOR shall be responsible for submitting plans, scheduling inspections and paying all costs incidental to such actions as required for any permit required by Salt Lake City Corporation. Except for construction water meter fees, the fees for these permits shall be paid by OWNER and shall not be included in CONTRACTOR's bid. The following list is not exclusive and does not relieve CONTRACTOR of the responsibility of obtaining all permits.
    a. From Salt Lake City Community & Neighborhoods Department, Division of Transportation, 349 South 200 East, Suite 450, Salt Lake City, Utah 84111. Phone 801-535-6630
        1. Parking meter bagging and removal permit
        2. Street closure permit
        3. Traffic control permit
        4. Any other applicable Division of Transportation imposed fee
    b. From Salt Lake City Department of Public Utilities, 1530 South West Temple Street, Salt Lake City, Utah 84115
        1. UPDES storm drain water discharge permit for sites 1 to 5 acres
        2. SLC SWPPP permit

3. All applicable water, fire, sewer and storm drainage impact and connection fees
4. ¾ inch meter permit for new and existing drinking fountain

c. From Salt Lake City Building Services and Licensing, 451 South State Street, Salt Lake City, Utah 84111. Phone 801-535-7751
   1. Building, plumbing, mechanical, electrical permit (as applicable)

d. The CONTRACTOR or subcontractor (whichever is doing work in the public way) shall obtain from Salt Lake City Corporation Department of Community and Neighborhoods, Engineering Division, 349 South 200 East, Suite 100, Salt Lake City, Utah 84111a permit to work in the Public Way. To obtain such permit the CONTRACTOR or subcontractor, as the case may be, shall provide or have on file a $15,000.00 bond to work in the Public Way and applicable insurance. The insurance required is the same as that required for this contract.

2. CONTRACTOR-Paid Permits: The fees for permits not paid for by OWNER shall be included in CONTRACTOR's Bid. The following list is not exclusive and does not relieve CONTRACTOR of the responsibility of obtaining all permits:

a. Construction Water Meter: If water for construction is required to be taken from fire hydrants or a new water meter, CONTRACTOR shall be solely responsible for obtaining and paying for such permits and water usage to Salt Lake City Corporation Department of Public Utilities permit office, 1530 South West Temple Street, Salt Lake City, Utah.
   1. Hydrant meters require a $1,000.00 deposit ($100.00, non-refundable). A refund will be returned to CONTRACTOR by the Department of Public Utilities if the meter and equipment is returned undamaged.

I. Other Permits: All other permit fees required by Salt Lake County, the State of Utah, the United States of America, and any of their agencies, or by any private utility companies, shall be paid for and obtained by CONTRACTOR and included in CONTRACTOR's Bid. The following list is not exclusive and does not relieve CONTRACTOR of the responsibility of obtaining all permits:

1. UDOT Region 2: Digging permit in a UDOT roadway right of way.
2. Private Property Owner Permit: Written permission to use private water.
3. Private Property Owner Permit: Written permission to store product, equipment, materials, and supplies outside of the Work site boundaries.
4. General Permit for Storm Water Discharge (Sites greater than 1 acres): From the State of Utah, Department of Environmental Quality, Division of Water Quality, 288 North 1460 West Street. P.O. Box 144870, Salt Lake City, Utah 84114-4879. Fee varies; contact the State for a quote.
5. Flood Control Permit: From Salt Lake County, Department of Public Works, Division of Flood Control, 2001 South State Street, Salt Lake City, Utah.

6. Monument Permit: From Salt Lake County Surveyor, 2001 South State Street, Salt Lake City, Utah. Fee will be at least $100.00 per monument and is based upon time of performance.

Modify paragraph 6.17A and add paragraph 6.17E

6.17 **INDEMNIFICATION**

A. **Indemnification of OWNER:** Subject to paragraph 6.17E below, CONTRACTOR shall indemnify, save harmless, and defend OWNER, its officers and employees, from and against all losses, claims, demands, actions, damages, costs, charges, and causes of action of every kind or character, including attorney's fees, arising out of CONTRACTOR's wrongful, reckless, or negligent performance hereunder. CONTRACTOR's duty to defend OWNER shall exist regardless of whether OWNER or CONTRACTOR may ultimately be found to be liable for anyone's negligence or other conduct. If OWNER's tender of defense, based upon this indemnity provision, is rejected by CONTRACTOR, and CONTRACTOR is later found by a court of competent jurisdiction to have been required to indemnify OWNER, then in addition to any other remedies OWNER may have, CONTRACTOR shall pay OWNER's reasonable costs, expenses, and attorney's fees incurred in proving such indemnification, defending itself, or enforcing this provision. Nothing herein shall be construed to require CONTRACTOR to indemnify the indemnitee against the indemnitee's own negligence.

E. Nothing herein shall be construed to require CONTRACTOR to indemnify OWNER, ENGINEER, or their agents or employees for any damages that are caused by or result from the fault of OWNER, ENGINEER, or their agents or employees.

Add the following Paragraph 10.4

PART 10 CHANGES IN THE WORK

10.4 **CHANGE ORDERS, ALLOWANCE WORK ORDERS, AND CONSTRUCTION CHANGE DIRECTIVES**

A DEFINITIONS

1. Construction Change Directive is a signed directive by the Owner's designated representative, directing a change in Work prior to a Work Order or Change Order where there is a dispute as to the terms of the Work Order or Change Order and/or there is an urgency to proceed with the change without pricing being obtained from the Contractor at the time of the directive.

3. Specific Allowances include specified items of Work generally known to be required for the Project but whose quantities and/or pricing is unknown until after the items of Work have been identified. Specific Allowances should be used only for work related to the bid items specified by the Allowance. The use of the Specific Allowances shall be documented by a Work Order signed by Owner's designated representative.

4. Work Orders are issued with an automated workflow from the Owner's Project Management System, Project Central, to the Contractor and shall authorize the

Contractor to perform Work for payment from the General Allowance and Specific Allowance(s), if any, set forth in the Contract between the Owner and Contractor for the Project. The content of these Work Orders is made up of previously defined RFP's, as accepted by the Owner's designated representative (as defined in Section 01 26 00 of APWA Standard Specifications).

B PROCESS

1. **Work Orders**

a. Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract and without notice to any surety, by Change Orders, Allowance Work Orders (both General Allowance and Specific Allowance) and Construction Change Directives. The Contract Sum and the Final Completion Date shall be adjusted accordingly, per Contract terms.

b. Except for emergencies, a Work Order authorizing payment from the General Allowance or the Specific Allowance requires prior authorization from the Owner's designated representative before starting the work. Work Orders are issued with an automated workflow from the Owner's Project Management System, Project Central, to the Contractor.

c. Work Order or Change Order signed by Contractor with no extension of time shall exclusively establish Contractor's contract that there shall be no time extension in connection with that Work Order or Change Order Contractor acknowledges that any attempt to preserve a future request for a time extension due to the performance of any Work associated with a Work Order or Change Order or the cumulative effects of multiple Work Orders or Change Orders is ineffective and has no force or effect pursuant to this Contract. Except for emergencies, changes to the Final Completion Date may be made only by a signed Change Order signed by the Owner's designated representative. Additional time associated with a General Allowance Work Order or a Specific Allowance Work Order must be processed with a change order.

d. Work Orders and Change Orders shall use the Request for Proposal (RFP) automated workflow from the Owner's Project Central system, specified by Owner and may be initiated by either party as follows:

e. Contractor may initiate the process by submitting a proposal, using the automated workflow, to the Owner which shall fully describe the changes sought, the reasons for the changes, and the impact, if any, on the contract Final Completion Date or Contract Sum. If the Final Completion Date will be impacted by the proposed change, Contractor shall submit a schedule highlighting the anticipated impact resulting from the proposed change. If Contractor is seeking additional payment from the General Allowance, a Specific Allowance, a Bid Item Number that comprises Contractor's Base Contract Price, or the Contract Sum, it shall submit a price proposal which identifies the basis and the net change for this proposal. Contractor shall also advise the Owner in writing the results of Contractor's technical evaluation of the proposed change stating any undesirable consequences then known or reasonably foreseeable to Contractor. The Owner shall promptly

respond to the proposal, within ten (10) calendar days, after reviewing the submitted material and shall either timely process the Work Order or Change Order or request additional information, clarifications or corrections until the Work Order or Change Order has been agreed upon by both Owner and Contractor.

f. The Owner may initiate the process, with consultation from the Engineer, by submitting a request with an automated workflow to Contractor describing the change in sufficient detail to permit evaluation and Contractor shall promptly respond (within ten (10) Calendar Days) by submitting a price and time proposal to Owner. At the same time, Contractor shall also advise the Owner of Contractor's technical evaluation of the requested change stating any undesirable consequences then known or reasonably foreseeable to Contractor. Contractor shall indicate the potential severity of impact and effect to the Contractor's schedule, Base Contract Price or Contract Sum at the time the request is initially made.

g. Any time during the Work Order or Change Order process, the Owner may elect to issue a Construction Change Directive requiring Contractor to immediately carry out the Work as defined in the Construction Change Directive or may cancel the proposed Work Order or Change Order. The Owner shall not be liable for any costs incurred by Contractor for proceeding with the contemplated Work Order or Change Order in anticipation of an approved Work Order or Change Order from the Owner's designated representative.

h. After the Owner's approval has been obtained, the Work Order or Change Order will be prepared by the Owner for execution by the parties. The documents shall be transmitted to Contractor for signature signifying acceptance through the automated workflow from the owner's Project Central system. The documents will be similarly signed by the Owner. The acceptance of a Work Order or Change Order constitutes a mutual contract with respect to all extensions of time and all direct or indirect costs related to the Work Order or Change Order.

2. **Construction Change Directives**

a. A Construction Change Directive is a signed directive by the Owner, directing a change in Work prior to an authorized Work Order or Change Order where there is a dispute as to the terms of the Work Order or Change Order or agreement on the pricing has not been reached for the Work associated with the Work Order or Change Order. A Construction Change Directive shall be signed, using an Automated Workflow from the owner's Project Central system, by Owner's designated representative.

b. An adjustment to the cost of the Work resulting from a Construction Change Directive shall be documented with an RFP and once accepted by the Owner's designated representative, authorized in a specific allowance work order, general allowance work order, or change order.

c. All Construction Change Directives shall be signed first by the Owner's designated representative(s) followed by the Contractor, respectively.

d. Upon receipt of a Construction Change Directive signed by Owner, Contractor shall promptly proceed with the Work provided in the Construction Change Directive. The Contractor will acknowledge and accept the work issued with an automated workflow within ten (10) calendar day. The Contractor shall promptly advise the Owner of disagreement with the method, if any, within ten (10 calendar days.

e. A Construction Change Directive acknowledged and accepted by Contractor indicates the adherence of Contractor to its terms. Such contract shall be effective immediately and shall be subsequently defined by an RFP which is authorized by a Specific Allowance Work Order or General Allowance Work Order signed by Owner's designated representative authorizing payment or a signed Change Order by Owner's designated representative(s).

f. Except as otherwise agreed by the Owner and Contractor, the method and the adjustment shall be initially determined by the Owner based on reasonable expenditures and savings of those performing the Work attributable to the Work Order or Change Order, including expenditures for design services and revisions to the Contract Documents. If the Contractor does not respond within ten (10) calendar days or disagrees with the method for adjustment, Contractor shall keep and present, in such form as Owner may prescribe, an itemized accounting together with appropriate supporting data to substantiate the accounting to the reasonable satisfaction of Owner.

g. When the Owner and Contractor, subsequent to the issuance of a Construction Change Directive, agree concerning the adjustments to the Work, the Construction Change Directive shall be effective immediately and subsequently documented by an RFP and is authorized by the preparation and execution of an appropriate signed Specific Allowance Work Order or General Allowance Work Order by the Owner's designated representative, or a Change Order signed by Owner's designated representative.

Modify paragraph 13.6A

13.6 **CORRECTION OR REMOVAL OF DEFECTIVE WORK BY CONTRACTOR**

A. In addition to CONTRACTOR's obligations under Article 6.16, if required by ENGINEER, CONTRACTOR shall promptly, as directed, either correct all Defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by ENGINEER, remove it from the site and replace it with non-Defective Work. No rejected material, the defects of which have been subsequently corrected, shall be used in the Work unless approval in writing has been given by ENGINEER. CONTRACTOR shall bear all direct, indirect, and consequential costs of such correction or removal (including but not limited to fees and charges of OWNER, engineers, architects, and other professionals) made necessary thereby.

Modify paragraph 13.7A

13.7 **CORRECTION PERIOD**

A. In addition to CONTRACTOR's obligations under Article 6.16, if any portion of the Work is found to be defective within **one year** after the date of Substantial Completion, CONTRACTOR shall correct it or replace it with non-Defective Work. The **one year** correction period may be superseded by such longer period of time as prescribed in the Contract Documents or by special guarantee terms required by the Contract Documents.

Add the following paragraph to Article 13.7

13.7 **CORRECTION PERIOD**

E. Nothing contained in this Article 13.7 shall be construed to establish a period of limitation with respect to other obligations CONTRACTOR has under the Contract Documents, including Article 6.16. Establishment of the **one year** period for correction of Work as described in this Article 13.7 relates only to the specific obligation of CONTRACTOR to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be enforced, nor the time within which proceedings may be commenced to establish CONTRACTOR'S liability with respect to CONTRACTOR's obligations other than specifically to correct the Work. Such times include the applicable statute of limitations or statute of repose, which may be longer than one year.

Modify Article 14.5

14.5 SUBSTANTIAL COMPLETION

A. CONTRACTOR to Certify Work is Substantially Complete: When CONTRACTOR considers the Work (or portion thereof) ready for its intended use, CONTRACTOR shall certify using the electronic workflow from SLCDPU's Project Central from the corresponding project site to ENGINEER that the Work (or portion thereof) has been completed in accordance with the Contract Documents. Contractor shall include in such written certification a list of any items not finished.

   The following must be accomplished to achieve Substantial Completion:

   i. All systems and parts are tied-in/commissioned; critical equipment inspected and functioning normally
   ii. All applicable O&M Manuals have been provided and required Owner training on equipment and systems have been completed
   iii. All applicable required safety and security deliverables have been completed
   iv. Updated operating maps and diagrams including redlines, and all other applicable required operational updates have been received by Owner
   v. Punchlist developed and issued

B. ENGINEER to Review CONTRACTOR's Certification: Within five (5) Days after ENGINEER receives CONTRACTOR certification and list of Work items not finished (punchlist), ENGINEER will issue notice via the electronic workflow agreeing the Work

is Substantially Complete or via email stating reasons why the Work is not Substantially Complete.

C. Prior to CONTRACTOR submitting their certification of Substantial Completion, ENGINEER shall conduct site walk with the CONTRACTOR. During the site walk, the punchlist items will be identified, and shortly thereafter the ENGINEER will issue the punchlist to the CONTRACTOR.

D. OWNER's Rights: OWNER shall have the right to exclude CONTRACTOR from the Work after the date of Substantial Completion, but owner shall allow CONTRACTOR reasonable access to complete or correct items on the Punch List.

Add the following Articles to Part 16

PART 16 DISPUTE RESOLUTION

16.2 **GENERAL**

A. Unless a decision is held by an appropriate court of law to have been procured by fraud or to be arbitrary and capricious or so grossly erroneous as necessarily to imply bad faith, any factual decision made under this dispute resolution procedure shall be final and binding in any suit or action arising under the Construction Contract, including any actions by CONTRACTOR or others against OWNER or any of OWNER's agents, consultants, or employees.

B. Compliance by CONTRACTOR with provisions of this Part shall be a condition precedent to any legal action by CONTRACTOR or any of CONTRACTOR's Subcontractors and Suppliers against OWNER or any of OWNER's agents, consultants, or employees.

C. The provisions of this Part shall not preclude or limit judicial review of issues of law.

D. Ambiguities in or between Contract Documents shall be construed in favor of the OWNER.

16.3 **DISPUTES NOT RELATED TO THE GUARANTEE OF THE WORK**

A. Any dispute arising under the Construction Contract concerning a question of fact, not related to the guarantee of the Work (Article 13.1 of the General Conditions (Document 00 72 00)), that is not disposed of by Contract Modification shall be decided pursuant to the following procedure.

1. Any decision by ENGINEER interpreting the requirements of the Contract Documents may be appealed in writing to the ENGINEER. The ENGINEER's decision, regarding that appeal shall be reduced to writing and a copy shall be mailed or otherwise furnished to CONTRACTOR within 10 days. The decision of ENGINEER shall be final and conclusive unless, within 30 days after the date of receipt of such copy, CONTRACTOR mails or otherwise furnishes to ENGINEER a written appeal to the head of OWNER's department responsible for constructing the project.

2. Within 15 days from the receipt of any such appeal, the department head shall issue a decision in writing and mail or otherwise furnish a copy thereof to CONTRACTOR. The decision of the department head shall be final and conclusive unless, within 15

days from the date of receipt of such decision, the CONTRACTOR mails or otherwise furnishes to the department head a written appeal to OWNER's Committee.

3. The Dispute Committee shall consist of three persons selected by the department head who are knowledgeable about the Work.
4. OWNER and CONTRACTOR shall each have the opportunity to fully present its case to the Dispute Committee before the Dispute Committee's deliberation. The Dispute Committee may request any other materials or written memoranda necessary to consider the issues, and may schedule other proceedings as necessary.
5. The decision of the Dispute Committee shall be rendered in writing within 15 days after the Dispute Committee's final hearing of the issue and receipt of any supplemental material requested by the Dispute Committee. The decision shall be mailed or otherwise delivered to CONTRACTOR.
6. The decision of the Dispute Committee shall be the final binding interpretation of the facts that are the subject of the appeal.

16.4 **DISPUTES RELATED TO THE GUARANTEE**

A. Except as otherwise provided by Contract Modification, any dispute concerning a question of fact involving or arising out of the guarantee required by the Contract Documents (Article 13.1 of the General Conditions (Document 00 72 00)), that is not disposed of by Contract Modification, shall be decided pursuant to the provisions of Paragraph 16.3 above, except that the initial factual decision shall be issued in writing by the ENGINEER, together with the department head.

B. Any appeal therefrom shall be made within 15 days directly to the Dispute Committee where such disputes shall be governed by provisions in sub-paragraphs 3 to 6 in paragraph 16.3A above.

16.5 **WORK DURING APPEAL**

A. Notwithstanding the pendency of any protest or appeal provided above, CONTRACTOR shall, if so ordered by ENGINEER, proceed with the Work under the Contract Documents according to ENGINEER's direction and according to the decision on any appeal. The existence of a claim or protest shall not excuse CONTRACTOR from the requirements of the Contract Documents, including, but not limited to, the Contract Time.

16.6 **APPEALS OF TERMINATION OR SUSPENSION**

A. Any decision of OWNER to terminate or suspend the Work shall not be subject to the provisions of this Part.

END OF DOCUMENT

SECTION 00 73 15
MODIFICATIONS TO APWA STANDARD PLANS
(Supplementary Conditions)

PART 1 GENERAL

1.1 DOCUMENT INCLUDES

A. This Document specifies changes to the Standard Plans published by the Utah Chapter of the American Public Works Association. Not all of these modifications will apply to the Work. CONTRACTOR is to apply the appropriate modification to the appropriate Standard Plan.

1.2 CHANGES

A. Modify the standard plans as follows.

Table 1 – WATER

APWA Standard Plan No.	Description	Modification
381	Trench backfill	Refer to Salt Lake City Public Utility (SLCPU) - Standard Practice #1. Maximum depth for magnetic marking tape is 18 inches.
382	Pipe zone backfill	Refer to SLCPU – Standard Practice #1 and notes given in Table 3 – Storm Drain.
502	27" frame & cover	Use smooth surface "waffle" pattern class 35 lid.
511	Fire hydrant	• Move the auxiliary valve to connect to the fitting at the fire hydrant. • If the pipe connecting to the main is greater than 16 feet, a second shutoff valve is required at the main.
521	3/4" & 1" meter	No material is to be backfilled inside meter box.
522-529	Various sized meters	See SLCPU standard drawings for Contractor checklist.
543		Not used
551	3/4" & 1" service taps	• Depth of service line is 48" minimum. • Tap will be at 10 or 2 o'clock position.
552	1-1/2" & 2" service taps	• B - 2-piece cast iron valve box with lid is required. • H – Type K–soft copper.
572	Detector check valve	• Fitting D will be MJ x flange • The extra gate valve located in the vault on the same side as the main supply pipeline is **not** required.
574	Cover collar	Concrete supports required under traffic box.
575	Air release valve	Not used – refer to SLCPU drawing. Use PVC piping above air released valve

Table 2 - SANITARY SEWER

Standard Plan No.	Description	Modification
381	Trench backfill	Refer to SLCPU - Standard Practice #1.
382	Pipe zone backfill	Refer to SLCPU - Standard Practice #1 and notes given in Table 3 – Storm Drain.
402	30" frame & cover	• Use smooth surface "waffle" pattern class 35 lid. • Low profile (1") rings are **not** allowed.
411	Manhole	• 5-foot minimum manhole diameter required. • Eccentric manhole cones are **not** allowed. • Lateral connections directly to the manhole are **not** allowed. • Ramneck manhole section joint sealant and concrete grouting of manhole section joints is required. • On precast manhole bases provide base with neoprene or rubber coupling system and stainless steel clamps
412	Invert cover	• 2"x4" bracing only required at manholes with pipe entering above the mainline flowline. • Normal manholes will have the invert cover supported by the manhole "shelf".
431	Sewer lateral connection	• Prior Public Utilities approval and permit required for all lateral installations. • Salt Lake City will provide and install wye. • 24-hour notice required. • Stainless steel straps required.
432	Sewer lateral relocation	• Note 2- Salt Lake City will provide & install wye. • Material under bottom of obstruction will be loosely compacted ¾"minus well graded granular material or sand. Flowable fill not allowed.
433	Pipe drop	Alternate 2- **not** used unless approved in writing by Public Utilities Chief Engineer.

Table 3 - STORM DRAIN

Standard Plan No.	Description	Modification
302	30" frame & cover	Use smooth surface "waffle" pattern class 35 lid.
303	44" frame & cover	Use smooth surface "waffle" pattern class 35 lid.
310	48" grate & frame	Not used
315	Catch basin	Note: CONTRACTOR to make back wall of box behind curb face opening as detailed.
316	Catch basin	Not used
320	Debris grate inlet	Not used
321	Automatic flap gate	Modify to include a clean-out box and lid over the flap gate.
361	Concrete grade rings	minimum height 6-1/2"
381	Trench backfill	Refer to SLCPU - Standard Practice #1.
382	Pipe zone backfill	Refer to SLCPU - Standard Practice #1 • Pipe zone material will be ¾" minus material. An exception may be granted for concrete pipe being installed below the water table. In these cases, the fill material below the pipe springline may be 2 inches minus sewer rock when approved in advance by the Chief Engineer. Sewer rock is not allowed with PVC and HDPE-N12 pipe. • In all cases, backfill in the pipe zone above springline of pipe will be Grade ¾" minus material . • The thickness of Type B – haunch material will be 6 inches below the outside diameter of the pipe.

PART 2 PRODUCT Not Used

PART 3 EXECUTION Not Used

END OF SECTION

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DOCUMENT 00 73 50
REQUIREMENTS OF THE DEPARTMENT OF PUBLIC UTILITIES

(Supplementary Conditions)

PART 1 GENERAL

1.1 DOCUMENT INCLUDES

A. Procedures for water line and sewer line construction.

1.2 RELATED WORK

A. Salt Lake City Department of Public Utilities has published a document entitled Standard Practices for Salt Lake City Public Utilities (most current edition). The document is available from 1805 West 500 South, Salt Lake City, Utah 84104. In that publication there is a list of standard practices that apply to contractors.

1. The standard practices are as follows
    a. Trench Backfill Requirements (No. 1).
    b. Jordan and Salt Lake Canal Standards (No. 3).
    c. Flushing and De-chlorination (No. 4).
    d. Cable Installations (No. 8).
    e. Water Service Kills (No. 9).
    f. Commissioning Waterlines (No. 12).
    g. Commissioning Large Service and Fire Lines (No. 13).
    h. Hydrostatic Testing of Water Lines (No. 14).
    i. Tree Pruning and Root Cutting (No. 15).
    j. Raising Manholes, Cleanout and Water Valve Boxes (No. 16).
    k. Standard Fire Hydrant Colors (No. 17).
    l. Disinfection Large Water Connections (No. 18).
    m. Waterline Installation in Hydrocarbon Contaminated Areas (No. 19).
2. Use the appropriate standard practice when doing work on sewer, water, and storm drain facilities that are owned by the City Department of Public Utilities.

1.3 SUBMITTALS

A. Prior to final payment, submit.

1. All Contract Documents as required by Article 6.11 of Document 00 72 00 in the Manual of Standard Specifications.

PART 2 CHANGES TO THE APWA SPECIFICATIONS

2.1 SECTION 01 11 00 – SUMMARY OF WORK

Replace specification 01 11 00 Summary of Work of APWA with specification 01 11 00 Summary of Work included in the contract in its entirety.

2.2 SECTION 01 25 00 – PRODUCT OPTIONS AND SUBSTITUTIONS

Replace specification 01 25 00 Product Options and Substitutions of APWA with specification 01 25 00 Substitution Procedures included in the contract in its entirety.

2.3 SECTION 01 31 19 – PRECONSTRUCTION CONFERENCE

Replace specification 01 31 19 Preconstruction Conference of APWA with specification 01 31 19 Project Meetings included in the contract in its entirety.

2.4 SECTION 01 73 29 – CUTTING AND PATCHING

Replace specification 01 73 29 Cutting and Patching of APWA with specification 01 73 29 Cutting, Coring, and Patching included in the contract in its entirety.

2.5 SECTION 01 74 13 – PROGRESS CLEANING

Replace specification 01 74 13 Progress Cleaning of APWA with specification 01 74 23 Cleaning Up included in the contract in its entirety.

2.6 SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA

Replace specification 01 78 23 Operation and Maintenance Data of APWA with specification 01 78 23 Operation and Maintenance Data included in the contract in its entirety.

2.7 SECTION 01 78 39 – PROJECT RECORD DOCUMENTS

Replace specification 01 78 39 Project Record Documents of APWA with specification 01 78 39 Project Record Documents included in the contract in its entirety.

2.8 SECTION 33 08 00 - COMMISSIONING OF WATER UTILITIES.

A. Add a new paragraph to Article 1.2

1.2 REFERENCES

C. AWWA C600, C602, and C606.

2.9 **SECTION 33 08 00 – COMMISSIONING OF WATER UTILITIES**.

A. Replace Article 3.6 with the following.

3.6 PRESSURE TEST AND DISINFECTION

A. Prevent contamination from entering the line during storage, construction, or repairs. For new construction, keep a plug on the end of the pipe except for installing the next section of pipe.

B. Disinfect the line by placing granular or tablet chlorine (10 to 25 mg/l concentration for 24 hours) in the line during installation and filling the line with water.

C. De-chlorinate the line or dispose of chlorinated water in an acceptable manner and flush the line (see Standard practice No. 4 and the following paragraphs.

D. Provide air release taps at pipeline's highest elevations and expel all air before test. Insert permanent plugs or air relief valves after test has been completed.

E. Complete a hydrostatic test of the line according to AWWA for the type of pipe used (i.e. for ductile iron pipe; AWWA C600, PVC pipe AWWA C605). This will include connecting any external pump to the pipe and applying a hydrostatic pressure as established for the work by the Chief Engineer. This will be at least 200 psi at the lowest point of the line. This pressure will be maintained within 5 psi for two hours (2 hrs.) and the amount of makeup water will be measured. The amount of makeup water must be less than 1.5 gallons and 2.2 gallons per 1,000 feet of pipe for eight inch (8") and 12 inch (12") pipe respectively. No piping installation will be accepted until the leakage is less than the amount listed above.

F. Locate and repair defective joints and retest until leakage rate is less than allowable.

G. Repair any noticeable leakage even if the total leakage is less than allowable.

H. Flush after hydrostatic test and let the line sit for at least 16 hours before collecting a water sample.

I. A representative of the Chief Engineer will collect and deliver a water sample to the City laboratory.

J. Earliest test results may be available the next day.

K. If the test passes, a second sample will be collected by the City representative and delivered to the City laboratory.

L. If the first sample is bad, then the line will be flushed and allowed to sit in chlorinated state for 16 hours before another sample is collected.

M. When two (2) acceptable samples have been obtained, the line is acceptable and services can be connected.

2.10 **SECTION 33 11 00 – WATER DISTRIBUTION AND TRANSMISSION.**

A. Add a new paragraph to Article 2.1

2.1 PIPES AND FITTINGS

E. Provide Chevron fm #1 non-oxide grease and 8 mil polyethylene wrap.

B. Add a new paragraph to Article 3.4

3.4 INSTALLATION – PIPE AND FITTINGS

I. Coat all exposed nuts and bolts with Chevron fm #1 non-oxide grease and 8 mil polyethylene wrap.

2.11 **SECTION 33 13 00 – DISINFECTION**.

A. Add a new paragraph to Article 3.2

3.2 DISINFECTION OF WATER LINES

H. Refer to Article 3.6 of Section 33 08 00 – Commissioning of Water utilities as amended in Section 00 73 50.

END OF DOCUMENT

DOCUMENT 00 91 13
ADDENDA

PART 1 GENERAL

1.1 **PROCEDURE**

A. For filing purposes, add Addenda and Modifications to the Contract Documents following this page.

B. All official Addenda and Modifications will be labeled, DOCUMENT 00 91 13.X, ADDENDUM NO. X

Any other document will not be considered as an Addendum for purposes of acknowledgement.

END OF DOCUMENT

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WAGE RATES

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"General Decision Number: UT20230097 01/06/2023

Superseded General Decision Number: UT20220097

State: Utah

Construction Type: Heavy
HEAVY CONSTRUCTION PROJECTS

Counties: Salt Lake and Tooele Counties in Utah.

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least $16.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2023.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least $12.15 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2023.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at http://www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/06/2023

ELEC0057-001 03/01/2022

	Rates	Fringes
LINE CONSTRUCTION (Lineman).....	$ 52.55	6.00%+16.48

ELEC0354-005 06/01/2022

	Rates	Fringes
ELECTRICIAN.....	$ 36.09	1.3%+16.26

ENGI0003-034 07/01/2020

	Rates	Fringes
POWER EQUIPMENT OPERATOR (Mechanic).....	$ 33.04	16.09

ENGI0003-035 07/01/2022

	Rates	Fringes
POWER EQUIPMENT OPERATOR		

(LOADER).....$ 31.99 17.64

LABO0295-001 07/01/2019

	Rates	Fringes
LABORER (Landscape).....	$ 23.97	9.70

LABO0295-002 07/01/2019

	Rates	Fringes
TRAFFIC CONTROL (Flagger).....	$ 23.71	9.78

TEAM0222-004 07/01/2021

	Rates	Fringes
TRUCK DRIVER (Dump Truck).....	$ 25.09	13.05

SUUT2018-008 05/07/2020

	Rates	Fringes
CARPENTER (Form Work Only).....	$ 24.61	8.45
CEMENT MASON/CONCRETE FINISHER...	$ 20.70	1.21
LABORER: Common or General.....	$ 18.33	6.70
LABORER: Pipelayer.....	$ 18.47	9.00
OPERATOR: Backhoe/Excavator/Trackhoe.....	$ 23.40	16.96
OPERATOR: Bobcat/Skid Steer/Skid Loader.....	$ 25.29	0.00

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at https://www.dol.gov/agencies/whd/government-contracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example:

PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISIO"

"General Decision Number: UT20230085 03/17/2023

Superseded General Decision Number: UT20220085

State: Utah

Construction Type: Building

County: Salt Lake County in Utah.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least $16.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2023.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least $12.15 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2023.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at http://www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/06/2023
1	01/27/2023

2	02/03/2023
3	02/10/2023
4	03/17/2023

CARP0801-002 12/01/2022

	Rates	Fringes
CARPENTER (Drywall Hanging and Metal Stud Installation Only)	$ 31.66	13.97

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* ELEC0354-001 03/11/2023

	Rates	Fringes
ELECTRICIAN (Low Voltage Wiring Only)	$ 27.75	14.53+1.5%
ELECTRICIAN	$ 36.09	1.3%+16.26

ELEV0038-003 01/01/2023

	Rates	Fringes
ELEVATOR MECHANIC	$ 50.87	37.335+a+b

FOOTNOTE:
a: Vacation Pay: 8% with 5 or more years based on regular hourly rate for all hours worked, 6% under 5 years based on regular hourly rate for all hours worked. b: Paid holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Veteran's Day; Thanksgiving Day; Friday after Thanksgiving and Christmas Day

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PAIN0077-003 07/01/2022

	Rates	Fringes
DRYWALL FINISHER/TAPER	$ 31.00	8.44

PAIN0077-004 08/01/2022

	Rates	Fringes
PAINTER (Brush, Roller, and Spray, excluding Drywall/Finisher and Taper)	$ 22.50	8.93

PLUM0140-001 08/01/2021

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 40.50	14.62

SFUT0669-003 01/01/2023

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers)	$ 38.17	23.27

SHEE0312-002 07/01/2022

	Rates	Fringes

SHEET METAL WORKER (Including
HVAC Duct Installation).....$ 39.26 11.67

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* SUUT2012-017 07/29/2014

	Rates	Fringes
CARPENTER (Acoustical Ceiling Installation Only).....	$ 21.25	2.15
CARPENTER (Form Work Only).....	$ 16.93	1.93
CARPENTER, Excludes Acoustical Ceiling Installation, Drywall Hanging, Form Work, and Metal Stud Installation.....	$ 20.66	7.47
CEMENT MASON/CONCRETE FINISHER...	$ 15.00 **	0.00
IRONWORKER, STRUCTURAL.....	$ 20.21	3.22
LABORER: Common or General.....	$ 13.84 **	0.00
LABORER: Mason Tender - Brick...	$ 16.38	1.00
LABORER: Mason Tender - Cement/Concrete.....	$ 14.94 **	0.00
LABORER: Pipelayer.....	$ 13.57 **	0.00
LABORER: Landscape and Irrigation.....	$ 9.50 **	0.00
OPERATOR: Backhoe/Excavator/Trackhoe.....	$ 14.48 **	0.00
OPERATOR: Loader.....	$ 19.34	0.00
PLASTERER.....	$ 18.36	0.00
ROOFER.....	$ 13.22 **	0.00
TILE FINISHER.....	$ 13.54 **	0.00
TILE SETTER.....	$ 23.50	0.00
TRUCK DRIVER: Dump Truck.....	$ 15.50 **	0.00

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 ($16.20) or 13658 ($12.15). Please see the Note at the top of the wage determination for more information.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this

contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at https://www.dol.gov/agencies/whd/government-contracts.

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A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

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Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.

Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

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U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISIO"

DIVISION 01

GENERAL REQUIREMENTS

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

A. Work of this Construction Contract comprises but not limited to the construction of the following:

A 105-mgd capacity wastewater IPS with future build-out to 137-mgd capacity consisting of:

1. Site preparation including demolition, clearing, grubbing, excavation, foundation preparation, backfill
2. Existing utility relocations
3. Two (2) pre-engineered metal buildings housing the IPS and electrical equipment
4. Two (2) trench style, self-cleaning wet wells side by side under same superstructure
5. Pump gallery consisting of five (5) vertical turbine solids handling pumps with space for a total of six (6) pumps, steel discharge headers, and valve pad.
6. Pre-manufactured biofilter odor control system
7. 4MW, n+1, emergency/standby power generator system , such that 4MW output is achievable even if one generator set is not operating
8. Yard utilities including fiber optic, ductbanks, potable water, non-potable water, natural gas, and site drainage
9. Approximately 4,000 feet of duct bank connecting WRF site to IPS site
10. Civil site improvements including paving, grading, curb and gutter, sidewalk, chain link fencing, and landscaping for an approximate 8-acre site
11. HDPE forcemains from the valve pad header to station 2+57.46.
12. Installation of GFRP influent sewer from the influent pump station to the connection extended from MH#3.

B. Along with the necessary temporary facilities and equipment including but not limited to bypass pumping to perform the work in accordance with the Contract Documents and listed in Specification 01 53 00.

The location of the work is: 1200 Reclamation Road.

1.2 CONTRACT METHOD

A. Construct the Work under a multiple lump sum price contract.

1.3 COORDINATION WITH PROPERTY OWNERS – PUBLIC RELATIONS PLAN

A. Maintaining good public relations with property owners and residents that use the streets affected by construction is an important component of this project. In order to maintain good public relations, the OWNER has employed WF&Co. as it's public relations manager. CONTRACTOR shall be responsible for coordinating with WF&Co. for all public relations matters.

2. The CONTRACTOR shall provide a professionally prepared, movable temporary project sign as outlined in Section 01 58 00, Project Identification and Signs at the work location of the project.

1.4 **COORDINATION WITH ADJACENT PROJECTS**

A. Sundt/PCL is currently constructing the new Salt Lake City Water Reclamation Facility (SLCWRF). CONTRACTOR shall be required to coordinate startup and testing of pump station with forcemain project and the new SLCWRF.

B. CONTRACTOR shall coordinate construction of influent sewer junction structure with 1800 North Sewer Realignment Project.

C. CONTRACTOR shall coordinate with contractor installing forcemain and influent sewer work to ensure site access as work will be in close proximity between the two projects.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01 14 00
WORK RESTRICTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for sequencing and scheduling the Work affected by existing site and facility, existing utility connections, work restrictions, and coordination between construction operations and plant operations.

1.02 GENERAL CONSTRAINTS ON SEQUENCE AND SCHEDULING OF WORK

A. Wastewater projects
   1. Conduct work such that Owner's ability to collect, pump, and treat wastewater is not impaired or reduced in terms of the required quantity or quality of treated wastewater. Do not impair the operational capabilities of essential elements of the treatment process or reduce treatment capacity below levels sufficient to meet demands for wastewater collection and treatment throughout the contract time. The required wastewater collection and/or treatment capacity are described in this Section.

B. Work sequence and constraints:
   1. Utilize description of critical events in work sequence as a guideline for scheduling and undertaking the Work, as follows:
      a. Connections to existing sewers
      b. Connections to existing electrical service
      c. Bypass pumping operations

C. Work sequence and constraints presented do not include all items affecting completion of the Work, but are intended to describe critical events necessary to minimize disruption of the existing facilities and to ensure compliance with Utah Pollutant Discharge Elimination System (UPDES) and other permit requirements.

D. Work impacting the use of the golf course shall be completed between November 1 and March 30 and minimized to the extent possible.

1.03 SHUTDOWN AND CONSTRUCTION CONSTRAINTS

A. General shutdown constraints:
   1. Execute the Work while the existing facility is in operation.
   2. All activities must be accomplished without a pump station or plant shutdown.
   3. Apply to activities of construction regardless of process or work area.
   4. Organize work to be completed in a minimum number of equipment and operations shutdowns.
   5. Provide thorough advanced planning, including having required equipment, materials, and labor on hand at time of shutdown.

6. Where required to minimize treatment process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.
7. Any full treatment plant shutdown, or significant reduction in treatment capacity or treatment capabilities is not permitted.

B. Dewatering of existing process and disposal of residue:
1. The Contractor is responsible for costs and procedures required to dewater and dispose of liquid, solids, etc. in the pipelines for making connections.
   a. Costs for dewatering, disposal of solids and residuals, and preparation of surfaces for the Work are Contractor's responsibility.
      1) Includes tipping fees for the removal and disposal of the grit/debris.
   b. Dewatering and/or testing of grit/debris to meet landfill requirements is the responsibility of the Contractor.
   c. Contractor shall provide adequate time in schedules for draining and cleanup.

C. Ductbank construction constraints:
1. During construction of the ductbank between the new pump station and new substation on the WRF site (by others) the existing overhead power lines and forcemains shall be protected at all times from construction activity.

D. Traffic constraints
1. All construction traffic must access the site through Reclamation Road from the North and shall not be permitted through the Rose Park neighborhood unless construction activities restrict access and require it.

1.04 REQUIREMENTS FOR OPERATION OF PLANT AND MAINTAINING CONTINUOUS OPERATION OF EXISTING FACILITIES

A. Coordinate with specification 01 53 00 Maintenance of Plant Operations During Construction.

B. Facilities or conditions required to keep the existing plant operational include, but are not limited to, the following:
1. Electrical power including transformers, distribution wiring, and motor control centers.
2. Influent sewers.

C. Conduct the Work and provide temporary facilities required to keep the existing plant and pump station continuously operational.

D. Do not remove or demolish existing facilities required to keep the existing pump station operational at the capacities specified until the existing facilities are replaced by temporary, new, or upgraded facilities or equipment.
1. Test replacement facilities to demonstrate operational success prior to removing or demolishing existing facilities.

1.05 OPERATIONS AND MAINTENANCE ACCESS

A. Provide safe, continuous access to process control equipment for plant operations personnel.

B. Provide access on 1-hour advance notice to process control equipment for plant maintenance personnel and associated maintenance equipment.

1.06 UTILITIES

A. Provide advance notice to, and utilize services of, Blue Stake for location and marking of underground utilities operated by utility agencies other than the Owner.

B. New utilities were designed using existing facility drawings.
   1. Field verification of utilities locations was not performed during design.
   2. Services crossed or located nearby by new yard utilities may require relocation and possible shutdowns.
   3. Pipe alignments as indicated on the Drawings.

1.07 COVID-19 RESTRICTIONS

A. COVID-19 Proclamations may require the project to be shut down or otherwise increase the Contractor's cost or time of performance by calling for things such as social distancing and the use of personal protective equipment.

1.08 LAYDOWN AND STORAGE RESTRICTIONS

A. Laydown area east of pump station designated in plans is an EPA superfund site and as such no disturbance of soils is permitted at any time.

1.09 EXISTING STRUCTURE SETTLEMENTS

A. Contractor must monitor and ensure no settlement to existing pipe, equipment, or facilities caused by Contractor operations, including but not limited to dewatering methods and sheet piling or other means of deep excavation shoring used for construction.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

APPENDIX A
"Method of Procedure" (MOP)
Instructions and Forms

Definition and Purpose

"Method of Procedure" (MOP) is a detailed document submitted by the Contractor to request process shutdown(s), utility tie-in(s), work in areas that may risk unanticipated outages, or flow diversions to accommodate site construction activities during a project. Such activities may include (but are not limited to) new tie-ins to utilities or structures, mechanical modifications to process piping or equipment, demolition, bulkhead installation, and cleaning processes.

The MOP provides a detailed plan to the Owner and Engineer that describes specific aspects of the work including purpose, time of execution, and anticipated impacts on treatment processes. The MOP also includes contingency measures and provisions for rapid closure in the event that shutdown or work progress difficulties are encountered. Information from relevant trades associated with the requested shutdown, diversion, or tie-in is also included.

The Owner should use the information within the MOP to define operational procedures and methods to safely and successfully assist the Contractor.

MOP Process Summary

WHO	STEP	TIMING
Contractor	1. Identify MOPs needed on MOP Log and Baseline Schedule.	7 days prior to Preconstruction Meeting
Contractor, Owner, Engineer	2. Pre-MOP Meeting.	More than 28 days prior to work
Contractor	3. Submits MOP.	No later than 28 days prior to work
Owner	4. Reviews MOP.	
Owner	5. MOP finalized.	7 days prior to work
Contractor	6. Complete Readiness Checklist.	5 days prior to work
Contractor	7. Complete Safety Checklist.	Just prior to commencing work
Contractor	8. Complete Work.	
Contractor	9. Update MOP Log and Progress Schedules.	Monthly

MOP Process Detail

STEP 1. Identifies MOPs needed on MOP Log and Baseline Schedule.

Contractor submits a preliminary list of anticipated project MOPs on MOP Log. MOPs identified but not limited to those shutdowns, diversions, or tie-ins described in the Contract Documents. Incorporate MOPs as tasks in Baseline Schedule. Date scheduled MOPs to coincide with the appropriate construction activities.

STEP 2. Pre-MOP Meeting.

Contractor requests a Pre-MOP Meeting with the Owner and Engineer to discuss the nature of the shutdown, diversion, or tie-in, and to gather the information necessary to complete the MOP Form. The pre-MOP meeting may be waived by the Owner or Engineer if the work is deemed to be minor.

STEP 3. Submits MOP.

Contractor completes the MOP Form and submit 3 copies for approval to the Engineer/Owner.

STEP 4. Reviews MOP.

Engineer/Owner distributes MOP Form for review by the Owner's Construction Coordinator, O&M Representative, and Engineer's Project Representative. Review MOP Form for completeness, accuracy, compliance with both the construction schedule, constraints defined in contract documents, and to ensure that the requested work does not negatively impact plant operations or other concurrent project activities. Additional information may be requested to better understand the nature of and method for completing the Work.

STEP 5. MOP finalized.

Once the MOP is agreed to by all parties, the MOP will be finalized by signature. Copies are distributed to the Owner, Engineer, and Contractor.

STEP 6. Complete Readiness Checklist.

Contractor verifies everything is ready for the work.

STEP 7. Complete Safety Checklist.

Contractor ensures safety.

STEP 8. Complete work.

Contractor complete work.

STEP 9. Update MOP Log and Progress Schedules.

Contractor updates MOP Log weekly and distributes at the regularly scheduled construction progress meetings.

METHOD OF PROCEDURE (MOP) FORM

Owner: _____ **Date:** _____

Contractor: _____ **City Project No.:** _____

Project Name: _____ **Submittal No.:** _____

Submittal Title: _____ **Spec/Dwg. Reference:** _____

MOP #	Task Title *(Provide <10 word title)*:	Submittal Date: *(No later than 28 days prior to work)*

SCHEDULE OF WORK ACTIVITY START: *(Date/Time)* END: (Date/Time)

REQUESTOR:

PRIMARY POINT OF CONTACT:	PHONE/PAGER:
SECONDARY POINT OF CONTACT:	PHONE/PAGER:
NOTIFY ☐ Control Room, Phone	☐ Security, Phone
BUILDING:	LOCATION OF WORK FLOOR/LEVEL:

DESCRIPTION OF WORK: *(Provide sufficient details on process isolation, work sequencing, and safety (i.e., control of significant hazards unique to the work) to demonstrate an understanding of the work and how it will be completed within the constraints, and its impact on the processes and facility.)*

Task Summary: _____

Processes Affected: _____

Trades Affected: _____

WORK PLAN:

Work Sequencing: _____

Process Isolation: _____

Spill Prevention Plan: _____

Contingency Plans: _____

CRITICAL EQUIPMENT/TOOLS: *(pumps and discharge hoses with correct fittings, blind flanges and pipe plugs, no-hub fittings, properly sized electrical service components, generators, portable lighting, chlorine for potable water pipe breaks, etc.)*

☐	Acoustic Ceiling/or Walls Access	☐	Excavation Permit	☐	Lock Out/Tag Out
☐	Chemical Use Approval	☐	Fire Sprinkler Impairment	☐	Life Safety Systems
☐	Confined Space Permit	☐	Flammable Materials	☐	Roof Protocol
☐	Critical Lift Plan	☐	Flush / Discharge	☐	Work After Dark

☐	Energized Electrical Work	☐	High Pressure Test	☐			
☐	Elect. Panel Schedules	☐	Hot Work/Open Flame	☐			
EXISTING SERVICE(S) AT RISK:							
☐	Breathing Air	☐	Elect Normal	☐	Process Access	☐	Telephones
☐	Chemical Distribution	☐	Fire Protection	☐	Safety Showers	☐	UPS
☐	City Water	☐	HVAC	☐	SCADA	☐	VAX/DATA
☐	Communication	☐	Inert Gas	☐	Security	☐	
☐	Domestic Drain	☐	Instrument - Air	☐	Solvent Drain	☐	
☐	Elect-Bus Duct	☐	Life Safety System	☐	Specialty Gases	☐	
☐	Elect Emergency	☐	Natural Gas	☐	Storm Drain	☐	
REVIEWER'S INSTRUCTIONS / COMMENTS:							
☐	PREJOB BRIEFING MUST BE COMPLETED PRIOR TO COMMENCING WORK:						

	Full Name (printed)	**Signature**	**Phone**	**Date**
Submitted By				
System Owner				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				

READINESS CHECKLIST
(5 days prior to work)

Checklist provided as a guide but is not all inclusive.

1. Confirm all parts and materials are on site: _____
   _____
2. Review work plan: _____
   _____
3. Review contingency plan: _____
   _____

SAFETY CHECKLIST
(Just prior to commencing work)

Checklist provided as a guide but is not all inclusive.

1. Location awareness:
   a. Emergency exits: _____
   b. Emergency shower and eyewash: _____
   c. Telephones and phone numbers: _____
   d. Shut-off valve: _____
   e. Electrical disconnects: _____
2. Inspect work area:
   a. Take time to survey the area you are working in. Ensure that what you want to do will work. Do you have enough clearance? Is your footing secure? Do you have adequate lighting and ventilation? Are surrounding utilities out of the way for you to perform your work?
3. SDS (Safety Data Sheets):
   a. Understand the chemicals and substances in the area you are working in by reading the SDS.
4. Lockout/Tagout Procedure:
   a. Lockout/tagout energy sources before beginning work.
   b. Make sure all valves associated with the work are locked out and tagged out on each side of the penetration.
   c. Make sure the lines are depressurized.
5. Overhead work:
   a. Use appropriate personal protective equipment; i.e., safety harness, lifeline, etc.
   b. Select appropriate tie-off points; i.e., structurally adequate, not a pipe or conduit, etc.
   c. Spotter assigned and in position.
   d. Pipe rack access; i.e., check design capacity, protective decking or scaffolding in place, exposed valves or electrical switches identified and protected.
6. Safety equipment:
   a. Shepherd's hook.
   b. ARC flash protection.
   c. Fire extinguisher.
   d. Other: _____.
7. Accidents:
   a. Should accidents occur, do not shut off and do not attempt to correct the situation, unless you are absolutely positive that your action will correct the problem and not adversely affect other people or equipment.
8. Review process start-up documents:
   a. In the event the system is shutdown, the Control Center should have a working knowledge of the process start-up procedures in order to deal effectively with unforeseen events.
9. Evacuation procedures:
   a. Do not obstruct evacuation routes.
   b. Take time to survey the area for evacuation routes.

Method of Procedure (MOP) Log
Sample

MOP Number	Task Title	Date Requested	Date Approved	Date Work Planned	Work Completed (yes/no)
001					
002					
003					

SECTION 01 14 14

CONTROL OF WORK

PART 1 - GENERAL

1.01 PLANT AND HOURS OF CONSTRUCTION:

A. Furnish labor, materials, and equipment which will be efficient, appropriate, and large enough to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the Contract Time. If at any time it appears to the Engineer or Owner to be inefficient, inappropriate, or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, the Engineer or Owner may order the Contractor to increase the efficiency, change the character, or increase the equipment, and the Contractor shall conform to such order. Failure of the Engineer or Owner to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

B. Normal construction activity shall take place only between the hours of 7 a.m. to 5 p.m., excluding Saturdays, Sundays, and legal holidays. Work outside the above time periods will be permitted only with the written approval of the Owner.

1.02 OCCUPYING PRIVATE LAND:

A. The Contractor shall not (except after written consent from the proper parties) enter or occupy with personnel, tools, materials, or equipment any land outside the rights of way or property of the Owner. A copy of the written consent from the proper parties shall be given to the Engineer and Owner.

1.03 DIMENSION OF EXISTING STRUCTURES:

A. The Contractor shall verify the dimensions and locations of existing structures in the field before the fabrication of any material or equipment which is dependent on the correctness of such information.

1.04 OPEN EXCAVATIONS:

A. All open excavations shall be adequately safeguarded by providing temporary barricades, fencing, caution signs, lights, and other means to prevent accidents to persons and damage to property, and in accordance with applicable occupational health and safety regulations. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access during construction shall be removed when no longer required. The length or size of excavation will be controlled by the particular surrounding conditions, but shall always be confined to the limits agreed upon with the Engineer or Owner. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer or Owner may require special construction procedures such as limiting the length of the open trench,

prohibiting stacking excavated material in the street, and requiring that the trench shall not remain open overnight.

B. All open excavations within the golf course property and roadway are public property and shall be properly barricaded and isolated from public access during installation of the forcemains and ductbank.

C. The Contractor shall take precautions to prevent injury due to open trenches. All trenches, excavated material, equipment, or other obstacles which could be dangerous shall be well lighted at night.

1.05 INTERFERENCE WITH AND PROTECTION OF STREETS:

A. The Contractor shall not close or obstruct any portion of a street, road, or private way without obtaining permits therefor from the proper authorities. If any street, road or private way shall be rendered unsafe by the Contractor's operations, he shall make such repairs or provide such temporary ways or guards as shall be acceptable to the proper authorities.

B. Streets, roads, private ways, and walks not closed shall be maintained passable and safe by the Contractor, who shall assume and have full responsibility for the adequacy and safety of provisions made therefor.

C. The Contractor shall, at least 72 hours in advance, notify the Police and Fire Departments in writing, with a copy to the Engineer and Owner, if the closure of a street or road is necessary. The Contractor shall cooperate with the Police Department in the establishment of alternate routes and shall provide adequate detour signs, plainly marked and well lighted, in order to minimize confusion.

1.06 TRAFFIC CONTROL:

A. Comply with the Public Way/Traffic Control Permit.

B. For control of moderate traffic, the Contractor shall provide an adequate number of flagmen.

C. Whenever and wherever, in the opinion of the Engineer or Owner, traffic is sufficiently congested or public safety is endangered, the Contractor, as required, shall furnish uniformed special officers to direct traffic and to keep traffic off the highway area affected by his construction operations. Such officers shall be in addition to the watchmen required under other provisions of the contract.

D. The employment or presence of traffic flagmen, special officers, or police shall in no way relieve the Contractor of any responsibility or liability which is his under the terms of the contract.

1.07 CARE AND PROTECTION OF PROPERTY:

A. The Contractor shall be responsible for the preservation of all public and private property, and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition similar or equal to that existing before the damage was done, or he shall make good the damage in other manner acceptable to the Engineer and Owner.

1.08 INTERFERENCE WITH EXISTING WORKS:

A. The Contractor shall at all times conduct his operations so as to interfere as little as possible with existing works. The Contractor shall develop a program, in cooperation with the Engineer and the Owner, which shall provide for the construction and putting into service of the new works in the most orderly manner possible. This program shall be adhered to except as deviations therefrom are expressly permitted. All work of connecting with, cutting into, and reconstructing existing pipes or structures shall be planned to interfere with the operation of the existing facilities for the shortest possible time when the demands on the facilities best permit such interference, even though it may be necessary to work outside of normal working hours to meet these requirements. Before starting work which will interfere with the operation of existing facilities, the Contractor shall do all possible preparatory work and shall see that all tools, materials, and equipment are made ready and at hand.

B. The Contractor shall make such minor modifications in the work relating to existing structures as may be necessary. Submit a claim if believed due compensation.

1.09 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES:

A. The Contractor shall assume full responsibility for the protection of all buildings, structures, and utilities, public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, water pipes, hydrants, sewers, drains, and electric and telephone cables, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from damage of any kind. Any damage resulting from the Contractor's operations shall be repaired by the Contractor at their expense.

B. The Contractor shall bear full responsibility for obtaining all locations of underground structures and utilities (including existing water services, drain lines, and sewers). Services to buildings shall be maintained, and all costs or charges resulting from damage thereto shall be paid by the Contractor when a result of Contractor’s work. Results of potholing done for this project will be provided to the Contractor.

C. Protection and temporary removal and replacement of existing utilities and structures as described in this Section shall be a part of the work under the Contract and all costs in connection therewith shall be included in the Total Price.

1.10 CLEANUP AND DISPOSAL OF EXCESS MATERIAL:

A. During the course of the work, the Contractor shall keep the site of operations in as clean and as neat a condition as is possible. Dispose of all residue resulting from the construction work and, at the conclusion of the work, remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other refuse remaining from the construction operations, and leave the entire site of the work in a neat and orderly condition.

B. In order to prevent environmental pollution arising from the construction activities related to the performance of this Contract, the Contractor and subcontractors shall comply with all applicable Federal, State, and local laws, and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and elsewhere in the Specifications.

C. The Contractor is advised that the disposal of excess excavated material in wetlands, stream corridors, and plains is strictly prohibited even if the permission of the property owner is obtained. Any violation of this restriction by the Contractor or any person employed by the Contractor, will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. Therefore, the Contractor will be required to remove the fill at their own expense and restore the area impacted.

D. Obtain prior approval from the Owner and Engineer for any stockpiling of material on-site.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 21 00

ALLOWANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Section includes administrative and procedural requirements governing allowances.

1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

B. Types of allowances include the following:

1. Lump-sum allowances.

2. Unit-cost allowances.

3. The Contractor agrees that they are not entitled to payment of Allowances, except for additional work carried out by them in accordance with the Contractor as directed by the Engineer and only to the extent of such additional work as directed by the Engineer. Use the allowances only as directed by Engineer for Owner's purposes and only by Change Order(s) that indicate amount(s) to be charged to the allowance.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit invoices for quantities of soil hauled for distribution of allowance funds.

C. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.

1.03 COORDINATION:

A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.04 ALLOWANCES:

A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Engineer under allowance and shall include taxes, freight**,** and delivery to Project site.

B. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.

1. If requested by Engineer, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.05 ADJUSTMENT OF ALLOWANCES:

A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.

2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.

3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances. Renegotiation of rates associated with unit-cost allowances shall not be permitted.

4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.

1. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.02 PREPARATION:

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.03 SCHEDULE OF ALLOWANCES:

A. Allowance No. 1 (Bid Item #9): Lump-Sum Allowance for Golf Netting: Include the sum of **$100,000** for netting around the Influent Pump Station Site.

1. This allowance includes costs associated with netting and support systems around the Influent Pump Station site.

B. Allowance No. 2 (Bid Item #10): Lump-Sum Allowance for Bypass Pumping: Include the sum of **$500,000** for bypass pumping associated with making the connection to the extension of the GFRP sewer at MH#3. Additionally this bypass pumping may include bypass pumping needed for redirecting flows for startup, and testing of the influent pump station facilities.

1. This allowance includes costs associated with material procurement, installation, rental, and labor associated with temporary facilities to bypass the influent sewers for construction and connection to existing facilities.

C. Allowance No. 3 (Bid Item #11): Lump-Sum Allowance for Permitting: Include the sum of **$30,000** for permitting fees.

1. This allowance includes costs associated with permitting fees for City Engineering Permits (Excavation, Public Way, Obstruction Traffic Control et.), Salt Lake City Building/Inspection, Storm Water Pollution and Prevention, and Construction Dewatering Permits.

D. Allowance No. 4 (Bid Item #12): Unit-Cost Allowance for Disposal and Hauling of Unsuitable Materials to Brown Property: Include the sum of costs associated with hauling, and grading 80,800 tons of unsuitable material at a unit rate bid by the Contractor. Contractor shall include costs for spreading dumped material across the site in this unit rate.

1. This allowance includes costs associated with hauling, and grading unsuitable material from the excavations to the Owners Brown Property located at 4650 W 700 S. Unsuitable material defined in Section 31 23 00.

E. Allowance No. 5 (Bid Item #13): Unit-Cost Allowance for Hauling and Disposal of Unsuitable or Impacted/Contaminated Materials to Landfill: Include the sum of costs associated with hauling and disposal fees for 20,200 tons of unsuitable material at a unit rate bid by the Contractor.

1. This allowance includes costs associated with hauling, testing, and tipping unsuitable and/or impacted/contaminated material from the excavations to the landfill. Unsuitable material defined in Section 31 23 00. Testing frequency shall be as required for landfill to accept the material.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 01 23 00

ALTERNATE BID ITEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This Section includes administrative and procedural requirements governing alternates.

1.02 DEFINITIONS:

A. Alternate is amount proposed by Bidder and stated on Bid Form in Section 00 43 00 for certain work defined in Bidding Requirements that may be added to or deducted from Contract Price if OWNER decides to accept corresponding change in either amount of construction to be completed, or in materials, equipment, or installation methods described in Contract Documents.

B. Cost or credit for each alternate is net addition or deduction from Contract price to incorporate Alternate into Work. No other adjustments will be made to Contract Price.

1.03 PROCEDURES:

A. Coordination:

1. Modify or adjust affected adjacent work as necessary to completely and fully integrate work of Alternate into Project.

2. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for complete installation whether or not indicated as part of Alternate.

B. Execute accepted alternates under same conditions as other work of Contract.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 DESCRIPTION OF ALTERNATES:

A. Alternate 1 (Bid Item 14): Installation of 6th Pump

1. Add for providing the 6th pump and ancillary components for functionality in accordance with Section 43 21 00.34. This shall include all inlet/discharge piping, ancillary components, electrical wiring, power, controls, instrumentation, seal water etc. for a fully operational pump similar to others.

END OF SECTION

SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Section includes administrative and procedural requirements for substitutions.

1.02 DEFINITIONS:

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Substitution Requests: Submit each request for consideration under a separate cover. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use Form 01 25 00-1 to request substitution.

2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Justification for use of the proposed equivalent item(s), including evidence, as applicable, that Contract specified material, product or equipment is unobtainable or unobtainable within an acceptable time for Contract completion.

b. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable. If the Contractor is proposing the substitution because of unavailability of the product, submit a letter from the manufacturer stating the product is unavailable with an explanation of why it is unavailable with the Form 01 25 00-1

c. Detailed comparison of qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, electrical characteristics, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated and specified. Indicate deviations, if any, from the Work specified.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

e. Samples, where applicable or requested.

f. Certificates and qualification data, where applicable or requested.

g. List of similar installations for completed projects with project names and addresses and names, telephone numbers and addresses of engineers and owners.

h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

i. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

j. Cost information, including a proposal of change, if any, in the Contract Sum.

k. A prediction of any effects the proposed change will have on operation and maintenance costs, where applicable.

l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is intended for applications indicated.

m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation in accordance with General Conditions review time for submittals.

    a. Forms of Acceptance: Change Order, Work Change Directive, RFI or submittal response.

1.04 ACCEPTABLE EQUIVALENT PRODUCTS, MATERIALS AND EQUIPMENT:

A. Any other product the contractor wants to substitute must follow the requirements of this Section.

B. If the Contractor chooses to substitute equipment other than a named manufacturer, any additional costs or time required to accommodate such equipment shall be made without a change in the Contract Price or Contract Time and at no additional cost to the Owner.

1.05 MATERIAL AND WORKMANSHIP:

A. Whenever a material, article, system or sub-system is specified or described by using the name and/or model of a proprietary product or trademark or the name of the manufacturer or vendor, the specified item shall establish the type, function, and quality required; it shall be understood that the words “or approved equivalent” are implied whether or not they follow the proprietary enumeration.

B. The Engineer and Owner reserves the right to determine when proprietary items have no equivalency, and when uniformity of operations, interchangeability of parts, standard parts inventory, etc., are in Owners’ best interest.

C. Requests for review of equivalency will be considered upon submission of sufficient information as described herein, to allow complete review.

D. Such requests will not be accepted from anyone other than the Contractor. Such submission must be made prior to purchase, fabrication, manufacture or use of the equivalent items under consideration.

E. The Contractor is responsible for all delays caused by its failure to submit complete and accurate information with any request for approval of any material, article, system or subsystem, as an equivalent.

    1. Contractor Risk:

        a. If the Contractor includes in his bid or later proposes any material, product or equipment that he considers equivalent to that specified, the Contractor assumes all risk of any sort associated with acceptance or rejection of proposed equivalent items.

b. The Contractor shall have no right to make claim based upon his bid that includes a proposed equivalent item(s) of work which resulted in a lower bid amount for said item(s) or lower total bid.

2. Equivalency:

a. An item will be considered equivalent to the item specified if:

(1) It is equal or better in design and strength in all subparts, quality, reliability and durability, operation, maintenance and serviceability, as applicable; and

(2) It is equal or better in specified parameters in performance in all respects for the specific function(s) indicated in the contract.

3. Supplemental Requirements:

a. Any tests required by the Engineer to establish quality and performance standards shall be promptly conducted by or through the Contractor at no additional cost to the Owner.

b. The Contractor shall submit any additional data requested by the Engineer for the equivalency review.

c. The Contractor shall satisfactorily accomplish all changes, including any engineering associated with use of equivalent items, at no additional cost to the Owner.

d. The Contractor shall have no right of appeal to any decision rejecting the equivalency of any item.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers at no cost to the Owner.

1.07 PROCEDURES:

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS:

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution is consistent with the Contract Documents and will produce specified and indicated results.

b. Substitution request is fully documented and properly submitted.

c. Requested substitution will not negatively affect Contractor's construction schedule.

d. Requested substitution has received necessary approvals of authorities having jurisdiction.

e. Requested substitution is compatible with other portions of the Work.

f. Requested substitution has been coordinated with other portions of the Work.

g. Requested substitution provides specified warranty.

B. Substitutions for Convenience: Engineer will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.

2. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution offers Owner an advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

b. Requested substitution does not require revisions to the Contract Documents.

c. Requested substitution is consistent with the Contract Documents and will produce specified and indicated results.

d. Substitution request is fully documented and properly submitted.

e. Requested substitution will not affect Contractor's construction schedule.

f. Requested substitution has received necessary approvals of authorities having jurisdiction.

g. Requested substitution is compatible with other portions of the Work.

h. Requested substitution has been coordinated with other portions of the Work.

i. Requested substitution provides specified warranty.

j. Requested substitution does not increase operation or maintenance costs to the Owner.

PART 3 - EXECUTION

3.01 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

Form 01 25 00-1
SUBSTITUTION REQUEST

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to design, including Engineer design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

_____

Telephone: _____

Attachments: _____

_____

_____

ENGINEER REVIEW AND ACTION

☐ Substitution approved – Make submittals in accordance with Specification Section 01 25 00.

☐ Substitution approved as noted – Make submittals in accordance with Specification Section 01 25 00.

☐ Substitution rejected – Use specified materials.

☐ Substitution Request received too late – Use specified materials.

Signed by: _____ Date: _____

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ Engineer ☐ Other: _____

_____

_____

_____

_____

_____

Form 01 25 00-1 (Continued)
SUBSTITUTION REQUEST

Project: _____ Substitution Request Number: _____

_____ From: _____

To: _____ Date: _____

_____ Engineer Project Number: _____

Re: _____ Contract For: _____

Specification Title: _____ Description: _____

Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No. _____

Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years ☐ More than 10 years old

Differences between proposed substitution and specified product: _____

_____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Reason for not providing specified item: _____

_____

Similar Installation:

Project: _____ Engineer/Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other part of Work: ☐ No ☐ Yes, explain _____

_____

Savings to Owner for accepting substitution: _____

Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____ days.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports _____

END OF SECTION

SECTION 01 31 13
COORDINATION

This specification changes a portion of APWA Standard Specification Section 01 31 13. All other provisions of the Section remain in full force and effect. This project is in Salt Lake City so it will be necessary to have a good coordination effort.

Add the following paragraph to Article 1.4 (page 97):

1.4 COORDINATING WITH SEPARATE CONTRACTORS

C. Forcemain contractor shall supply influent sewer GFRP pipe and couplings and provide to CONTACTOR. CONTRACTOR shall install all piping and coupling shown on drawing 0101-D101 to pump station.

Add the following paragraph to Article 1.5 (page 98):

1.5 COORDINATION WITH ADJACENT PROPERTY OWNER

F. 14-days prior to beginning work in any area and once each month during construction, hand deliver a written **"Construction Status Update Notice"** to all residents, businesses, schools and property owners adjacent to and affected by the Work. Notice shall be based on the template provided by the ENGINEER and be secured to door knob should occupants not be home. Obtain ENGINEER's final review of notice and distribution list/map prior to distribution. As a minimum the notice shall contain the following:

1. name and phone number of CONTRACTOR's representative for the project;
2. name and phone number of Public Relations Supervisor
3. name and phone number of OWNER's project manager
4. work anticipated for the next 30 days including work locations and work by subcontractors and utility companies;
5. rough estimate of construction schedule through end of work affecting area;
6. anticipated impact to driveway approach access and closures;
7. anticipated water, sewer or power outages;
8. anticipated vehicular traffic impacts, rerouting or lane closures;
9. anticipated pedestrian impacts and sidewalk closures;
10. changes to public transportation bus routes; and
11. any other construction or work items which will impact or restrict the normal use of streets and amenities.

Failure to comply with this contract provision is considered grounds for project suspension per Article 15.1 of the General Conditions (APWA Document 00 72 00, page 71).

G. CONTRACTOR shall notify all businesses affected by water shutdowns 72-hours in advance of the shutdown

H. CONTRACTOR shall notify all residents affected by water shutdowns 48-hours in advance of the shutdown.

Add the following Article to Part 1:

1.8 **PUBLIC AGENCIES AND UTILITY PERSONNEL TO CONTACT**

A. Utility Companies: Utility companies generally require a minimum of 48 hours' notice if their utility requires location, relocation or protection. Contact the following individuals to coordinate. (Please note Contractor must contact **Blue Stakes** before digging, phone **(801) 208-2100**.)

1. Questar Gas Company: Jason McGee, Design: phone (801) 324-3640, email Jason.mcgee@questar.com; Craig Johnson, North of 3900 South (Salt Lake City Area) – (801) 324-3841; Wade Homer, West of Redwood Road and South of 2100 South – (801) 324-3339; Michael "Rudy" Bryant, South of 3900 South – 801-324-3375. Call 2 weeks prior to requiring Questar work on gas mains and 1 week on service lines to property owners. A Questar representative must be present at the pre-construction meeting and when working around high pressure gas mains.
2. Rocky Mountain Power Company:
   a. Suzan Baker: phone (801) 220-2444; cell (801) 497-6334
3. Qwest CenturyLink:
   a. Jeff Stapley: office (801) 974-8505; fax (801) 974-8192
   b. Darren Keller: (801) 356-6975
   c. Deanne Powell: (801) 974-8165
4. The Salt Lake City Department of Public Utilities: Tamara Wambeam, G.I.S. & IT Manager, (801) 483-6834 – Mapping Questions
5. The Salt Lake City Department of Public Utilities to schedule inspection and survey of project of installed sanitary sewer mains, storm drain mains, street lighting and water mains prior to backfilling fittings, valves, washouts, etc.: Call (801) 483-6727.
6. The Salt Lake City Department of Public Utilities Industrial Storm Program Coordinator, Greg Archuleta, (801) 483-6821
7. The Salt Lake City Department of Public Utilities Street Lighting Program Manager, David Pearson, (801) 483-6738
8. AT&T: Ken Howcroft, (801) 580-8005
9. Comcast (Cable TV): Gary Goldstein, (801) 401-3041; Kent Johnson (801) 401-3039; Eric Patten eric_patten@cable.comcast.com; (801) 255-2711
10. Integra Telecom, Inc., (801) 924-3000; (801) 265-0928
11. Questar Infocomm, Inc.: Jeff Jerabek, (801) 324-1942
12. XO Communications:

B. Salt Lake County Engineering Division: (385) 468-6600

C. Salt Lake County Public Works Operations Division: Kevin Smeltzer (385) 468-6124; Brandon Johnson cell, (801) 557-9699; email brjohnson@slco.org a minimum of 48 hour prior to:

1. Setting traffic barricades.
2. Removal and relocation of traffic regulation, information signs and all striping modifications

D. Salt Lake County Flood Control, Bonnie McCallister, BMcCallister@slco.org (385) 468-6626

E. Salt Lake County Health Noise Ordinance – Sanitation and Safety, (385) 468-3835

F. Salt Lake City Golf Course – Mike Price, (801) 596-5030

G. State of Utah (UDOT), Region 2 – Shane Safford, Encroachment and Permits Officer, (801) 975-4809, email lsafford@utah.gov, (801) 975-4979 fax.

H. Utah Transit Authority: Dispatch, phone (801) 287-3202. UTA generally requires 72 hours' notice if it becomes necessary to move bus stops or make scheduling changes

I. Salt Lake City Urban Forestry: (801) 972-7818, a minimum of 72 hours prior to removing trees.

J. Salt Lake City Transportation Division: Mr. Scott Vaterlaus, (801) 535-6630, a minimum of 48 hours prior to:

1. Setting traffic barricades.
2. Removal and relocation of traffic regulation and information signs.

K. Salt Lake City Traffic Signal: Cabot Jennings, (801) 535-6994; (801) 910-5720, a minimum of 48 hours prior to have Traffic Detector Loops marked.

L. Salt Lake City, City Engineer, (801) 535-6248, a minimum of 48 hours prior to street closure.

M. Chevron Pipe Line Company: Concerning location and crossing crude oil lines.

1. Melissa Horiuchi, Conflict Inquiry Coordinator, Salt Lake Station, 801-539-7285
2. Don Bristol, Facility Inspector, office 801-539-7189; cell 801-598-6131

END OF SECTION

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SECTION 01 31 19

PROJECT MEETINGS

PART 1 - GENERAL

1.01 SUMMARY:

A. Contractor shall schedule and administer progress meetings with their own staff and/or other contractors, construction foremen's meetings, and specially called meetings with these parties throughout progress of Work. Contractor shall:

1. Prepare agenda for meetings.

2. Distribute written notice of specially called meetings minimum of one working day(s) in advance of meeting date.

3. Make physical arrangements for meetings.

4. Preside at meetings.

5. Record minutes; include significant proceedings and decisions.

6. Prepare formal minutes and distribute within two working days after each meeting to the following:

a. Meeting participants.

b. Parties affected by decisions made at meeting.

c. Engineer and Owner

B. Representatives of Contractor, Subcontractors, and Suppliers attending meetings shall be qualified and authorized to act on behalf of entity each represents.

C. Owner and Engineer may attend meetings.

1.02 PRECONSTRUCTION CONFERENCE:

A. Engineer will schedule and conduct preconstruction conference in accordance with General Conditions paragraph 2.6 and this section.

B. Location: At location to be selected by Engineer.

C. Attendance.

1. All Contractor's Project Managers.

2. All Contractor's Resident Superintendents.

3. All Contractor's "hands-on" persons designated by Contractor to submit Shop Drawings to Engineer.

4. Subcontractors' or suppliers' representatives Contractor may desire to invite or Engineer may request.

5. Engineer's representatives.

6. Owner's representatives.

7. Local utility representatives, if applicable.

D. Suggested format includes, but not be limited to following:

1. Project Safety.

2. Presentation of preliminary schedules in accordance with General Condition paragraph 2.5.

3. Check of required bonds and insurance policies prior to Notice to Proceed.

4. Liquidated damages.

5. Procedures for handling submittals such as substitutions and Shop Drawings.

6. O&M submittal procedures.

7. Training requirements.

8. Requirements for plant functional testing, startup, commissioning, performance testing, and reliability testing.

9. On-site witness testing by independent subconsultants and approval/regulatory agencies.

10. Direction of correspondence and coordinating responsibility.

11. Weekly and monthly progress meetings.

12. Equal opportunity requirements.

13. Laboratory and field testing requirements.

14. Provisions for inventory of material stored on-site or off-site if off-site storage is authorized.

15. Schedule of values, application for progress payment, and progress payment procedures.

16. Change Order procedures.

17. Contractor's proposed Environmental Management and Erosion Control Plan.

18. Contractor's proposed Health and Safety Plan.

19. Contractor's proposed Quality Control Plan.

20. Coordination requirements with plant staff and ongoing operations.

21. Construction sequencing and stipulated construction and plant operational constraints.

22. Project funding and associated requirements (WIFIA, AIS)

1.03 PROGRESS MEETINGS WITH ENGINEER AND OWNER:

A. In addition to other regular project meetings for other purposes (as indicated elsewhere in the Contract Documents), hold general progress meetings weekly with times coordinated with preparation of payment requests. Meeting dates shall be established by the Owner and overseen by Owner. Require every entity then involved in the planning, coordination or performance of work to be properly represented at each meeting. Include (when applicable):

1. Consultants

2. Separate contractors (if any)

3. Principal subcontractors

4. Suppliers/manufacturers/fabricators

5. Governing authorities

6. Insurers

7. Special supervisory personnel and others with an interest or expertise in the progress of the work.

B. Suggested format includes, but not limited to following:

1. Review each entity's present and future needs including interface requirements

2. Construction sequence, coordination and shutdown requirements

3. Construction schedule and progress reporting

4. On-site witness testing by independent subconsultants and approval/regulatory agencies

5. Deliveries

6. Access

7. Site utilization

8. Temporary facilities and services

9. Hours of work

10. Safety, hazards and risks

11. Housekeeping

12. Submittals

13. Change managements (request for quotation, change directives, change orders)

14. Contract administration logs (request for information, etc.)

15. Documentation of information for payment requests

16. O&M submittal

17. Training

18. Pump station functional testing, startup, and performance testing.

C. Discuss whether each element of current work is ahead of schedule. Determine how behind-time work will be expedited and secure commitments from the entities involved in doing so. Discuss whether schedule revisions are required to ensure that current work and subsequent work will be completed within the Contract Time. Review everything of significance which could affect the progress of the work.

D. Immediately following each progress meeting where revisions to the Progress Schedule/Critical Path Schedule have been made or recognized (regardless of whether agreed to by each entity represented), revise the Schedule. Reissue revised Schedule within 10 working days after meeting.

E. At intervals matching the preparation of payment requests, revise and reissue the Schedule to show actual progress of the work in relation to the latest revision of the Schedule.

1.04 FUCTIONAL TESTING, STARTUP AND COMMISSIONING MEETING:

A. Schedule three months prior to the start of functional testing.

B. Location: At location to be selected by Engineer.

C. Attendance.

1. All Contractor's Project Managers.

2. All Contractor's Resident Superintendents.

3. All Contractor's Startup Managers.

4. Subcontractors' or suppliers' representatives Contractor may desire to invite or Engineer may request.

5. Engineer's representatives.

6. Owner's representatives.

7. Local utility representatives, if applicable.

D. Suggested Agenda.

1. Detailed testing and commissioning plans and schedules.

2. Requirements and schedules for training of Owner's staff.

3. Requirements and schedules for O&M data.

4. Coordination and shutdown requirements.

5. On-site witness testing by independent subconsultants and approval/regulatory agencies.

6. Sampling and analytical requirements and responsibilities.

7. SCADA integration and control

8. Engineer's responsibility for separate training of Owner's staff.

9. Engineer's responsibility for separate process O&M manual.

1.05 SCADA MEETING:

A. Schedule six months prior to the start of functional testing (if SCADA programming is being done by the Engineer, OR prior to the submission of SCADA-programming related submittals (if SCADA programming is being done by the Contractor.

B. Location: At location to be selected by Engineer.

C. Attendance.

1. All Contractor's Project Managers.

2. All Contractor's Startup Managers.

3. Subcontractors' or suppliers' representatives Contractor may desire to invite or Engineer may request.

4. Engineer's representatives.

5. Owner's representatives.

D. Suggested Agenda.

1. SCADA software and programming requirements.

2. Detailed testing and commissioning plans and schedules.

3. FAT testing requirements and schedules.

4. SAT testing requirements and schedules.

5. SCADA training of Owner's staff.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 32 17
BASELINE AND PROGRESS SCHEDULES

PART 1 GENERAL

1.1 PURPOSE

A. The OWNER is committed to delivering quality, cost-effective infrastructure to its customers in a timely manner. One of the most important tools the OWNER uses to achieve this goal is accurate, updated, current schedules for its capital projects. Accurate and updated schedules allow the OWNER to effectively track and manage its projects both in aggregate (at the program or OWNER-wide level) and project-by-project.

B. The OWNER's goal is to take every reasonable step to ensure that projects finish on time and within budget. Project schedules are the fundamental building blocks to planning and executing projects efficiently and on time. These schedules are best prepared by those closest to the work. Because the vast majority of capital project delivery at the OWNER is performed by CONTRACTOR, it is critical that CONTRACTOR prepare schedules as part of performing their work for the OWNER.

C. This Schedule Guidance Document is designed to guide CONTRACTOR in preparing and submitting acceptable schedules for use by the OWNER.

1.2 APPLICABILITY AND BASIC REQUIREMENTS

A. CONTRACTOR is responsible for preparing schedules as defined herein and as required in their contracts. A waiver allowing a CONTRACTOR not to prepare a schedule in accordance with this Schedule Guidance Document may only be granted by the OWNER or designee.

There are three (3) basic elements to schedule submittals.

1. **Baseline Schedule**: Initial schedule submitted before work begins that will serve as the baseline for measuring progress and departures from the schedule. The Baseline Schedule is prepared by the CONTRACTOR at the beginning of the project and submitted to the OWNER for review and approval.

2. **Progress Schedule**: Monthly submittal of a Progress Schedule documenting progress on the project and any changes anticipated. The Progress Schedule is prepared monthly by the CONTRACTOR and submitted to the OWNER.

3. **Schedule Narrative**: Concise narrative that highlights changes in the schedule, expected delays, key schedule issues, etc., along with a cash flow graph or summary table. The Schedule Narrative is submitted to the OWNER monthly in conjunction with the Progress Schedule.

B. The schedules required herein will be prepared using the following software (or saved down in the following version) in order to be compatible with the OWNER's schedule system, unless prior permission to use another software is requested and granted by the OWNER.

a. Primavera Project Planner (now owned by Oracle) version 8.2 or later

b. or Microsoft Project.

1.3 **BASELINE SCHEDULE**

A. General: The CONTRACTOR will develop a cost loaded schedule using the software version required in Section 1.2 and the Critical Path Method (CPM).

1. The OWNER will inform the CONTRACTOR of the Project Code (Project Number) for the Project. The file naming convention is demonstrated in the examples below.

- Baseline

  Format. ProjectCode (project number)_DocumentType_Date_

  Example. 1701_ScheduleBaseline_03162017.XER

- Monthly Update

  Format. ProjectCode (project number)_DocumentType_Date_

  Example. 1701_ScheduleUpdate_03162017.XER

- Monthly Schedule Narrative

  Format. ProjectCode (project number)_DocumentType_Date_

  Example. 1701_ScheduleNarrative_03162017.DOC

2. The approved Baseline Schedule is a part of the contract by reference. The CONTRACTOR has the sole responsibility to correct any latent defects in the Baseline Schedule and perform to the subsequently revised schedule.
3. The CONTRACTOR will use the Baseline Schedule to coordinate and monitor the work (including the activities of subcontractors, equipment vendors and suppliers).
4. The CONTRACTOR must keep a copy of the approved Baseline Schedule.

B. Schedule Work Breakdown Structure and Activities

1. **Work Breakdown Structure (WBS)**: The OWNER's Work Breakdown Structure is designed to meet the basic reporting needs for the OWNER's financial and tracking systems. The CONTRACTOR's project-specific WBS should work within this basic framework and provide additional detail to efficiently deliver and track the work.

   WBS elements that are definitely not a part of the scope of services need not be included in the schedule. Note that as many subtasks and activities as desired may be included underneath the WBS elements.

2. **Activities**: Activities are the discrete elements of work that make up the schedule. They should be organized underneath the umbrella of the WBS as described in Exhibit A.

   The following information should be provided for each activity:

   a. Activity ID Number
   - Use a four-digit number left justified in the activity I.D. field.
   - Alphanumeric activity numbers are NOT acceptable.

b. Activity Description
- Activity descriptions should adequately describe the activity and in some cases the extent of the activity. Examples of acceptable descriptions might include "install pipeline between Avenue A and Avenue B", "water line route layout", etc.).

c. Activity Durations
- The activity duration will be based upon the physical amount of work that is to be performed for the stated activity and are limited to 20 working days. If work is to exceed 20 days, then break the work down so the work will be completed within a 20-day time frame.
- The intent of this requirement is to ensure that the activities are segmented sufficiently to adequately track progress.

d. Activity Start and Finish Dates
- Activity start and finish dates will only be accepted if calculated by the software.
- Actual activity start and finish dates may not be assigned in a baseline. However, they must accurately be assigned in the working version of the schedule (see Section 4 Progress Schedule).

e. Activity Dependencies
All activities will be logically tied with a predecessor and a successor. The only exception to this rule will be for the project start and project finish milestones.

f. Milestone Activities
- The following milestone activities (i.e., important events on a project that mark critical points in time) are of particular interest to the OWNER and should be reflected in the Project Schedule for all phases of work, as applicable. Notice to Proceed (Construction)
- Draft Baseline Schedule submittal
- Preparation and submission of shop drawings, submittals, and any required re-submittals (if applicable)
- Mobilization
- Fabrication and delivery of equipment and materials (if applicable)
- Substantial Completion
- Construction Complete

C. **Baseline Schedule Development**: The CONTRACTOR will designate an authorized representative (Project Scheduler) responsible for developing and updating the schedule and preparing reports. It is recommended that a qualified scheduler develop the Baseline Schedule.

The CONTRACTOR's initial schedule submittal will contain NO progress and represent the planned work for the duration of the project. Once approved by the OWNER, this schedule will become the baseline against which all future variance analysis will be performed.

The use of activity external constraint dates and lags on relationships is discouraged unless specified or approved by the OWNER. An example of an external constraint date is "concrete placement will begin no later than January 1." The reason for this requirement is that it creates an artificial (rather than calculated) critical path.

The Baseline Schedule will consider delivery lead times, construction and access constraints and the coordination of construction with OWNER operations.

1. **Safety Requirements**: Schedule performance should never take precedence over safety. Project schedules must allow work to be performed in a safe manner.

   The CONTRACTOR cannot reduce safety or worker protection in order to shorten schedules, recover lost time or accelerate the work.
2. **Inclement Weather**: Refer to climatology data for anticipating work that can be affected by inclement weather. Historical rain days can be reviewed from the following web site: http://www.noaa.gov/climate

D. Changes to Approved Baseline Schedule: The approved Baseline Schedule is the basis for measuring progress on the project (see Paragraph 1.4, Progress Schedule). As such, the CONTRACTOR should develop the Baseline Schedule considering the realistic delivery of the work tasks and likely constraints.

Total and free float is not for the exclusive use or benefit of either the OWNER or the CONTRACTOR, but is a resource available to both parties for the benefit of the project on a first needed basis. Changes to the Baseline Schedule will only be considered after all float has been consumed.

Changes to the approved Baseline Schedule may only be considered under limited circumstances. If warranted, any changes will require PRIOR approval by the ENGINEER's Designee and OWNER's Program Manager. Project circumstances that could be considered by the OWNER as potentially warranting re-baselining include the following:

- Change Orders to the contract affecting the scope of the work to be performed and the associated schedule completion date

1.4 PROGRESS SCHEDULE

As described in Paragraph 1.3, the Baseline Schedule is used to coordinate and monitor the work. The CONTRACTOR is required to keep a copy of the approved Baseline Schedule.

The Progress Schedule is simply a copy of the approved Baseline Schedule that will be statused monthly. In other words, progress on the project will be shown monthly as an update of the schedule that will be compared to the approved Baseline Schedule.

Note that the Progress Schedule will be statused (data date) through month end, although the submittal date must comply with Paragraph 1.6 of this section.

A. **Progress Updates**: The CONTRACTOR should show on the Progress Schedule updates of the following:

- The actual dates that activities start
- The actual dates that activities finish
- The remaining duration of activities in progress
- The percent complete of all activities on the schedule (0 percent to 100 percent complete)

B. **Schedule Narrative**: The Progress Schedule will be accompanied monthly by a concise Schedule Narrative that explains the submitted schedule. The purpose of the Schedule Narrative is to:

- Speed review time
- Explain variances from Baseline on critical path activities
- Explain to the OWNER logic changes and potential schedule conflicts related to dependences.
- Concisely summarize the projected cash flow for the project based on the statused schedule.

If the project is on schedule, and no significant issues related to schedule exist, then the Schedule Narrative is extremely brief. On the other hand, if the project is falling behind, and/or there are significant conflicts and obstacles to meeting the Baseline Schedule, then the Schedule Narrative should describe the issues and what steps will be necessary for the project to recover. Sharing this information ensures that the entire project team will be aware of the issues and have opportunity to assist, where applicable.

1.5 ADDITIONAL GUIDANCE APPLICABLE TO CONSTRUCTION SCHEDULES ONLY

In addition to the requirements in Sections 1.1 – 1.4 of this Schedule Guidance Document, the CONTRACTOR's schedule will include the following.

A. **Schedule of Value Pay Items**: Schedule of Values Pay Items (Work) shall be loaded into the scheduling software using the labor, materials, and equipment resource types showing the quantity of Work to be done along with the corresponding value of the Work measured in dollars.

1.6 SUBMITTAL OF SCHEDULES

A. **Submittal File Formats**: Every time that a schedule or report is submitted (baseline and monthly progress) the following file formats are required.

1. Baseline Schedule: Submit the schedule in native file format (see below).

   Also submit a .pdf of the bar chart schedule consisting of the following columns:

   - Activity ID
   - Activity Name
   - Duration
   - Start Date
   - Finish Date
   - Float

- Cost

2. **Progress Schedule**: Submit the schedule in native file format (see below).
   Also submit a .pdf of the bar chart schedule consisting of the following columns:
   - Activity ID
   - Activity Name
   - Physical Percent Complete
   - Duration
   - Start Date
   - Finish Date
   - Total Float
   - Remaining Total Cost
3. **Schedule Narrative**: Submit the schedule narrative in .doc format.
4. **Native Schedule File Formats**: The native file structure is to save the schedule as follows:
   a. In Primavera 6, save the file as an .XER file.
   b. In Microsoft Project, save the file as an .MPP file.

B. **Submittal Process**: All submittals of schedules must be made to the ENGINEER's Designee. Draft project Baseline Schedules must be submitted within thirty (30) calendar days after the formal Notice to Proceed from the OWNER. All schedules must be submitted in their native format (.XER file or .MPP) as well as in a PDF format. The OWNER will review, accept or reject the schedule within five (5) days of submittal.
   Once the Baseline Schedule has been accepted, Progress Schedule updates will be due monthly prior to the monthly progress meetings.

END OF SECTION

EXHIBIT A – OWNER WORK BREAKDOWN STRUCTURE

WBS shown in gray are reserved for the OWNER. WBS shown in blue are reserved for CONTRACTOR.

WBS Number	Name
1	**Pre-Design**
1.1	Project Planning & Development
1.2	Design Consultant Procurement
1.3	RFP Development
1.3.1	OWNER Review Process & Consultant Negotiations
1.3.2	Consultant Selection
2	**Project Design**
2.1	Survey and Geotechnical
2.2	Design
2.2.1	30% Design
2.2.2	60% Design
2.2.3	90% Design
2.3	Bid Documents
3	**Bidding**
3.1	Bid & Award
4	**Contract**
4.1	Contract Negotiation
5	Project Construction
5.1	Mobilization
5.2	Construction
5.2.1	Task 1
5.2.2	Task 2
5.2.3	Task 3
5.2.4	Task 4
5.2.5	Task 5
5.2.6	Task 6
5.2.7	Task 7
5.2.8	Task 8
5.2.9	Task 9
5.2.10	Task 10
5.3	Testing and Commissioning
5.4	Construction Services
6	Closeout
6.1	Closeout

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SECTION 01 32 33

CONSTRUCTION VIDEO

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Pre-construction video pertinent to the Contract work will be taken by Contractor.

1.02 QUALITY ASSURANCE:

A. Dates for videography at site will be coordinated by the Engineer, Owner, and SLCDPU staff.

B. Videographer will make and retain detailed records of all video under this Contract:

1. The records will be in sufficient detail to support any attestation that may be required of videographer.

2. Videographer will retain such records for a period not less than two years from the final acceptance of entire work under this Contract.

1.03 USAGE RIGHTS:

A. Contractor will have access to documentation.

PART 2 - PRODUCTS

2.01 MEDIA:

A. Digital Video Recordings: High-resolution, digital video in format. Ability to extract high-resolution photographs from the video.

PART 3 - EXECUTION

3.01 CONSTRUCTION VIDEO:

A. General: Video will provide the maximum range of depth of field, and that are in focus, to clearly show the Work.

1. Videographer will maintain key plan with each set of pre-construction videos that identifies each video location.

B. Digital Images: Maintain one set of files accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to the Engineer.

C. Preconstruction Video: Before starting construction, video will be taken of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by the Engineer. Video will:

1. Show existing conditions adjacent to property before starting the Work.

2. Show each existing building structure, or feature either on or adjoining property to accurately record physical conditions at start of construction.

3. Take additional video as required to record settlement or cracking of adjacent structures, pavements, and improvements.

4. Take video the existing conditions and facilities at the existing raw wastewater pump station.

5. Take video along the proposed Influent Sewer route. If a drone is proposed to be used, confirm with the Owner and Engineer approval for use of a drone. Due to proximity to the airport, restrictions may be required.

3.02 FORCEMAIN AND DUCTBANK ROUTE VIDEOGRAPHY:

A. Video of route before commencement of construction will be:

1. Progressive video of route starting at one end of route and progressing to other end then reverse progressive video back to point of beginning.

2. Additional video of features along route as directed by the Owner and Engineer.

3.03 PRE-CONSTRUCTION VIDEO RECORDINGS:

A. Recording will display continuous running time and date. At start of each video recording, records weather conditions from local newspaper or television and the actual temperature reading at Project site.

B. Before starting construction, record video recording of forcemain route, ductbank route, Project site, and surrounding properties from different vantage points, as directed by the Owner and Engineer.

1. Showing existing conditions adjacent to Project site before starting the Work.

2. Showing existing buildings either on or adjoining Project site to accurately record physical conditions at the start of construction.

END OF SECTION

SECTION 01 32 63

CONSTRUCTION SURVEYS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide pre and post construction surveys as indicated and specified.

B. Section includes administrative and procedural requirements for the following:

1. Certified topographic field surveys performed by a registered land surveyor to determine first floor elevations, etc. as specified herein.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Field Reports:

1. One copy of final Pre and Post-Construction Survey report and native survey files.

1.03 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. The topographic surveys shall be performed by or under the supervision of and certified by a Registered Land Surveyor.

1.04 SEQUENCING AND SCHEDULING:

A. Dates for surveys at the site shall be coordinated with the Engineer and Owner.

PART 2 - PRODUCTS

2.01 TOPOGRAPHIC SURVEYS

A. Provide first floor elevations, the corners of buildings and structures foundations both front and rear.

B. Provide elevations of sidewalks, driveways, edge of roadway, retaining walls, fences, garages, sheds, valve boxes, meters, cleanouts etc.

C. The location of each elevation shall be described in detail in words and located on the plan. The cotour interval shall be 1-foot.

D. Provide construction surveys for surroundings buildings both on and off the property. Contractor shall coordinate with adjacent property owners to gain access as needed.

PART 3 - EXECUTION

3.01 CONSTRUCTION SURVEYS:

A. Provide construction surveys in accordance with the following:

1. Notify the Owner a minimum of 24 hours prior to post construction surveys.

2. The Contractor shall obtain permission, from adjacent Facility Owners a minimum of 7 days prior to conducting each survey.

3. If the Contractor is unable, after two repeated attempts, to obtain permission from adjacent Facility Owners, then the Contractor shall immediately notify the Owner so that appropriate measure may be taken.

4. Obtain the age of each facility, known permit modification and foundation information from local building departments.

5. Detailed examination shall include a visual internal and external survey of the building or structure; digital video and color photographs showing visually evident internal and external structural cracks and damage.

3.02 CONSTRUCTION SUREVEYS DURING CONSTRUCTION:

A. Provide continuous construction surveys of existing adjacent buildings at frequencies adequate to monitor existing structures for settlement but not less than once every other month.

1. Submit results of surveys in accordance with 01 33 00.

2. Locations for settlement monitoring shall be coordinated with ENGINEER and OWNER and shall be included in each monitoring event.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURE

This specification changes a portion of APWA Standard Specification Section 01 33 00. All other provisions of the Section remain in full force and effect.

Add the following article to Part 1.

1.8 **PROCEDURE**

A. Transmit submittals to ENGINEER through SLCDPU Engineering's Project Central SharePoint site. Access and use instructions are provided at the end of this section.

1.9 **SUBMITTAL REGISTER**

A. List submittals required by Contract Documents on the attached Submittal Register form. Identify CONTRACTOR's need dates and ENGINEER's action dates.

B. The following list identifies required submittal due dates. Submittals not identified in the list but specified in the Specifications shall be submitted as need to progress the project.

When Due	Section Reference	Submittal	Responsible
Pre-construction conference	01 33 00	Submittal Register	
	00 72 00	Preliminary Progress Schedule	
	00 72 00	Mobilization Plan	
	00 72 00	Safety and Protection Plan	
	00 72 00	Quality Control Program	
Prior to Starting Work	00 73 10	Permits for Work	
	01 55 26	Traffic Control Plan	
	01 57 00	Storm Water Pollution Prevention Plan	
	01 71 23	Surveyor's Name, Certificate of Assurance, License Number, Schedule of Values.	
	32 01 93	Arborist's Certification and Registration Number	
	32 01 93	Tree Protection Plan	
Prior to Use	00 73 10	Written Permission to use Private Citizen's Property and Water	
	31 05 13	Top Soil Supplier and Source Data	
Prior to Delivery On Site	31 05 13	Common Fill	
	32 11 23	Target Gradation Curve Crushed Aggregate	

When Due	Section Reference	Submittal	Responsible
	32 12 05	Asphalt Concrete Mix Design Supplier's Mix Number.	
Prior to Delivery On Site	03 30 04	Portland Cement Concrete Source Data and Supplier's Mix Number.	
	33 11 00	Water System Product Data	
Upon Delivery to Site	32 12 16	Asphalt Concrete Batch Delivery Ticket	
	03 30 10	Portland Cement Concrete Batch Delivery Ticket	
Prior to Water Line Use	33 12 19	Water System Disinfection Report	
Prior to System Use	33 08 00	Pipeline Commissioning	
Prior to 1st Concrete Placement	03 30 10	Name, Certification Number and renewal date for all ACI Certified Finishers	
	03 30 10	Portland Cement Concrete Curing Compound Source, Type, and Data	
Daily as applicable	03 30 04 03 30 10	Portland Cement Concrete Quality Control Test Reports	
With Each Monthly Pay Request	01 32 16	Progress Schedule, Survey Schedule of Values	
5 Working Days Prior to Substantial Completion	01 78 50	Certification of Compliance and Request for Final Inspection	
Prior to Final Payment	01 71 23 01 71 24 31 05 10	Land Survey Closeout Documentation of Un-classified Excavation Calculations	
	01 78 50	Evidence of Payment to Suppliers and Sub-contractors	
	01 78 39	Redlines	
	01 78 39	Water Line Commissioning Test Reports	

NOTES:

1. Section references listed in this table that are not found in the Project Manual may be found in the APWA Standard Specifications.

END OF SECTION

SUBMITTAL REGISTER

PROJECT TITLE: _____

LOCATION: _____ Job No. _____

CONTRACTOR:

SCHEDULED ACTIVITY	SUBMITTAL ITEM No.	SPECIFICATION PARAGRAPH No.	DESCRIPTION OF MATERIAL	TYPE OF SUBMITTAL										REVIEW ACTION	CONTRACTOR NEED DATES			ENGINEER ACTION DATES		OTHER
				SAMPLES	SHOP DRAWINGS	PARTS LIST	PRODUCT DATA	DESIGN DATA	SPECIFICAITONS	CERTIFICATIONS	INSTRUCTIONS	O&M MANUAL	OTHER	REVIEW REQUIRED BY	SUBMITTAL DATE	APPROVAL NEEDED BY	MATERIAL NEEDED BY	DATE RECEIVED	ACTION CODE	

FORM 01 33 00.1

INSTRUCTIONS

GENERAL

1. CONTRACTOR to complete electronic SLCDPU Project Central Submittal Form: Review the Contract Documents to insure completeness. Expand general category listings. Show individual entries on this form for each item. Attach each item properly labeled.
    a. As an example, a general category would be "Plumbing Fixtures" which the CONTRACTOR is to breakdown into individual entries such as "Toilet P-1, Lavatory P-2, etc.". Complete the Submittal Register, and submit it to ENGINEER.
2. Resubmittals: If a submittal is returned for correction, create a new Submittal workflow and reference the original SR ID number in the description and include the submittal register number. Do not amend the data already contained on the Submittal Register.

SUBMITTAL REGISTER

1. SCHEDULED ACTIVITY: If an activity on the Progress Schedule is assigned to the submittal, place the schedule activity number in the "SCHEDULED ACTIVITY" column.
2. SUBMITTAL ITEM No.: Assign to each entry on the Submittal Register a sequential number in the "SUBMITTAL IDENTIFICATION (ITEM NUMBER)" column.
3. REVIEW ACTION: The "REVIEW ACTION" column identifies technical review responsibility of submittal. Review of all products and materials is the CONTRACTOR's responsibility; however, certain specified submittals will also require ENGINEER's review.
    a. If REVIEW ACTION Column is Blank: Identified submittal shall be approved by the CONTRACTOR and then submitted to the ENGINEER for information.
    b. If the "ENGINEER" is Identified in the REVIEW ACTION Column: Identified submittals shall be first approved by the CONTRACTOR and then submitted to the ENGINEER for review.
4. ENGINEER ACTION DATES: This column is for ENGINEER's use to record date submittal was received and the action code assigned in the submittal review process.
5. Upload the Submittal Register to the SLCDPU Project Central site

ACCESS AND USE OF THE OWNER’s SHAREPOINT WEBSITE

9. The CONTRACTOR shall utilize the OWNER’s SharePoint website for all written CONTRACTOR correspondence, submittals, transmittals, pay applications, schedule updates or other communication where feasible. CONTRACTOR shall utilize OWNER-established SharePoint workflows as directed.

10. The CONTRACTOR shall request access to the OWNER's SharePoint website through the Project Manager, by providing the name, employer, e-mail address and phone number of each individual for which access is requested.
11. All SharePoint workflow functions require one (1) individual to be designated as the point of contact to receive workflow e-mail alerts from the system. The CONTRACTOR shall designate one individual as the point of contact for these workflows at the time access is requested. The point of contact can be changed upon the request from the CONTRACTOR at any time during the execution of the project.
12. The OWNER will determine the level of access to the SharePoint website that will be granted to each individual.
13. The OWNER and or OWNER's Representative shall provide SharePoint training to the CONTRACTOR(s).
14. The OWNER shall provide instruction sheets for the electronic workflows executed through the SharePoint site.
15. CONTRACTOR is required to have access to computer hardware and software that is compatible with the OWNER's SharePoint system, capable of running automated process workflows, and supporting electronic signatures. Minimum system requirements include:
    g. Windows 7 or higher.
    h. Microsoft Internet Explorer version 8 or higher (Google Chrome preferred).
    i. Microsoft Office 2010 or higher.
    j. Latest version of Adobe Acrobat (at a minimum Reader, Standard or Professional for editing).
    k. Broadband internet connection.
    l. Open access to https://slcut.sharepoint.com
16. CONTRACTOR shall verify current system requirements at start of contract and may need to adjust requirements during the contract period to accommodate upgrades or changes to the SLCDPU's system.

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DOCUMENT 01 35 24

CONTRACTORS CERTIFICATION OF COMPLIANCE TO SAFETY PLAN

PART 1 GENERAL

1.1 CONTRACTORS CERTIFICATION

1. The Contractor will certify that they will comply with the Safety and Protection Plan requirements of the City. A letter from the Contractor describing the hazards present on this project and their plan to mitigate those hazards is attached following this page.

END OF DOCUMENT

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SECTION 01 41 13

FEDERAL REQUIREMENTS

PART 1 - GENERAL

1.01 REGULATIONS FOR PROJECTS SUBJECT TO FEDERAL REQUIREMENTS:

A. This contract is subject to the requirements and regulations governing projects receiving Federal Funding. These include the following:

1. Representatives of the U. S. Environmental Protection Agency and of the State shall have access to the Work wherever it is in preparation or progress and the Contractor shall provide proper facilities for such access and inspection.

2. Whenever a material, article or piece of equipment is identified on the drawings or in the specifications by reference to brand name or catalog number, it shall be understood that this is referenced for the purpose of defining the performance or other salient requirements and that other products of equal capacities, quality and function shall be considered. The Contractor may recommend the substitution of a material, article, or piece of equipment of equal substance and function for those referred to in the Contract Documents by reference to brand name or catalog number, and if, in the opinion of the Engineer, such material, article or piece of equipment is of equal substance and function to that specified, the Engineer may permit its substitution and use by the Contractor. Any cost differential shall be deductible from the contract price and the Contract Documents shall be appropriately modified by a change order. The Contractor warrants that if substitutes are permitted, no major changes in the function or general design of the project will result. Incidental changes or extra component parts required to accommodate the substitute shall be made by the Contractor without a change in the contract price or contract time for completion.

1.02 MINIMUM WAGE RATES:

A. Federal Wage Determination No. UT20230097, dated 01/06/23, issued by the U.S. Department of Labor is included at the end of this section.

B. Federal Wage Determination No. UT20220085, dated 03/17/23, issued by the U.S. Department of Labor is included at the end of this section.

1.03 WATER INFRASTRUCTURE FINANCING AND INNOVATION ACT (WIFIA) REQUIREMENTS:

A. Partial funding for the project is being provided under the WIFIA program.

B. The Contractor shall comply with the requirements of the WIFIA program as described herein.

C. Debarment and Suspension:

Contractor certifies that it will not knowingly enter into a contract with anyone who is ineligible under the 2 CFR part 180 and part 1532 (per Executive Order 12549, 51 FR 6370, February 21, 1986) or who is prohibited under Section 306 of the Clean Air Act or Section 508 of the Clean Water Act to participate in the Project. Suspension and debarment information can be accessed at http://www.sam.gov. Contractor represents and warrants that it has or will include a term or conditions requiring compliance with this provision in all of its subcontracts under this Agreement.

D. Federal Lobbying Restrictions (31 U.S.C 1352):

Recipients of federal financial assistance may not pay any person for influencing or attempting to influence any officer or employee of a federal agency, a member of Congress, an officer or employee of Congress, or an employee of a member of Congress with respect to the award, continuation, renewal, amendment, or modification of a federal grant, loan, or contract. These requirements are implemented for USEPA in 40 CFR Part 34, which also describes types of activities, such as legislative liaison activities and professional and technical services, which are not subject to this prohibition. Upon award of this contract, Contractor shall complete and submit to the City the certification and disclosure forms in Appendix A and Appendix B to 40 CFR Part 34. Contractor shall also require all subcontractors and suppliers of any tier awarded a subcontract over $100,000 to similarly complete and submit the certification and disclosure forms pursuant to the process set forth in 40 CFR 34.110.

E. Civil Rights Obligation:

Contractor shall comply with the following federal non-discrimination requirements:

a. Title VI of the Civil Rights Act of 1964, which prohibits discrimination based on race, color, and national origin, including limited English proficiency (LEP). (42 U.S.C 2000D, et. seq)

b. Section 504 of the Rehabilitation Act of 1973, which prohibits discrimination against persons with disabilities. (29 U.S.C. 794, supplemented by EO 11914, 41 FR 17871, April 29, 1976 and EO 11250, 30 FR 13003, October 13, 1965)

c. The Age Discrimination Act of 1975, which prohibits age discrimination. (42 U.S.C 6101 et. seq)

d. Section 13 of the Federal Water Pollution Control Act Amendments of 1972, which prohibits discrimination on the basis of sex.

e. 40 CFR Part 7, as it relates to the foregoing.

F. Equal Employment Opportunity:

The Contractor shall comply with Executive Order 11246, entitled 'Equal Employment Opportunity,' as amended by Executive Order 11375, and as supplemented in Department of Labor regulations (41 CFR Part 60). (EO 11246, 30 FR 12319, September 28, 1965)

Contractor's compliance with Executive order 11246 shall be based on implementation of the Equal Opportunity Clause, and specific affirmative active obligations required by the Standard Federal Equal Employment Opportunity Construction Contract Specifications, as set forth in 41 CFR Part 60-4.

During the performance of this contract, the contractor agrees as follows:

1) The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

2) The contractor will, in all solicitations or advancements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.

3) The contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee’s essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the contractor’s legal duty to furnish information.

4) The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the labor union or workers’ representative of the contractor’s commitments under Section 202 of

Executive Order No. 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

5) The contractor will comply with all provisions of Executive Order No. 11246 of Sept. 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

6) The contractor will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

7) In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of such rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 11246 of Sept. 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

8) The contractor will include the provisions of paragraphs (1) through (8) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as may be directed by the Secretary of Labor as a means of enforcing such provisions including sanctions for noncompliance: Provided, however, that in the event the contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction, the contractor may request the United States to enter into such litigation to protect the interests of the United States. [Sec. 202 amended by EO 11375 of Oct. 13, 1967, 32 FR 14303, 3 CFR, 1966–1970 Comp., p. 684, EO 12086 of Oct. 5, 1978, 43 FR 46501, 3 CFR, 1978 Comp., p. 230, EO 13665 of April 8, 2014, 79 FR 20749, EO 13672 of July 21, 2014, 79 FR 42971]

G. Standard Federal Equal Employment Opportunity Construction Contract Specifications. (41 CFR 60-4.3)

1) As used in these specifications:

a) "Covered area" means the geographical area described in the solicitation from which this contract resulted;
b) "Director" means Director, Office of Federal Contract Compliance Programs, United States Department of Labor, or any person to whom the Director delegates authority;

c) "Employer identification number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.

d) "Minority" includes:

i) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);

ii) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);

iii) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and

iv) American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

2) Whenever the Contractor, or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of $10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.

3) If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

4) The Contractor shall implement the specific affirmative action standards provided in paragraphs 7 a through p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered Construction contractors performing construction work in geographical areas where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being

performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.

5) Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

6) In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

7) The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:

   a) Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

   b) Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.

   c) Maintain a current file of the names, addresses and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred

back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefor, along with whatever additional actions the Contractor may have taken.

d) Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.

e) Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under 7b above.

f) Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

g) Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment decisions including specific review of these items with onsite supervisory personnel such as Superintendents, General Foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

h) Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and Subcontractors with whom the Contractor does or anticipates doing business.

i) Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the

Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

j) Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's work force.

k) Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR part 60-3.

l) Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.

m) Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.

n) Ensure that all facilities and company activities are non-segregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.

o) Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

p) Conduct a review, at least annually, of all supervisors' adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

8) Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations (7a through p). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under 7a through p of these Specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete

benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

9) A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

10) The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, sexual orientation, gender identity, or national origin.

11) The Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

12) The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.

13) The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

14) The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex,

status (e.g., mechanic, apprentice trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15) Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

H. **Segregated Facilities.** (41 CFR 60-1.8) The contractor must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, sexual orientation, gender identity, or national origin cannot result. The contractor may neither require such segregated use by written or oral policies nor tolerate such use by employee custom. The contractor's obligation extends further to ensuring that its employees are not assigned to perform their services at any location, under the contractor's control, where the facilities are segregated. This obligation extends to all contracts containing the equal opportunity clause regardless of the amount of the contract. The term "facilities," as used in this section, means waiting rooms, work areas, restaurants and other eating areas, time clocks, restrooms, wash rooms, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing provided for employees; Provided, That separate or single-user restrooms and necessary dressing or sleeping areas shall be provided to assure privacy between the sexes.

I. Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246) located at 41 CFR § 60-4.2:

1. The Offeror's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Specifications" set forth herein.

2. The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Timetables	Goals for minority participation for each trade	Goals for female participation in each trade
	Goal from https://www.dol.gov/agencies/ofccp/construction	6.9%

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the contractor

performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the contractor also is subject to the goals for both its federally involved and non-federally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR part 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.

4. 4. As used in this Notice, and in the contract resulting from this solicitation, the "covered area" is (insert description of the geographical areas where the contract is to be performed giving the state, county and city, if any).

J. **Disadvantaged Business Enterprises (DBE).** The contractor must ensure that the DBE's six good faith efforts are used during the procurement of subcontractors for the Project. The six good faith efforts are found at:

https://www.epa.gov/grants/disadvantaged-business-enterprise-program-requirements#sixgoodfaithefforts.

1.04 AMERICAN IRON AND STEEL (AIS) REQUIREMENTS:

A. The Contractor acknowledges to and for the benefit of the Salt Lake City Department of Public Works and the United States Environmental Protection Agency ("EPA") that it understands the goods and services under this Agreement are being funded with monies made available by the Water Infrastructure Finance and Innovation Act program of the EPA that has statutory requirements commonly known as "American Iron and Steel" that requires all of the iron and steel products used in the project to be produced in the United States ("American Iron and Steel Requirement") including iron and steel products

provided by the Contactor pursuant to this Agreement. The Contractor hereby represents, warrants and covenants to and for the benefit of the Purchaser and the EPA that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the EPA. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or the EPA to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney's fees) incurred by the Purchaser or the EPA resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the EPA or any damages owed to the EPA by the Purchaser). While the Contractor has no direct contractual privity with the EPA, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the EPA is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the EPA.

1.05 COMPLIANCE WITH DAVIS-BACON AND RELATED ACTS:

(a) In any contract in excess of $2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a public building or public work, or building or work financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in 29 C.F.R. § 5.1, the following clauses (or any modifications thereof to meet the particular needs of the agency, provided that such modifications are first approved by the Department of Labor):

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of

any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics. Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(ii)

(A) The WIFIA assistance recipient, Salt Lake City Department of Public Works, on behalf of the U.S. Environmental Protection Agency (EPA), shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The WIFIA assistance recipient shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the WIFIA assistance recipient agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent to the Administrator of the Wage and Hour Division (WHD Administrator), U.S. Department of Labor, Washington, DC 20210. The WHD Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the WIFIA assistance recipient or will notify the WIFIA assistance recipient within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the WIFIA assistance recipient do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the WIFIA assistance recipient shall refer the questions, including the views of all interested parties and the recommendation of the WIFIA assistance recipient, to the WHD Administrator for determination. The WHD Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the WIFIA assistance recipient or will notify the WIFIA assistance recipient within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii) (B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis Bacon Act have

been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding. Salt Lake City Department of Public Works, shall upon written request of the WIFIA Director or an authorized representative of the Department of Labor withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), all or part of the wages required by the contract, the WIFIA Director may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii) {no text here}

(A) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to Salt Lake City Department of Public Works. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at https://www.dol.gov/agencies/whd/forms/wh347 or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to Salt Lake City Department of Public Works, for transmission to the EPA, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to Salt Lake City Department of Public Works).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under § 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under § 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the Salt Lake City Department of Public Works, EPA, or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the EPA may, after written notice to the Salt Lake City Department of Public Works, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12

(4) Apprentices and trainees-

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the

classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the WHD Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the WHD Administrator determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event

the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and Salt Lake City Department of Public Works, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001

(b) Contract Work Hours and Safety Standards Act. The following clauses set forth in paragraphs (b)(1), (2), (3), and (4) of this section shall be inserted in full in any contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by § 5.5(a) or § 4.6 of part 4 of this title. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (b)(1) of this section, in the sum of $25 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The Salt Lake City Department of Public Works shall upon its own action or upon written request of an authorized representative of the Department of Labor, or the EPA, withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this

section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

(c) In addition to the clauses contained in paragraph (b), in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in § 5.1, the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the EPA shall cause or require the Salt Lake City Department of Public Works to insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the Salt Lake City Department of Public Works, EPA and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

1.06 PROHIBITION ON CERTAIN TELECOMMUNICATIONS AND VIDEO SURVEILLANCE SERVICES OR EQUIPMENT (EFFECTIVE AUGUST 13, 2020)

The John S. McCain National Defense Authorization Act for Fiscal Year 2019 (P.L. 115-232), at Section 889, prohibits EPA financial assistance recipients, including WIFIA borrowers, from expending loan funds to procure or obtain; extend or renew a contract to procure or obtain; or enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that use covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As described in the Act, "covered telecommunications equipment or services" means:

a) Telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities).

b) For the purpose of public safety, security of government facilities, physical security surveillance of critical infrastructure, and other national security purposes, video surveillance and telecommunications equipment produced by Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities).

c) Telecommunications or video surveillance services provided by such entities or using such equipment.

d) Telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country.

The Act does not prohibit:

a) Procuring with an entity to provide a service that connects to the facilities of a third-party, such as backhaul, roaming, or interconnection arrangements.

b) Telecommunications equipment that cannot route or redirect user data traffic or permit visibility into any user data or packets that such equipment transmits or otherwise handles.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 41 20

SEISMIC AND WIND REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section establishes the minimum seismic design requirements for architectural, mechanical, electrical and non-structural components.

B. The Contractor shall be responsible for the seismic requirements specified including the conformance of work for all subcontractors, manufacturers and suppliers with regard to the indicated and specified seismic requirements.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 318: Building Code Requirements for Structural Concrete

B. American Petroleum Institute (API):

1. STD 650: Welded Steel Tanks for Oil Storage

C. American Society of Civil Engineers (ASCE):

1. 7-16: Minimum Design Loads for Buildings and Other

D. American Society of Mechanical Engineers (ASME):

1. A17.1: Safety Code for Elevators and Escalators

2. B31: Code for Pressure Piping

3. Boiler and Pressure Vessel Code

E. ASTM International (ASTM):

1. C635: Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems or Acoustical Tile and Lay-in Panel Ceilings

2. C636: Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels

F. American Water Works Association (AWWA):

1. D100: Welded Steel Tanks for Water Storage

2. D110: Wire Wound Prestressed Concrete Tanks for Water Storage

G. FEMA NEHRP Recommended Seismic Provisions for New Buildings and Other Structures, 2015 Edition

H. International Code Council (ICC):

1. International Building Code 2018

I. Manufacturers Standardization Society of the Valve and Fitting Industry:

1. SP-58: Pipe Hangers and Supports - Materials, Design and Manufacture

J. National Fire Protection Association (NFPA):

1. Standard for the Installation of Sprinkler Systems

K. Rack Manufacturers Institute:

1. Specification for the Design, Testing, and Utilization of Industrial Steel Storage Racks

L. FM Global Standards for Certification:

1. FM Global standards for design.

1.03 DEFINITIONS:

A. Components are defined as systems, equipment, parts, or other elements, including supporting structures and attachments.

B. The reference building code is defined as the building code cited on the structural drawings or specified herein for the design of the basic structure.

C. The specified seismic criteria is defined as the seismic criteria cited on the structural drawings or specified herein for the design of the basic structure.

D. The specified wind criteria is defined as the wind criteria cited on the structural drawings or specified herein for the design of the basic structure.

1.04 MINIMUM DESIGN REQUIREMENTS:

A. Architectural, mechanical, electrical and non-structural components shall be designed and constructed to resist the seismic and wind forces and displacements

based upon ASCE/SEI 7, the reference building code, and the specified seismic and wind criteria. In the case of conflict the more stringent requirements shall govern.

B. The interrelationship of components and their effect on each other shall be such that the failure of one component shall not cause the failure of any other component.

C. Components shall be anchored to the building structure to transfer seismic and wind forces. Connections shall be bolted, welded or otherwise positively anchored to the structure. Anchorage shall not rely on friction for force transfer.

D. Exceptions: Exemption from the requirements for seismic and wind analysis and design are permitted only to the extent permitted in the reference code.

E. The following design criteria shall be used in conjunction with the appropriate minimum design criteria section listed below.

1. Influent Pump Station Occupancy Category: IV

2. Electrical Building Occupancy Category: IV

F. The pre-engineered metal buildings shall be designed to meet or exceed FM Global standards for snow and wind loads.

1.05 WIND LOADING MINIMUM DESIGN CRITERIA:

A. Design in accordance with the requirements of the above referenced codes.

1. Wind Speed : 110 miles per hour, 115 miles per hour for Risk Category IV structures

2. Wind Exposure: C

1.06 SEISMIC LOADING MINIMUM DESIGN CRITERIA:

A. Design Requirements: Design in accordance with the requirements of the above referenced codes.

1. Risk Category:

a. III

b. IV, specifically designated structures

2. Short Period MCE (Ss) = 1.547

3. Long Period MCE (S1) = 0.564

4. Soil Site Class: E

5. Seismic Parameters for soil site Class E:

   a. Site Coefficient, Fa = 1.0

   b. Site Coefficient, Fv = 4.0

   c. Site Specific Short Period Spectral Acceleration (SDS) = 0.830

   d. Site Specific Long Period (1-sec) Spectral Acceleration (SD1) = 1.200

6. Seismic Design Category: D

7. Importance Factor (Ie):

   a. Select based upon Risk Category and corresponding values provided by ASCE/SEI 7.

8. Component Importance Factor (Ip):

   a. Equipment and systems related to operations, including but not limited to pumping systems, supply piping; Ip = 1.5

   b. Other structures, Ip = 1.0

9. Selection and application of the appropriate seismic design sections of ASCE/SEI 7 shall be the responsibility of the Engineer responsible for the element being designed; however final approval of the selected section of ASCE 7 shall be provided by the Engineer.

1.07 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Where specified in the technical specifications, provide and complete the Certificate of Unit Responsibility form in Section 01 33 00 and submit to Engineer prior to manufacture of components.

C. In addition, submit the following support data along with Certificate of Unit Responsibility:

   1. Certification, signed and sealed by a Professional Structural Engineer registered in the jurisdiction where the project is located, stating that all systems, equipment, and other elements, including supporting structures, attachments and connections are designed to withstand the required seismic and wind forces and displacements.

2. Codes and specifications to which structural design conforms.

D. A copy of this specification section, with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.

E. Manufacturer's information and catalog data showing compliance with this specification and a full description of the product.

F. Design calculations for shoring systems and support and anchorage of equipment and appurtenances. Calculations shall be stamped and signed by a civil or structural engineer currently licensed in the State of Utah and submitted under the appropriate technical specification Section.

G. Submit complete shop drawings and corresponding calculations which thoroughly cover the work elements associated with an area of work being requested for review.

1. Calculations shall be signed and stamped by a civil or structural engineer licensed in the state of Utah and submitted under the appropriate technical specification section.

1.08 SPECIFIC COMPONENTS:

A. Compound Equipment: Connecting elements for equipment combinations such as pumps and motors, valves and operators, engines and generators, etc. which are not capable of transferring seismic and/or wind loads or accommodating seismic and wind displacements shall be protected by appropriate design.

B. Storage Tanks: Tanks, supporting structures and anchorages shall be designed for the weight of the tank, appurtenances and the tank contents at the maximum capacity. Tank contents shall not be considered in resistance to seismic and wind loads.

1. Where applicable include impulsive and convective "sloshing" effects.

2. Component response modification factor for impulsive effects, Ri: In accordance with ASCE 7, Table 15.4-2.

3. Component response modification factor for convective effects, Rc = 1.0.

4. Component importance factor, Ie: Determine in accordance with ASCE 7, Section 15.4.1.1.

C. Ductwork: Equipment installed within ductwork shall be independently supported and braced. Support and bracing of heating and cooling coils shall account for the weight of the contents.

D. Piping Systems: Support and bracing of piping systems shall account for the weight and hydrodynamic effects of the contents.

E. Pressure Piping: Pressure piping support and bracing shall conform to ASME B31 in addition to the force and displacement requirements of the reference code.

F. Sprinkler Systems: Sprinkler system support and bracing shall conform to NFPA 13 in addition to the force and displacement requirements of the reference code.

G. General Supports: Pipe, duct, raceways and cable tray supports and bracing shall conform to the AISC Manual of Steel Construction and MSS SP-58 in addition to the force and displacement requirements of the reference code.

H. Submerged components shall be designed for hydrodynamic sloshing forces.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 01 45 00
QUALITY CONTROL

This specification changes a portion of APWA Standard Specification Section 01 45 00. All other provisions of the Section remain in full force and effect.

Add the following Article to Part 1.

1.7 **QUALITY CONTROL PROGRAM**

A. **Quality Control Program**: Provide a quality control program which includes procedures and organization so equipment, workmanship, fabrication, construction, operations, and inspections comply with the Contract Documents.

B. **Quality Control Program Manager Qualifications**:

1. Not CONTRACTOR's work or site superintendent.
2. Quality control experience with projects of similar type and magnitude.
3. Authorized as CONTRACTOR's representative for all quality control and quality assurance matters.

C. **Quality Control Program Manager Responsibilities**:

1. Manage and supervise quality control plan and quality control surveillance personnel.
2. Verify that testing procedures comply with contract requirements.
3. Verify that facilities and testing equipment are available and comply with testing standards.
4. Check test instrument calibration data against certified standards.
5. Verify that recording forms, including all the documentation requirements, have been prepared.
6. Prepare copies of each test result with all necessary data recorded and with documentation and computations compiled.
7. Provide more testing, if, in ENGINEER's opinion, work is not being adequately controlled.
8. Immediately report any non-compliance of materials and mixes to ENGINEER and CONTRACTOR.
9. When an out-of-tolerance condition exists, perform additional control testing until tolerance is attained.
10. Correlate CONTRACTOR's assurance testing program (APWA Section 01 43 00) with ENGINEER's acceptance testing program (APWA Section 01 45 00).

END OF SECTION

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SECTION 01 45 33

STRUCTURAL TESTS AND INSPECTIONS

PART 1 - GENERAL

1.01 GENERAL:

A. The Structural Engineer of Record (SER) is the Structural Engineer (an individual) who is in responsible charge of the preparation of the structural drawings and structural specifications for this project and whose professional engineering seal appears on said structural drawings.

B. The Program of Structural Tests and Inspections which has been or will be submitted to the building official who has jurisdiction over this project is included in the Contract Drawings.

C. The Structural Tests and Inspections shall not relieve the Contractor or its subcontractors of their responsibilities and obligations for quality control of the Work, their other obligations for supervising the work, for any design work, which is included in their scope of services, and for full compliance with the requirements of the Contract Documents. The detection of, or failure to detect, deficiencies or defects in the Work during the testing and inspection conducted pursuant to the Structural Tests and Inspections shall not relieve the Contractor or its subcontractors of their responsibility to correct all deficiencies or defects, whether detected or undetected, in all parts of the Work, and to otherwise comply with all requirements of the Contract Documents. Further, while the SER, and the Resident Project Representative shall perform certain tasks in the Program requiring the review of certain construction activities, the SER and Resident Project Respresentative shall only perform such tasks to ensure compliance with the SER approved submittals and the specifications. Neither the SER nor the Resident Project Representative shall assume any responsibility or liability for the means, methods, procedures or techniques used by any construction contractor.

D. The program of structural tests and inspection does not apply to the Contractor's equipment, temporary structures used by the Contractor to construct the project, the Contractor's means, methods, and procedures, and job site safety.

1.02 CONTRACTOR'S RESPONSIBILITIES:

A. Where the Program of Structural Tests and Inspections indicates that a structural component or system is subject to structural tests and inspections and that the SER for the project has not been retained to design said component or system or to prepare a performance specification for said component of system, the Contractor shall retain, or require others under Contractor's aegis to retain, a professional engineer registered in the jurisdiction where the project is located to design said component or system and to

provide the required program of structural tests and inspections for said component or system.

B. The Contractor shall provide free and safe access to the Work for the SER and all other individuals who are observing the Work or performing structural tests or inspections. The Contractor shall provide all ladders, scaffolding, staging, and up-to-date safety equipment, all in good and safe working order, and qualified personnel to handle and erect them, as may be required for safe access.

C. The Contractor shall be responsible for all scheduling and coordination of Owner and Contractor's Testing Laboratory Services to comply with testing frequencies and tests required as indicated in the Contract Documents.

D. Building permit applications are submitted by the Engineer through the City's Citizen Access Portal. Inspections required for the project by the building department must additionally be requested through the online Citizen Access Portal by the Contractor. Engineer shall not be responsible for scheduling building department inspections. Engineer and Owner shall not be responsible for any additional costs or delays to the project caused from Contractor delay in getting or requesting building department inspections.

1. Any costs associated with rework or removal to allow access/inspection by building department shall be at Contractor expense.

1.03 CONTRACTOR FURNISHED TESTING LABORATORY SERVICES:

A. An independent commercial testing laboratory acceptable to the Engineer shall perform all tests that require the services of a laboratory to determine compliance with the Contract Documents. The laboratory shall be staffed with experienced technicians, properly equipped, and fully qualified to perform the tests in accordance with the specified standards.

B. Preliminary Testing Services: The Contractor shall be responsible for all testing laboratory services in connection with concrete materials and mix designs, the design of asphalt mixtures, gradation tests for structural and embankment fills, backfill materials, and all other tests and engineering data required for the Engineer's review of materials and equipment proposed to be used in the Work. The Contractor shall obtain the Engineer's acceptance of the testing laboratory before having services performed, and shall pay all costs for services.

C. The Contractor shall not retain any testing laboratory against which the Owner or the Engineer have reasonable objection, and if at any time during the construction process the services become unacceptable to the Owner, or the Engineer, either the Owner or the Engineer may direct in writing that such services be terminated. The request must be supported with evidence of improper testing or unreasonable delay. If the Engineer determines that sufficient cause exists, the Contractor shall terminate the services and engage a different testing laboratory.

D. Transmittal of Test Reports: Written reports of testing and engineering data furnished by the Contractor for the Engineer's review of materials and equipment proposed to be used in the Work shall be submitted as specified for Shop Drawings.

E. The Contractor's testing laboratory shall furnish electronic copies of a written report of each test performed by laboratory personnel within three days after each test is completed.

1.04 OWNER FURNISHED TESTING AND INSPECTION SERVICES:

A. The Owner or the Owner through a subcontract with the Engineer will employ the services of an independent testing agency to conduct the Program of Structural Tests and Inspections as described in the Contract Drawings and perform all quality control tests of materials of construction in the field or in the laboratory during and after their incorporation in the Work. Field sampling and testing shall be performed in the general manner indicated in the specifications, with minimum interference with construction operations.

B. The Contractor shall furnish a construction schedule and a minimum of 24 hour notice of readiness for testing and inspection of the work. The Engineer shall determine the exact time and location of field sampling and testing, and may require such additional sampling and testing as necessary to determine that materials and equipment conform with data previously furnished by Contractor and with the Contract Documents.

C. The Contractor shall schedule the work to permit adequate time for testing and re-testing should test results not conform to the contract documents. Lack of testing or inspection which is attributable to insufficient notice by the Contractor or failure of the Contractor to cooperate, will be cause for rejection of the work.

D. The Contractor shall deliver materials in sufficient quantities to the Owner's testing agency as may be required. Laboratory testing shall be performed within a reasonable time, consistent with the specified standards.

E. The Contractor shall furnish material samples and cooperate in the field sampling and testing activities, interrupting the work when necessary. The Contractor shall furnish personnel, facilities and access to assist in the sampling and testing activities.

F. Contractor shall be responsible for all costs associated with retests as indicated in the General Conditions Paragraph 13.3.B. In addition, Contractor shall be responsible for reimbursement of trip costs and personnel time associated with Owner's material testing services in which Contractor was not ready or prepared and testing laboratory arrives on-site to perform the test.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

ATTACHMENT 01 45 33-1
PROGRAM OF STRUCTURAL TESTS AND INSPECTIONS

Project: [_____]

Location: [_____]

Owner: [_____]

Owner's Address: [_____]

Architect of Record: [_____]

Structural Engineer of Record (SER): [_____]

This program of structural tests and inspections is submitted as a condition for issuance of the building permit in accordance with the International Building Code 2000.

The following firms, agencies, or individuals (hereinafter referred to collectively as agents) will perform the tests and inspections under the direction of the SER:

Abbreviation	Agent
SER	Structural Engineer Of Record Listed Above
RES	The Resident Representative
ITA	Independent Testing Agency Employed By Owner
ITA(C)	Independent Testing Agency Employed By Contractor
RPE(C)	Registered Professional Engineer Employed by Contractor
GEO	The Project Geotechnical Engineer
IWI	Independent Welding Inspector

The above abbreviations will be used on the attached pages to identify which agent is performing the particular tests or inspections.

The following categories of structural tests and inspections, if checked, are included in the program for structural tests and inspections for this project. The specific tests and inspections required for each checked category are listed on the page noted opposite the category and further described in the various technical specification sections.

	Category	Page		Category	Page
☐	**Steel Construction**	**7**	☒	**Controlled Structural Fill**	**13**
☒	**Cast-in-Place Concrete**	**8**	☐	**Pile Foundations**	**14**
☒	**Precast Concrete Construction**	**9**	☐	**Drilled Pier Foundations**	**15**
☒	**Masonry Construction**	**11**	☒	**Aluminum Construction**	**16**
☒	**In-Situ Bearing Strata for Foundations**	**12**	☒	**Special Cases**	**17**

The following items of construction, if checked, are specified in the structural plans or specifications on a performance basis. The structural design of these items will be performed by the RPEC and reviewed by the SER. The construction of these items is included in the program for tests and inspections on the attached sheets.

	Category		Category
☒	**Curtain Walls**	☒	**Metal Buildings**
☒	**Precast Concrete Components**	☐	**Metal Stairs**
☐	**Post-Tensioning Steel**	☐	**Metal Railings**
☐	**Structural Steel Connections**	☒	**Metal and Composite Gratings**
☐	**Structural Aluminum Connections**	☒	**Metal Plate Covers**

The following items are excluded from this program of structural tests and inspections, since other structural engineers not under the aegis of the SER designed them and the SER has no duties or responsibilities with respect to such performance specifications or designs. The Owner shall assign other architects, or construction contractors, as applicable; to be special SER's for their respective designs and such architects and/or contractors shall be responsible for all such structural tests and inspections for their respective designs.

- Seismic design of mechanical or electrical components, systems and their anchorage to the structure.
- Excavation support systems.
- Temporary bracing, temporary platforms, scaffolding, temporary guards and railings.
- Anything related to jobsite safety or construction means and methods.

Structural Engineer of Record:

Name:

Signature:_____
Firm: AECOM
Date:

_____ Registration Seal

STEEL CONSTRUCTION

Item	Agent	Scope	Frequency
1. Fabricator Certification/ Quality Control Procedures.	SER	Review to ensure that quality control procedures have been adopted for each Fabricator.	Start of project
2. Fabricator Inspection	SER	Review to ensure that an Independent Inspection Agency has approved each Fabricator.	Start of project
3. Material Certification	SER	Review for conformance to the specifications.	Each produce
4. Bolting	ITA	Test and inspect bolted connections in accordance with specifications. Verify bolt size and grade in accordance with AISC specifications A325/A490.	Periodic
5. Welding	IWI	Check welder qualifications. Verify filler material in accordance with AWS D1.1. Visually inspect fillet welds. Test complete and partial penetration groove welds full length by dye penetrant, ultrasonic, or radiographic testing in accordance with the contract documents.	Periodic
6. Shear Connectors	IWI	Inspect for size and placement. Test for proper weld attachment.	Periodic
7. Structural Framing, Details and Assemblies	RES	Review for conformance with specifications and shop drawings.	Continuous
8. Open Web Steel Joists	RES	Inspect for size, placement, bridging, bearing and connection to structure.	Continuous
9. Open Web Steel Joists	IWI	Visually inspect all welds of a minimum of 5 percent of the joists, randomly selected.	Periodic
10. Steel Decking	RES/ IWI	Verify gage, width, and type. Inspect placement, laps, welds, side lap attachment and screws or other mechanical fasteners (IWI). Check welder qualifications (RES).	Periodic

CAST-IN-PLACE CONCRETE CONSTRUCTION

Item	Agent	Scope	Frequency
1. Mix Design	ITA(C)	Design concrete mixes	Each mix
	SER	Review mix designs.	Each mix
2. Materials Certification	SER	Review for conformance to specifications.	Each product
3. Batching Plant	ITA/SER	Review to ensure that Plant quality control procedures have been adopted.	Start of project
4. Reinforcement Installation	RES	Inspect reinforcing for size, quantity, condition and placement.	Prior to each placement
5. Formwork Geometry	RES	Inspect form sizes for compliance with specifications.	Prior to each placement
6. Concrete Placement	RES	Review for conformance with specifications.	Each placement
	ITA	Perform slump, density and air content tests at point of discharge.	Each truck
7. Curing and Protection	ITA/RES	Observe procedures for conformance to the specifications.	Each placement
8. Evaluation of Concrete Strength	ITA	Test and evaluate in accordance with the specifications.	Every 50 cubic yards or part thereof
Note: The Contractor may elect to have the Contractor's independent testing agency (ITA(C)) perform additional tests in addition to the testing by the Owner's Independent Testing Agency (ITA) at no cost to the Owner.			

PRECAST CONCRETE CONSTRUCTION

Item	Agent	Scope	Frequency
1. Plant Certification/Quality Control Procedures	SER/ ITA	Review to ensure that Plant quality control procedures have been adopted (SER). Inspect plant storage and handling procedures (ITA). Confirm that approved submittals are being used for fabrication; review welder's certifications (SER). Monitor finished product for structural defects (cracks) (ITA).	Start of project
2. Material Certification	SER	Review for conformance to ACI 318.	Each product
3. Formwork Geometry	ITA	Inspect form sizes.	Selected placements
4. Reinforcement Installation	ITA	Inspect reinforcing and prestressing strands for size, quantity, condition and placement for conformance with Contract Documents, SER approved submittals, and ACI 318. Inspect welding.	Selected placements
5. Mix Design	ITA(C)	Design concrete mixes	Each mix
	SER	Review for conformance with specifications (SER).	Each mix
6. Concrete Placement	RES/ ITA	Inspect concrete placement procedures for conformance to ACI 318, Sections 5.9 and 5.10 (ITA), and for conformance with specifications (RES).	Selected placements
7. Curing and Protection	RES/ ITA	Inspect for maintenance of specified curing temperatures and techniques per ACI 318 (ITA), and for conformance with specifications (RES).	Each placement
8. Evaluation of Concrete Strength	ITA	Test for conformance to specifications in accordance with ACI 318.	Every 50 cubic yards or part thereof
9. Prestress Operation	ITA	Inspect application of prestressing forces per ACI 318. Inspect grouting of bonded, post-tensioned, prestressing tendons.	Selected placements

Item	Agent	Scope	Frequency
10. Assembled/Erected Precast Elements.	RES	Inspect for compliance with SER approved submittals and specifications. Review site storage and handling procedures for consistency with design of precast elements. Verify that SER approved erection drawings are on site and are being used for erection. Verify that SER approved erection procedures are being followed. Review welder's certifications.	Each unit
11. Connections/ Embedded Items	ITA	Inspect interface connections including end and edge doweling. Inspect embedment for proper location. Inspect shimming, bearing, bolting and welding of connections.	Each unit

MASONRY CONSTRUCTION

Item	Agent	Scope	Frequency
1. Material Certification	SER	Review for conformance to specifications.	Each product
2. Evaluation of Masonry Strength	ITA	Verify strength in accordance with the specifications.	Periodic
3. Proportioning, Mixing and Consistency of Mortar and Grout	ITA	Inspect field-mixing procedures for conformance to the specifications.	Continuous
4. Installation of Masonry	RES	Inspect placement for conformance to the specifications.	Continuous
5. Reinforcement Installation	RES/ IWI	Inspect reinforcing steel for conformance to SER approved submittals and specifications (RES) Inspect welding of reinforcement and review welder's certifications (IWI).	Periodic
6. Grouting Operations	RES	Review grouting procedures for conformance with the specifications.	Periodic
7. Weather Protection	RES	Review procedures for protection for cold and hot weather for conformance with the specifications.	Periodic
8. Anchorage	RES	Inspect anchorage of masonry to other construction for conformance with specifications.	Periodic

IN-SITU BEARING STRATA FOR FOUNDATIONS

Item	Agent	Scope	Frequency
1. Bearing strata for foundations	GEO/ RES	Review strata for conformance to the structural drawings, specifications, and/or geotechnical report.	Prior to foundation placement
2. Bearing surfaces of foundations	GEO/RES	Review for conformance to the requirements of the structural drawings, specifications, and/or geotechnical report.	Prior to foundation placement

CONTROLLED STRUCTURAL FILL (PREPARED FILL)

Item	Agent	Scope	Frequency
1. Fill Material	ITA	Test material for conformance to specifications or geotechnical report. Perform laboratory compaction tests in accordance with the specifications to determine optimum water content and maximum dry density.	Each material
2. Installation of Controlled Structural Fill	RES/ ITA	Provide review of the installation, in accordance with the specifications. Verify maximum lift placement thickness (ITA).	Each lift
3. Density of Fill	ITA	Perform field density tests of the in-place fill in accordance with the specifications.	Each lift
NOTE: Above testing is confirmatory testing by the Owner's Independent Testing Agency (ITA). These tests are <u>in addition</u> to the testing required by the Contractor's independent testing agency (ITA(C)).			

PILE FOUNDATIONS

Item	Agent	Scope	Frequency
1. Pile Material	SER/ RES	Review for conformance with the specifications, and that the identification is maintained from the point of manufacture to the point of delivery to the site.	Each pile shipment
2. Pile Material Tests	ITA	If Item 1 is unsatisfactory, test material for conformance to the Contract Documents.	As required
3. Precast Concrete Piles.	-	Perform structural tests and inspections as listed under Precast Concrete Construction.	See precast concrete requirements
4. Steel Piles	-	Perform structural test and inspections as listed under Steel Construction.	See steel construction requirements
5. Pile Installation	RES/ GEO	Provide review for conformance with specifications. Maintain accurate records for each pile. Record final location of each pile in plan.	Continuous
6. Cast-in-Place Concrete Piles	-	Perform structural tests and inspections as listed under Cast-in-Place Concrete Construction.	See cast-in-place concrete construction
Note: Additional confirmatory observations and/or testing by the Owner's independent testing agency (ITA) in addition to the observations and testing required by the Contractor's independent testing agency (ITA(C)) and the Contractor's registered professional engineer (RPE(C)) may be performed at the Owner's discretion.			

DRILLED PIER FOUNDATIONS

Item	Agent	Scope	Frequency
1. Load-bearing Steel Components	SER	Review documents identifying material and certifying grade of material for conformance to the specifications	Each component
2. Concrete and Reinforcing Steel Components	-	Perform structural tests and inspections as listed under Cast-in-Place Concrete Construction.	See concrete requirements
3. Pier installation	RES	Provide review of installation for conformance with specifications. Maintain accurate records for each pier, documenting observations.	Continuous

ALUMINUM CONSTRUCTION

Item	Agent	Scope	Frequency
1. Fabricator Certification/ Quality Control Procedures.	SER	Review to ensure that quality control procedures have been adopted for each Fabricator.	Start of project
2. Fabricator Inspection	SER	Review to ensure that an Independent Inspection Agency has approved each Fabricator.	Start of project
3. Material Certification	SER	Review for conformance to the specifications.	Each product
4. Bolting	ITA	Test and inspect bolted connections in accordance with specifications. Verify bolt size and grade in accordance with AISC specifications A325/A490.	Periodic
5. Welding	IWI	Check welder qualifications. Verify filler material in accordance with AWS D1.1. Visually inspect fillet welds. Test complete and partial penetration groove welds full length by dye penetrant, ultrasonic, or radiographic testing in accordance with the contract documents.	Periodic
6. Structural Framing, Details and Assemblies	RES	Review for conformance with specifications and shop drawings.	Periodic

SPECIAL CASES

Item	Agent	Scope	Frequency
1. Rock Anchors	RES	Witness testing in accordance with contract documents.	Each anchor
2. Pressure Relief Valves	RES	Verify that quantity, location and details conform to SER approved submittals and specifications.	Each valve
3. Tank Leakage Testing	RES	Witness testing in accordance with contract documents.	Each tank
4. Concrete Anchor Installation	RES	Verify diameters, depth and cleaning of holes conforms to manufacturer's instructions.	Each anchor

END OF SECTION

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SECTION 01 50 00

TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. The Contractor shall provide all temporary facilities for the proper completion of the work as indicated and in compliance with Contract Documents.

1. Section Includes:

a. User Charges:

(1) Sewer.

(2) Water.

(3) Electric.

(4) Temporary heat.

b. Project identification.

c. Traffic regulation.

d. Temporary Facilities:

(1) Field offices and sheds.

e. Equipment.

f. Support facility installation.

g. Security and Protection:

h. Operation, termination, and removal.

B. American National Standards Institute (ANSI):

1. A 117.1: Accessible and Usable Buildings and Facilities.

C. American Society for Testing and Materials (ASTM):

1. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

2. E136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 deg. C.

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code

2. 241: Standard of Safeguarding Construction, Alteration, and Demolition Operations

3. 701: Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

1.02 USE CHARGES:

A. General: Costs for installation, removal and use of temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's operation staff, Engineer, testing agencies, and authorities having jurisdiction.

B. Sewer Service: Pay sewer-service use charges for sewer usage by all entities for construction operations.

1. The Contractor shall provide adequate sanitary facilities for the use of those employed on the Work. Such facilities shall be made available when the first employees arrive on the site of the Work, shall be properly secluded from public observation, and shall be constructed and maintained during the progress of the Work in suitable numbers and at such points and in such manner as may be required by pertinent health and safety regulations.

2. The Contractor shall maintain the sanitary facilities in a satisfactory and sanitary condition at all times and shall enforce their use. He shall rigorously prohibit the committing of nuisances on the site of the Work, on the lands of the Owner, or on adjacent property.

a. The Contractor shall not use the Owner's sanitary facilities.

C. Potable Water Service: Obtain from Owner water meter for use of any potable water.

1. The Contractor shall furnish all necessary pipe or hose extensions to conduct the water to the points of use and shall exercise due care not to waste water. The Contractor shall be responsible for acquiring a temporary water meter that can be attached to the water source to monitor water use in accordance with local standards and regulations. The Contractor shall not contaminate the water supply and shall comply with all applicable regulations and code requirements.

2. The Owner reserves the right to limit, suspend, or terminate the supplying of water as set forth above should it consider such action to be necessary on account of damage to the distribution system, the necessity of conserving water, or other

emergency. In this event, the Contractor shall obtain water from some other approved source, at his own expense.

D. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.

1. The Contractor shall make all necessary applications and arrangements and pay all fees and charges for electrical energy for power and light necessary for the proper completion of the Work and during its entire progress. The Contractor shall provide and pay for all temporary wiring, switches, connections, and meters.

2. The Contractor shall provide sufficient electric lighting so that all work may be done in a workmanlike manner when there is not sufficient daylight.

E. Temporary Heat:

1. If temporary heat is required for the protection of the Work, the Contractor shall provide and install suitable heating apparatus, shall provide adequate and proper fuel, and shall maintain heat as required. Costs for temporary heating, cooling, and ventilating required to execute the Work shall be borne by the Contractor.

2. Temporary heating apparatus shall be installed and operated in such manner that finished work will not be damaged thereby. After the permanent heating system has been installed, tested, and made ready for operation, the Contractor may, at his own risk and expense, use it for providing heat for protection of the Work. He shall provide and pay for all fuel and care necessary, and, when the Work is ready for acceptance, he shall, at his own expense, put the system into first-class condition, even to the extent of replacing worn or damaged parts.

3. If permanent natural gas piping is used for temporary heating units, the Contractor shall not modify or reroute gas piping without the prior approval of the natural gas supplier. The Contractor shall provide separate gas metering as required by the natural gas supplier.

1.03 PROJECT IDENTIFICATION:

A. Project Identification Sign:

1. Contractor shall provide one project signs in accordance with 01 58 00.

1.04 TRAFFIC REGULATION:

A. Comply with requirements of Public Way Permit, Traffic Control Permit, and 01 55 26 Traffic Control.

1.05 SUBMITTALS:

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

1.06 QUALITY ASSURANCE:

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.07 PROJECT CONDITIONS:

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

B. During adverse weather and against the possibility thereof, the Contractor shall take all necessary precautions so that the Work may be properly done and satisfactory in all respects. When required, protection shall be provided by use of tarpaulins, wood and building-paper shelters, or other suitable means.

C. During cold weather, materials shall be preheated, if required, and the materials and adjacent structure into which they are to be incorporated shall be made and kept sufficiently warm so that a proper bond will take place and a proper curing, aging, or drying will result. Protected spaces shall be artificially heated by suitable means which will result in a moist or a dry atmosphere according to the particular requirements of the work being protected. Ingredients for concrete and mortar shall be sufficiently heated so that the mixture will be warm throughout when used.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 8 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts.

2.02 TEMPORARY FACILITIES:

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. The Contractor shall maintain a temporary field office near the work for his own use during the period of construction at which readily accessible copies of all contract documents shall be kept. The office shall be located where it will not interfere with the progress of the work. In charge of this office there shall be a competent superintendent of the Contractor.

C. Temporary Storage Yards: The Contractor shall construct temporary storage yards for storage of Products that are not subject to damage by weather conditions.

D. Temporary Storage Buildings:

1. The Contractor shall provide environmental control systems that meet the recommendations of Suppliers and manufacturers of the equipment and materials stored.

2. The Contractor shall arrange for a chain link partition fence to provide security of contents and ready access for inspection and inventory.

E. The Contractor shall store combustible materials (paints, solvents, fuels) in a well ventilated and remote building meeting all applicable safety standards.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.02 TEMPORARY UTILITY INSTALLATION:

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.

C. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

E. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

F. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.

G. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.03 SUPPORT FACILITIES INSTALLATION:

A. General: Comply with the following:

1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according to ASTM E136. Comply with NFPA 241.

2. Maintain support facilities until Engineer schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.

1. Provide dust-control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.

2. Do not use chemical means of dust control without prior written approval from the Engineer. The use of petroleum products will not be allowed at any time.

C. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.

2. Maintain access for fire-fighting equipment and access to fire hydrants.

3. Unless described and approved under a Traffic Control Plan (TCP), conduct operations on the site so that the use of any plant roads by vehicles employed under this Contract will not restrict pedestrian and vehicular traffic thereon nor hinder the use of such facilities.

4. All roads within the plant are used simultaneously by vehicles and pedestrians. The speed limit of 10 mph applies throughout the plant, including the access roads and parking lots. Failure to comply with speed limit or to operate vehicles safely will result in possible removal of the staff from the plant.

D. Parking: Provide temporary areas for construction personnel. The Contractor shall not use public roads or undesignated areas for parking.

E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.

2. Remove snow and ice as required to minimize accumulations.

F. Waste Disposal Facilities: Comply with requirements specified in 01 81 13.01 Sustainable Design Requirements – Envision.

3.04 SECURITY AND PROTECTION FACILITIES INSTALLATION:

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Division 01 Section.

C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant- protection zones.

2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.

4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates. The Owner shall not assume liability for breaches of security on the Contractor's Work Area. It is the Contractor's responsibility to secure its construction materials, tools and equipment. The Owner is not responsible for providing security services, and is not responsible for any loss, theft or damage to any equipment/material within the Contractor's Work Area

1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.

2. Comply with Owner requirements for access to existing Water Reclamation Facility.

F. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.

G. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

H. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

I. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

J. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Prohibit smoking in construction areas.

2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.

3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.05 MOISTURE AND MOLD CONTROL:

A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.

2. Protect stored and installed material from flowing or standing water.

3. Keep porous and organic materials from coming into prolonged contact with concrete.

4. Remove standing water from decks.

5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.

2. Keep interior spaces reasonably clean and protected from water damage.

3. Periodically collect and remove waste containing cellulose or other organic matter.

4. Discard or replace water-damaged material.

5. Do not install material that is wet.

6. Discard, replace, or clean stored or installed material that begins to grow mold.

7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.

2. Use permanent HVAC system to control humidity.

3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.

b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Engineer.

c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.06 CLEANING CONSTRUCTION OFFICES DURING CONSTRUCTION:

A. Contractor to maintain the grounds within his working limits and around any equipment or storage areas. This includes removal of waste material, cutting of grass, weed whacking around storage racks and material, snow plowing and snow shoveling.

B. The Contractor shall make arrangements with, and obtain permits from, any authorities having jurisdiction for disposal of waste and debris.

C. The Contractor shall wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, the Contractor shall sweep all floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up all debris and dispose of off Site.

D. The Contractor shall provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least at weekly intervals, the Contractor shall dispose of such waste materials, debris, and rubbish off Site.

E. At least weekly, the Contractor shall brush sweep entry drive and roadways, and all other streets and walkways affected by the Work and where adjacent to the Work.

3.07 OPERATION, TERMINATION, AND REMOVAL:

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.

2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.

3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

END OF SECTION

SECTION 01 50 10

WEATHER PROTECTION STANDARD

PART 1 - GENERAL

1.01 DESCRIPTION:

A. It is the intent of these standards to require the general contractor to provide temporary enclosures and heat to permit construction work to be carried on year round. These standards are not to be construed as requiring enclosures or heat for operations that are economically infeasible to protect in the judgment of the awarding authority. Included in this category, without limitations, are such items as Site Work, Excavation, Pile Driving, Steel Erection, Erection of Certain Exterior Wall Panels, Roofing, and similar operations.

1.02 WEATHER PROTECTION:

A. "Weather Protection" shall mean the temporary protection of that work adversely affected by moisture, wind and cold by covering, enclosing and/or heating. This protection shall provide adequate working areas year round as determined by the awarding authority and consistent with the accepted construction schedule to permit the continuous progress of all work necessary to maintain an orderly and efficient sequence of construction operations. The General Contractor shall furnish and install all "weather protection" material and be responsible for all costs, including heating required to maintain a minimum temperature of 40 degrees F (4.4 degrees C) at the working surface. This provision does not supersede any specific requirements for methods of construction and/or curing of materials.

B. The General Contractor may, with the approval of the awarding authority, elect to utilize the permanent heating systems for temporary heat after the building is enclosed and after it has been tested and is ready to operate. However, it shall be his responsibility to have all portions of the permanent heating system that are used for heating during construction thoroughly cleaned and restored to first-class condition, to the satisfaction of the awarding authority.

C. Installation of weather protection and heating devices shall comply with all safety regulations including provisions for adequate ventilation and fire protection devices.

D. The General Contractor shall furnish and install dual scale Celsius and Fahrenheit thermometers at places designated by the awarding authority in order to determine if specified temperatures are maintained.

E. Within 30 calendar days after his award of contract, the General Contractor shall submit in writing to the awarding authority for approval, three copies of his proposed methods for "Weather Protection".

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 53 00

MAINTENANCE OF PLANT OPERATIONS DURING CONSTRUCTION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide maintenance of plant operations during construction as indicated and in compliance with Contract Documents.

B. The existing influent pump station will be maintained in continuous operation during the entire construction period as specified herein. The intent of this section is to outline the minimum additional and necessary requirements required of the Contractor to maintain continuous treatment of all wastewater treatment plant facilities and operations throughout the construction period.

1. Limitations on removal of channels, tanks, equipment, conduits, chemical systems, electrical systems and other systems are described.

2. Removal of any portion of existing facilities not described herein shall be planned to maintain service to the greatest extent possible as approved by Owner.

C. Work under this Contract shall be scheduled and conducted by the Contractor so as not to impede any treatment process, reduce the quality of plant effluent or cause odor or other nuisance. In performing the work indicated and specified, the Contractor shall plan and schedule his work to meet the plant operating requirements.

D. Owner will maintain operation of all existing facilities during the construction of the project. The Contractor shall develop his sequence of construction, outage requests and outage work-plans such that all services to on-line facilities are available to Owner to provide unimpeded operation and maintenance during construction. These services will include, but are not to be limited to the following:

1. Safe access to facilities for operations and maintenance staff, vehicles and equipment using plant roads, paths, walkways and other existing physical features.

2. Electrical power for equipment, controls, and lighting.

3. Water for housekeeping, pump seals and bearings.

4. Heating and ventilating and sanitary facilities.

5. Drainage.

6. Process and equipment controls and instrumentation.

7. Railings and toe plates around all open channels and tanks and slab openings.

E. The Contractor shall be responsible for coordinating the general construction and demolition, electrical, mechanical, HVAC, instrumentation, plumbing and other disciplines' construction schedules to ensure that temporary requirements are met for maintaining the operation of all existing pump station facilities that are required to be on line at any given time.

F. After the Contractor has developed and submitted its detailed Work Plan and outage request, the Contractor, the Engineer and Owner's operations and maintenance staff shall meet to review the proposed Work Plan and outage request. The meeting purpose shall be to solicit Plant staff recommendations, limitations and necessary changes to the proposed Work Plan.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Sustainable Design Submittals.

B. Temporary Bulkhead Design Drawings and Calculations, Signed and Sealed by a Professional Structural Engineer, registered in the State of Utah, for each proposed Bulkhead location.

1. To the greatest extent possible at each location indicate all field verified dimensions, depths, locations of existing adjacent piping, equipment, conduits, etc.

2. Include copies of all available existing construction drawings documenting the existing construction and geometry of the area where each bulkhead is to be installed.

3. Provide step-by-step installation sequence and schedule for each bulkhead location.

4. Provide step-by-step removal sequence and schedule for each bulkhead location.

5. Comply with all requirements stated in the Project Manual for Temporary Flow Isolation.

C. Outage Requests:

1. Submit outage request a minimum of 14 days prior to the requested outage start date.

2. Submit outage request only after work plan, bulkhead design, flow isolation design and strategy, etc. have been previously submitted and reviewed and commented on.

3. Include all proposed methods, equipment and plan for transferring or dewatering contents of the existing pipe(s), conduits, tanks, channels, etc.

D. Work Plans:

1. Where required for large, complicated or long-term outages and/or tie-ins, provide more detailed and comprehensive written work plan in addition to the outage request. Include information such as:

a. Detailed description of the work in step-by-step manner from start to finish.

b. Work Schedule and Work Times

c. Labor forces anticipated

d. Materials and equipment required

e. Special tools required

f. Safety Plan

g. Lighting and HVAC plan.

h. Work supervisor’s name and contact information

i. Full time (24 hr/day, 7 days/week) emergency contact

j. Daily and final clean-up

k. Traffic maintenance plans

2. Required Work Plan submittals are defined herein.

E. All outage requests and Work plans will be subject to Owner review and shall be modified as necessary to accommodate Owner requirements and concerns and Plant's operation, maintenance and delivery schedules.

1.03 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sustainability Standards Certifications.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.07 GENERAL CONSTRAINTS:

A. The Contractor shall schedule all Work so that the existing influent pump station and all pump station systems are maintained in continuous operation. All treatment processes shall be maintained in continuous operation during the construction period except during approved interruptions.

B. All system shutdowns, complete or partial, temporary or extended, must be approved by Owner. Each request for shutdown shall be submitted a minimum of 14 calendar days prior to the planned start of the shutdown. When required by Owner, requests for shutdown shall include a written workplan with details of the Contractor's proposed work schedule, labor forces, materials, special tools and equipment, safety plan, etc. If in the judgment of Owner, a requested shutdown is not required for the Contractor to perform the Work, the Contractor shall utilize approved alternative methods to accomplish the Work.

C. All shutdowns shall be coordinated with and scheduled at times approved by Owner. The scheduling and duration of tie-ins and connections that require process interruptions or removal of equipment from service, or are dependent on process operations, performance requirements, flow of wastewater, or weather as related to flow rate, shall be coordinated with and approved by Owner based on field conditions and consideration of the above listed factors.

D. Wherever possible, process interruptions shall be scheduled during low flow periods. All night work premiums, overtime and other costs related to scheduling of process interruptions shall be borne by the Contractor. Shutdowns shall not begin until all required materials are verified to be on site and ready for installation. Each shutdown period shall commence at a time approved by Owner, and the Contractor shall proceed with the Work continuously, start to finish, until the Work is completed and normal plant operation is restored. If the Contractor completes all required Work before the specified shutdown period has ended, Owner may immediately place the existing system back into service.

E. The Contractor shall schedule short-term and extended shutdowns in advance and shall present all desired shutdowns in the construction schedules. Contractor shall allow a minimum 7-day "window" for each shutdown when assembling his initial construction schedule, Actual shutdowns and shutdown duration and times shall be fully coordinated with Owner. Owner personnel shall operate Owner's facilities involved in the short-term and extended shutdowns and diversions, unless otherwise noted. Denial of an outage or shutdown request for a specific date shall not entitle the Contractor to an extension in the contract time.

F. Short term shutdowns in plant systems will be allowed for tie-ins to existing facilities, installation of temporary bulkheads, shoring, and similar construction activities. All such shutdowns shall be scheduled for low-flow periods or low demand periods as applicable to the plant operation. The Contractor shall provide appropriate diversion facilities to be approved by Owner, and at no additional cost to Owner, when the plant services cannot be shut down for a sufficiently long time to accomplish the required work. The schedule and duration of short-term shutdowns shall be at the discretion of Owner.

G. Any temporary work, facilities, roads, walks, protection of existing structures, piping, blind flanges, valves, equipment, protection of existing open channels and basins and other items that may be required within the Contractor's work limits to maintain continuous and dependable plant operation shall be furnished, installed, and maintained by the Contractor at the direction of Owner at no extra cost to Owner.

H. Owner shall have Work stopped or prohibit Work that would, in his opinion, unreasonably result in interrupting the necessary functions of the plant operations.

I. If the Contractor impairs the performance or operation of the plant as a result of not complying with specified provisions for maintaining plant operations, then the Contractor shall immediately make all repairs or replacements and do all work necessary to restore the plant to operation to the satisfaction of Owner. Such work shall progress continuously to completion on a 24-hours per day, seven work days per week basis.

J. The Contractor shall provide the services of emergency repair crews on call 24-hours per day.

K. Protection of Existing Facilities and Structures:

1. The Contractor shall plan all work and develop all sequences of construction such that the structural and functional integrity of all existing facilities and structures surrounding the work areas are maintained and protected from damage which may impede or interrupt plant operations. This shall include, but is not limited to:

    a. Protection of existing structures and facilities from damages due to site excavation, site dewatering, drilling of foundation piers and excavation shoring, driving of foundation piling, etc.

    b. Protection of existing structures and facilities from damages due to impact by heavy construction or delivery equipment, tools, lifted or conveyed loads, etc.

    c. Protection of existing structures and facilities from damages due to impact from hoisting mishaps or accidents, crane failure, crane collapse, etc.

    d. Protection of the interior surfaces and/or liquid contents of existing structures and facilities, tankage, channels, etc. from damages or contamination which are detrimental to their intended wastewater treatment

process or function due to: hoisting mishaps or accidents; spillages or leakage from construction equipment or fuel tanks; construction debris; etc.

2. As used herein, "damage" shall include:

   a. Any new cracking, leakage, settlement, tilting position or alignment shifting, obvious areas of impact damage, etc. to the surfaces of each existing structure observed throughout the construction period.

   b. Any sudden or unexplained changes in normal operating water levels or volume capacities of tanks, channels, etc. surrounding the construction area due to observed cracking, leakages, settlement, etc. of portions of the existing structure, or perceived to be due to similar cracking, leakages, settlements, etc. affecting portions of the existing structure not visible or exposed.

   c. The potential for damage to existing structures due to failures (or the observed instability or potential for future failure) of the Contractor's excavations, shorings, site dewatering systems, etc. which, if uncorrected could lead to, or contribute to, physical damage to the plant's existing structures and facilities.

3. All such damages shall immediately be investigated by the Contractor and the Engineer upon their observation, and a written report prepared by the Contractor and submitted to Owner within 30 calendar days following their observation. Reports shall be prepared and sealed by a Registered Structural Engineer licensed in the State of Utah. Reports shall include:

   a. Full assessment of the locations, nature and extent of the damage.

   b. Temporary corrective action and repairs to be made, and the Contractor's schedule therefor.

   c. Permanent corrective action and repairs to be made, and the Contractor's schedule therefor.

   d. The effect of such temporary and permanent repairs on the Contractor's overall construction schedule and his ability to meet all construction milestones. Include recovery schedules as necessary to demonstrate that such corrective repairs shall be planned and made using means and methods which will not cause delay to the overall construction schedule or the Contractor's failure to achieve the construction milestones as specified.

   e. All damages to existing facilities and structures surrounding the work areas shall be promptly repaired, to the satisfaction of Owner, at the Contractor's expense.

f. Repairs of damages to existing facilities and structures shall not be cause or source of claims filed by the Contractor (or his subcontractors or vendors) against Owner for time delay or additional compensation.

1.08 TEMPORARY FLOW ISOLATION:

A. If installation of temporary bulkheads and/or portable cofferdams is required for completion of the Work. Any temporary device, structure, stoplog, gate or bulkhead required to isolate channels, tanks, conduits, pipelines, or other existing work for construction shall be designed, fabricated, installed, maintained and removed by the Contractor. These items shall be placed at a location selected by the Contractor and approved by Owner. Owner owned stop logs shall not be used by the Contractor for temporary flow isolation.

B. Where temporary devices, structures, stoplogs, gates or bulkheads are placed into active channels, the maximum open area possible shall be provided to maintain flow with minimum disruption of plant hydraulics and without flooding of tanks, conduits, or other plant facilities. The sizing, design and water-tightness of all such temporary devices, structures, stoplogs, gates or bulkheads shall be provided by the Contractor and shall be:

1. Design drawings and calculations shall be submitted three (3) weeks prior to scheduled fabrication of cofferdams and/or bulkheads. Submittal shall include description of proposed installation methods, special labor requirements such as underwater divers, localized removal of settled solids and anticipated sequences of bulkhead installation and bulkhead removal.

2. The design submittal shall have been reviewed and be acceptable to Owner prior to the Contractor's submittal of the outage request and Work Plan for which the bulkhead is to be used.

3. Contractor shall be responsible for field measurements, fabrication, installation, maintenance and removal of the temporary bulkheads and/or portable cofferdams.

4. Temporary flow isolation Work may also require localized removal of varying depths of settled solids to clear the channel or basin area in the immediate area where the Work is required.

C. Existing stop log grooves may be used by the Contractor for temporary flow isolation at the Contractor's risk. Owner does not warrant or guarantee that the grooves are acceptable for temporary flow isolation.

1.09 GENERAL OPERATING REQUIREMENTS, CONSTRAINTS, AND CONSTRUCTION REQUIREMENTS:

A. Plant Traffic: Must be maintained in accordance with the General Requirements and Special Provisions to all plant buildings and facilities. Maintain a minimum of one-way traffic access to Contractor's work areas for emergency response access.

B. Personnel Access: Treatment plant personnel shall have safe access to all areas that remain in operation throughout the construction period. The Contractor shall locate stored material, dispose of construction debris and trash, provide temporary walkways and fall protection, provide temporary lighting, and other such work as to maintain personnel access to areas in operation. Access and adequate parking areas for plant personnel must be maintained throughout construction. Temporary chain link fencing or equivalent barrier shall be maintained around the periphery of all excavations, trenches and other hazardous areas to preclude inadvertent access by treatment plant personnel.

C. Electrical and Control Demolition Work:

1. All switching to de-energize existing cables and equipment will be performed by Owner personnel.

2. Prior to any electrical demolition work, the Contractor shall perform final testing and shall demonstrate to Owner that all associated electrical and control conductors, cables, fiber optic / communication cables, have been disconnected and made harmless; and that all temporary and / or permanent replacement services have been provided.

3. Any ductbanks, manholes or other structures / piping encountered which are not indicated on the Contract Drawings shall be left intact until such time as a determination is made by the Owner as to the necessary disposition of the item.

4. Electrical and control service to equipment which is to remain in service shall be relocated and fed by new power sources and new or existing control interfaces and the equipment energized and demonstrated prior to demolition of the original electric and control service connections and feeders.

5. Where the relocated power sources or control interfaces are not indicated in the Contract Documents, the Contractor shall submit power/control connection location(s) for Owner review and approval.

D. Power, Light and Communications Systems:

1. Electric power, lighting service and communications systems shall be maintained in uninterrupted operation in all areas.

2. Individual units may be disconnected as required for replacement, but service shall be available at all times including periods when certain plant utilities are out of service.

3. The Contractor shall coordinate shutdowns required in order to minimize the total number of shutdowns necessary to complete construction. Owner's phone service to the plant shall be maintained in continuous operation during construction.

E. Temporary Power:

1. Temporary Power shall be provided as required.

2. Contractor has the option of using a standby generator to provide temporary power, subject to approval by Owner and unless otherwise specified in the contract documents. Any temporary generator shall be insulated to keep noise to a minimum.

F. Protection of Existing and New Facilities:

1. The Contractor shall be required to provide bulkheads and cover sufficient to protect all equipment and electrical components from damage due to weather elements, including but not limited to rain, snow, wind, hail, sleet, and other weather events.

G. Draining Process Pipes, Tanks, Channels and Conduits:

1. The contents of all pipes, tanks, channels, structures and conduits to be removed, demolished, replaced or relocated (or dewatered for a specific purpose) shall be transferred to a suitable facility in a manner approved by Owner through hoses, vacuum hoses, or piping, or by using pumps if hydraulic conditions so require them.

2. The Contractor shall provide the pumps, piping and hoses at no additional cost to Owner.

3. No uncontrolled spillage of a pipe, tank, or conduit shall be permitted. Any spillage, other than potable water, shall be immediately contained, cleaned up and properly disposed of in a manner acceptable to Owner and the surrounding plant areas and structures cleaned of residual spilled materials.

H. Settled Solids Removal:

1. Following the dewatering of existing operating channels, basins, tanks, etc., varying depths of settled solids and grit may be encountered. Such settled solids and grit shall be removed by the Contractor and disposed of on-site as hereinafter described in order to provide clear, clean and safe working areas for the Contractor's Work, In the preparation of bids for this Project, the following shall be used as "baseline" settled solids depths and volumes expected to be encountered and which shall be removed and disposed of by the Contractor:

a. Existing Semielliptical Pipeline: Up to a 1-foot average depth over the entire pipeline's floor area. (Note: Settled solids removal within an existing structure shall be carefully conducted in such a manner to not impact, disturb or damage any existing equipment or piping within the structure's interior area).

b. Volumes of settled solids encountered in excess of the volume anticipated by the above baseline average depths shall be reported immediately to the construction manager. Such excess volume shall be measured by the Contractor and construction manager and, after receiving authorization for its removal and disposal by Owner, shall be paid for as a negotiated change order to this Contract

c. Solids and grit removed shall be transported by the Contractor to the Plant's Septage Receiving Station (SRS) where it shall be discharged. Quantities and scheduling of such discharge shall be coordinated with Plant Management and Operations.

d. Solids and grit removal activities shall be conducted in such a manner so as to not leave large accumulations of removed solids, water, etc. on the roadways, walkways and operating surfaces surrounding the tankage. All such surface areas shall be thoroughly flushed and cleaned of all sludge and grit residue at the end of each working day.

I. Potable Water System:

1. Potable water service shall be maintained in continuous service at all times during construction except for short term interruptions required for tie-ins.

2. Shutdown of the potable water system shall be fully planned and coordinated at least fourteen (14) days in advance with Owner and shall be limited to not more than two (2) hours.

3. Existing fire hydrants within the plant site shall be maintained operational at all times, unless otherwise approved by Owner.

J. Reuse Water System (W3):

1. The existing W3 services shall be maintained in continuous operation during construction except for short term tie-ins of new or temporary facilities to existing facilities.

2. The Contractor may require temporary support or relocation or demolition of existingW3 facilities to complete the work as shown. The Contractor shall provide all temporary supports, relocation of existing piping, or demolition of existing W3 piping including replacement with temporary or permanent W3 piping as required at no additional cost to Owner.

3. Shutdowns of the W3 system shall be fully planned and coordinated at least 14 days in advance with Owner.

K. Networked Systems:

1. When a networked system is to be modified, the Contractor shall not be allowed to modify the system until notification has been given to Owner.

2. Upon completion of modifications to a networked system, the Contractor must demonstrate that the networked system works for all components, including those previously connected to the network and those most recently added.

3. Once components have been connected to a networked system, interruptions to data flow shall not be permitted.

PART 2 - PRODUCT

(Not Used)

PART 3 - EXECUTION

3.01 PREPARATION:

A. Submit, and receive Owner's approval of, outage request, electrical switching/de-energizing request (if applicable), (and detailed workplan where applicable) prior to final scheduling of the Work.

B. Prior to commencement of any outage, Contractor and Owner shall jointly verify that all necessary equipment, tools, materials, etc. are on-site and ready for utilization throughout the outage and/or the Work Plan's execution.

C. Prior to commencement of any outage, provide photograph documentation of condition of existing facilities, structures, buildings, equipment, etc. within and immediately surrounding the work area.

3.02 SPECIFIC CONSTRAINTS:

A. The following specific constraints are based on concept designs of anticipated connections with the existing plant and provide minimum requirements that must be implemented to maintain plant operations. The Contractor shall prepare a specific plan during final design to define the requirements to the satisfaction of Owner for each interface and connection with the existing plant facilities, systems and utilities.

B. Connection to new junction structures (Beck Street, Orange Street, 1800 N) constructed by others.

1. Required Work: Bypass pumping as necessary to dewatering new sewer junction structures to connect to extension from MH#3.

C. Relocation of existing overhead power lines:

1. Required Work: Coordinate with Rocky Mountain Power to relocate overhead power lines. Coordinate and sequence earthwork required to not undermine relocated power poles as shown on drawing 0100-E111 and 0100-E112.

a. Disruption time:

(1) Coordinate with Rocky Mountain Power on acceptable outages for service.

3.03 EXECUTION:

A. Owner will release facilities for construction in accordance with the Contractor's Outage Requests and Work Plans which have been previously reviewed by Owner.

B. Execute Work diligently and in compliance with the Contract Documents and as detailed in Contractor's Work Plan(s) for the specific work area or outage request and within the outage time limitations.

C. For long-term work provide regular written updates to work plan's schedule to advise plant and construction manager of all anticipated activities, truck traffic and field inspection requirements.

D. Contractor shall plan, schedule and perform all work so as to minimize interference operations of the facility and the work of other Contractors.

E. Attend and participate in Contract Coordination Meetings.

3.04 PROCESS INTERFACING:

A. Distribution of Responsibility:

1. Owner’s Responsibility:

a. Owner will operate all fixed and existing pumps, gates, sluice gates, valves, circuit breakers, switches, and instrumentation.

b. Owner will make operational changes in the existing plant as described in the Contractor' s Sequence of Construction.

2. Contractor's Responsibility:

a. The Contractor shall be responsible for all other activities.

b. Fines for violation of the discharge permit due to the specified or scheduled shutdown times being exceeded shall be the responsibility of the Contractor.

END OF SECTION

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SECTION 01 55 26
TRAFFIC CONTROL

This specification changes a portion of APWA Standard Specification Section 01 55 26. All other provisions of the Section remain in full force and effect.

Change paragraph 1.2 D. to read as follows.

1.2 **REFERENCES**

D. Manual on Uniform Traffic Control Devices for Streets and Highways published by the American Traffic Safety Services Association (ATSSA), 15 Riverside Parkway, Suite 100, Fredericksburg, Virginia, 22406-1717, U.S. Department of Transportation Federal Highway Administration, 2009 Edition of MUTCD.

END OF SECTION

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SECTION 01 57 00
TEMPORARY CONTROLS

This specification changes a portion of APWA Standard Specification Section 01 57 00. All other provisions of the Section remain in full force and effect.

Change the following paragraph in **Article 3.2 DUST AND MUD CONTROL** to:

C. At a minimum, dust and mud control efforts shall include a daily sweeping of the work area streets. One sweeping shall take place at the end of the workday at a minimum, if needed additional sweeping shall take place midway through the workday. Additional efforts may be required as determined by the ENGINEER, OWNER, SWPPP inspector, or other representative.

Add the following paragraph in **Article 3.2 DUST AND MUD CONTROL**:

D. Contractor shall prepare, submit and implement a Fugitive Dust Control Plan with the Utah Department of Environmental Quality, Division of Air Quality.

Change the following paragraph to **Article 3.3 SURFACE WATER CONTROL** to:

A. Control all on-site surface water. Provide proper drainage so flooding of the site or changed flow conditions including path, quantity or quality onto an adjacent property does not occur.

Add the following paragraph to **Article 3.3 SURFACE WATER CONTROL**:

F. CONTRACTOR shall prepare a Storm Water Pollution Prevention Plan (SWPPP) specifically for this project in compliance with Salt Lake City and State of Utah requirements for Stormwater Discharges Associated with Construction and Land Disturbance Activities. CONTRACTOR shall comply with all Clean Water Act, City Ordinance and SWPPP requirements for the project.

G. Some minimum erosion control and storm water protection components have been identified. These do not constitute all necessary components of a comprehensive SWPPP.

1. For projects less than one acre the CONTRACTOR shall provide all labor, equipment, materials, and services necessary to complete the work.
    a) Site Map: Showing boundaries and BMPs that will be implemented.
    b) Concrete washout: Describe in detail how concrete washout will be contained.
    c) Concrete/Road cutting (must be contained): Describe in detail how concrete & road cutting dust and pollutants will be contained.
    d) Housekeeping BMPs: Describe in detail general housekeeping e.g. restroom (port-a-potty), dumpster(s), roll off container or cans, etc.
    e) Erosion/sediment controls: Describe in detail the boundary controls to be used e.g. inlet protection, silt fence, fiber rolls, wattle, cut back, etc.
    f) Offsite tracking prevention: Describe in detail how you will mitigate tracking dirt/mud outside of construction boundaries in compliance with the City's Clean Wheel Ordinance.
    g) De-watering: Describe in detail BMPs that will be used to de-silt the discharge before entering a waterway/storm drain e.g. de-watering bag, filter sock, check down dam, frac tank, etc.
2. The CONTRACTOR shall identify type and placement of BMPs.
3. The CONTRACTOR shall be responsible for implementation and maintenance of all BMPs.

4. The CONTRACTOR shall perform weekly inspections of the site for the duration of the project. Note: Inspection shall include housekeeping, placement and condition of all BMPs.
5. The CONTRATOR shall be responsible stabilizing and removing all temporary BMPs at the conclusion of the job.
6. If work is being performed outside the boundaries of Salt Lake City the CONTRACTOR shall contact the MS4 operator and comply to any additional stormwater pollution prevention requirements for that jurisdiction.

H. If CONTRACTOR is assessed fines for not meeting permit requirements, those costs will not be passed onto the OWNER.

Change the following paragraph to **Article 3.4 GROUND WATER CONTROL** to:

C. Remove all dewatering facilities meeting inspector requirements when no longer required.

Add the following **Article 3.7 Sanitation to Part 3 – Execution**

3.7 Sanitation

A. Toilet Facilities: Provide portable chemical toilets at each active work site or staging area for the use of employees. Toilets at construction job sites shall conform to the requirements of Part 1926 of the OSHA Standards for Construction.
    1. Furnish at least one portable toilet at each active work site.

END OF SECTION

SECTION 01 57 13

EROSION CONTROL, SEDIMENTATION AND CONTAINMENT OF CONSTRUCTION MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide all work and take all measures necessary to control soil erosion resulting from construction operations, prevent flow of sediment from construction site, and contain construction materials (including excavation and backfill) within protected working area as to prevent damage to any stream or wetlands as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. United Stated Environmental Protection Agency (USEPA):

1. Guidelines for Erosion and Sediment Control, Planning and Implementation.

2. Processes, Procedures and Methods to Control Pollution Resulting from all Construction Activity.

B. Stormwater Pollution and Preventation Plan

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Two weeks prior to the start of the work, submit to Engineer, for review, a plan with detailed sketches showing the proposed methods to be used for controlling erosion during construction.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Use acceptable procedures, including use of water diversion structures, diversion ditches, settling basins, and sediment traps.

C. Operations restricted to areas of work indicated on drawings and area which must be entered for construction of temporary or permanent facilities.

D. If construction materials are washed away during construction, remove materials from fouled areas.

E. Stabilize diversion outlets by means acceptable to Engineer.

F. Engineer has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill operations and to direct immediate permanent or temporary pollution control measures to prevent contamination of any stream or wetlands, including construction of temporary berms, dikes, dams, sediment basins, sediment traps, slope drains, and use of temporary mulches, mats, or other control devices or methods to control erosion.

PART 2 - PRODUCTS

2.01 BALES:

A. Hay or straw or other suitable material acceptable to Engineer.

2.02 WOOD STAKES:

A. 2 inches by 2 inches by 3 feet.

PART 3 - EXECUTION

3.01 GENERAL:

A. Do not discharge chemicals, fuels, lubricants, bitumen, raw sewage and other harmful waste into or alongside any body of water or into natural or man-made channels.

B. Design erosion and sediment controls to handle peak runoff resulting from storm events.

C. The Contractor shall be responsible for inspecting and maintaining these control measures to ensure their proper function and adequate sediment storage at all times. The Contractor shall remove sediment once it reaches 50 percent of the capacity of the structure. Sediment collected shall be disposed of offsite at the Contractor's cost.

3.02 INSTALLATION:

A. Install baled hay or straw erosion checks in all locations as directed, surrounding base of all deposits of stored excavated material outside of disturbed area, and where directed by the Engineer.

B. Install checks immediately after site is cleared and before trench excavation. Locate checks, surrounding stored material, approximately 6 feet from material.

C. Hold bales in place with two 2 inches by 2 inches by 3 feet stakes so that each bale is butted tightly against adjoining bale thereby precluding shortcircuiting of erosion check.

D. Construct earth berms or diversions to intercept and divert runoff water from critical areas.

E. Discharge silt-laden water from excavations onto filter fabric mat and/or baled hay or straw sediment traps to ensure that only sediment-free water is returned to watercourses.

F. Do not place excavated soil material adjacent to water-course in manner that will cause it to wash away by high water or runoff.

G. Prevent damage to vegetation by excessive watering or silt accumulation in the discharge area.

H. Do not dump spoiled material into any streams, wetlands, surface waters, or unspecified locations.

I. Prevent indiscriminate, arbitrary, or capricious operation of equipment in streams, wetlands or surface waters.

J. Do not pump silt-laden water from trenches or excavations into surface waters, streams, wetlands, or natural or man-made channels leading thereto.

K. Prevent damage to vegetation adjacent to or outside of construction area limits.

L. Do not dispose of trees, brush, debris, paints, chemicals, asphalt products, concrete curing compounds, fuels, lubricants, insecticides, washwater from concrete trucks or hydroseeders, or any other pollutant in streams, wet-lands, surface waters, or natural or man-made channels leading thereto, or unspecified locations.

M. Do not alter flow line of any stream unless indicated or specified.

END OF SECTION

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SECTION 01 58 00
PROJECT IDENTIFICATION AND SIGNS

PART 1 GENERAL

1.1 SECTION INCLUDED

A. Temporary on-site identification and informational signs to identify key elements of construction facilities and traffic routing.

1.2 SUBMITTALS

A. Sketch of informational signs.

1.3 QUALITY ASSURANCE

A. Sign Painter: Professional experienced in type of work required.
B. Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

PART 2 PRODUCTS

2.1 SIGN MATERIALS

A. Structure and Framing: May be new or used, wood or metal, in sound condition, structurally adequate to work and suitable for specified finish.
B. Sign Surfaces: Exterior grade plywood
   1. Type 4'x4': 4-feet high by 4-feet wide
   2. Thickness: As required by standards to span framing members, resist wind loading, and to provide an eve, smooth surface without waves or buckles.
C. Rough Hardware: Galvanized steel or equal.
D. Paint: Exterior quality
   1. Background: White
   2. Lettering: Black
   3. Accents: Green

PART 3 EXECUTION

3.1 PROJECT INDENTIFICATON SIGNS

A. Content to include:
   1. Title of Project
   2. City logo and motto
   3. Name of Mayor
   4. Names of City Council members and the district they represent
   5. Names of professional consultants and their titles
   6. Name of ENGINEER and title
   7. Name of CONTRACTOR
B. Graphic design, style of lettering, colors: See Drawing
C. Paint exposed surfaces of supports, framing, and surface material; one coat of primer and one coat of exterior paint.
D. Erect on the site at a lighted location of high public visibility, adjacent to the main

entrance to the site, as approved by ENGINEER.

3.2 INFORMATIONAL SIGNS

A. Size of signs and lettering: As required by regulatory agencies, or as appropriate to usage.
B. Colors: As required by regulatory agencies, otherwise of uniform colors throughout project.
C. Paint exposed surfaces: One coat of primer, and one coat of exterior paint.
D. Paint graphics in styles, sizes, and colors selected.
E. Install at a height for optimum visibility, on ground-mounted poles, or attached to temporary structural surfaces.

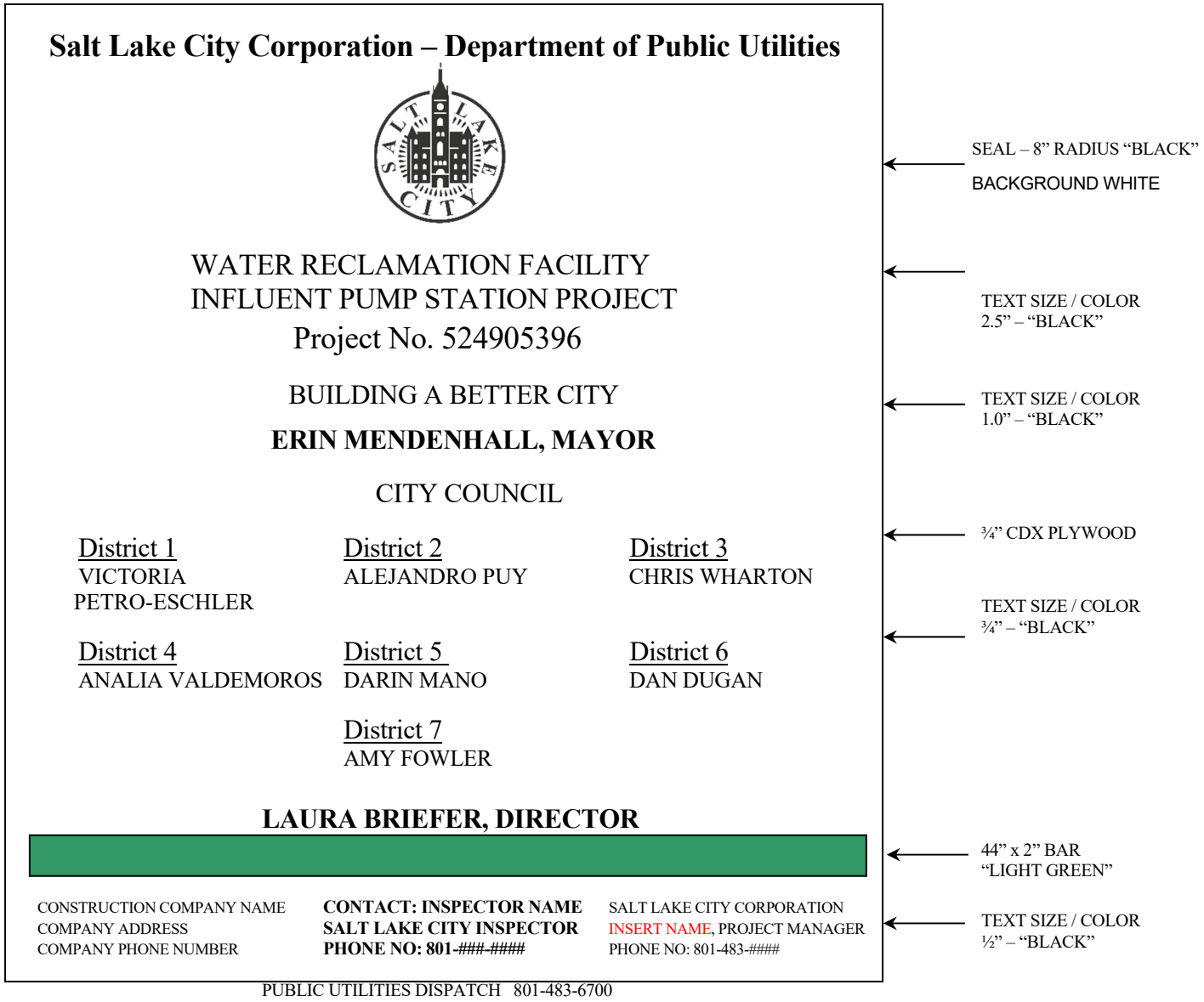
3.3 MAINTENANCE

A. Maintain signs and supports in a neat, clean condition; repair damages to structure, framing, or sign.
B. Relocate information signs, as required by progress of the Work.
C. Remove graffiti from signs immediately.

3.4 REMOVAL

A. Remove signs, framing, supports, and foundations at completion of Project.
B. Repair landscaping, and surface improvements damaged by removal.

PROJECT IDENTIFICATION SIGN
USE WITHIN SALT LAKE CITY LIMITS



4' x 4' PROJECT SIGN ATTACHED TO WOODEN OR METAL POSTS

NOTE: SEE APWA SPECIFICATION 01 58 00 FOR DETAILED INFORMATION REGARDING PROJECT SIGNS.

END OF SECTION

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SECTION 01 61 00

CONTROL OF MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

1. Section Includes:

a. Definitions.

b. Submittals.

c. Spare parts.

d. Quality assurance.

e. Delivery, storage and handling.

f. Warranty.

g. Products.

h. Substitution and “Or Equal” items.

i. Reuse of existing material.

j. Manufacturer’s instructions.

k. Special tools.

l. Lubrication.

m. Nameplates.

n. Loads and seismic forces.

o. General material and equipment requirements.

p. Materials and Equipment.

q. Field Quality Control; Installation, Instructional, and Post Startup Services.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B1.1: Unified Inch Screw Threads (UN and UNR Thread Form)

B. American Society for Testing and Materials International (ASTM):

1. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A325: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

1.03 DEFINITIONS:

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.

2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.

1.04 SPARE PARTS:

A. Provide spare parts for Products as specified in the individual technical specification sections. Comply with the requirements specified in Section 01 61 00.

B. Pack spare parts to protect them during storage. Tag spare parts and containers to clearly identify them in accordance with Contractor’s parts numbering system as reviewed by the Engineer. All parts shall be cross-referenced to their applicable the Specification Section.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Arrange deliveries of materials and equipment in accordance with construction Progress Schedule, coordinate to avoid conflict with Work and conditions at site.

B. Comply with the requirements of APWA Section 01 66 00.

C. Provide equipment and personnel to handle materials and equipment by methods recommended by manufacturer to prevent soiling or damage to materials or equipment, or their packaging.

D. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

E. Owner assumes no responsibility for damage or loss due to storage of materials and equipment.

F. Interior Storage:

1. Store with seals and labels intact and legible.

2. Store materials and equipment subject to damage by elements in weathertight enclosures.

3. Maintain temperature and humidity within ranges required by manufacturer’s instructions.

G. Exterior Storage:

1. Store fabricated materials and equipment above ground, on blocking or skids, to prevent soiling or staining. Cover materials and equipment subject to deterioration with impervious sheet coverings. Provide ventilation to avoid condensation.

2. Store loose granular materials in well-drained area on solid surfaces to prevent mixing with foreign matter.

3. Store materials such as pipe, reinforcing steel, structural steel, and equipment on pallets or racks, off ground.

H. Inspection and Maintenance:

1. Arrange storage to provide easy access for inspection, maintenance, and inventory.

2. Make periodic inspections of stored materials and equipment to ensure materials and equipment maintained under specified conditions are free from damage or deterioration, and coverings are in-place and in condition to provide required protection.

3. Perform maintenance on stored material and equipment in accordance with manufacturer’s written instructions and in presence of Owner or Engineer.

a. Notify Engineer 24 hrs before performance of maintenance.

b. Submit report of completed maintenance and condition of coverings to Engineer with each Application for Payment.

c. Failure to perform maintenance, to notify Engineer of intent to perform maintenance or to submit maintenance report may result in rejection of material or equipment.

I. Assume responsibility for protection of completed construction and repair and restore damage to completed Work equal to original condition.

J. Wheeling of loads over finished floors, with or without plank protection, is not permitted in anything except rubber-tired wheelbarrows, buggies, trucks or dollies. This applies to finished floors and exposed concrete floors, as well as those covered with composition tile or other applied surfacing.

K. Where structural concrete is also finished surface, avoid marking or damaging surface.

1.07 WARRANTY:

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.

2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.

3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

1.08 PRODUCTS:

A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

1.09 SUBSTITUTION AND “OR EQUAL” ITEMS:

A. Follow the procedures in Section 01 25 00.

1.10 ACCEPTANCE OF MATERIALS:

A. Unless otherwise specified, only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the Contractor shall be subject to the inspection and acceptance of the Engineer. No material shall be delivered to the work without prior acceptance of Engineer.

B. As specified in Section 01 33 00, the Contractor shall submit to the Engineer, data relating to materials and equipment he proposes to furnish for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications.

C. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, the Contractor shall submit additional samples or materials for such special tests as may be necessary to demonstrate that they conform to the specifications. Such samples shall be furnished, stored, packed, and shipped at the Contractor's expense. Except as otherwise noted, the Owner will make arrangements for and pay for the tests.

D. Any delay of acceptance resulting from the Contractor's failure to submit samples or data promptly shall not be used as a basis of a claim against the Owner or the Engineer.

E. In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, types, finishes, and surfaces, the Contractor shall provide such samples of workmanship or finish as may be required.

F. The materials and equipment used on the work shall correspond to the accepted samples or other data.

1.11 MANUFACTURER’S INSTRUCTIONS:

A. Installation of equipment and materials shall comply with manufacturer’s instructions. Obtain and distribute printed copies of such instructions to parties involved in installation, including 2 copies to Engineer.

1. Maintain one set of complete instructions at Site during installation and until completion of Work.

B. Handle, store, install, connect, clean, condition, and adjust materials and equipment in accordance with manufacturer's written instructions and in conformance with Specifications.

1. If Site conditions or specified requirements conflict with manufacturer's instructions, consult Engineer for further instructions. Do not proceed with Work without written instructions.

1.12 SPECIAL TOOLS:

A. For each type of equipment furnished, the Contractor shall provide a complete set of all special tools (including grease guns or other lubricating devices) which may be necessary for the adjustment, operation, maintenance, and disassembly of such equipment. Tools shall be high-grade, smooth, forged, alloy, tool steel. Grease guns shall be lever type.

B. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment.

C. Pack items to protect them during storage. Tag items and containers to clearly identify them in accordance with Contractor's part system, as reviewed by the Engineer. Cross-reference all items to their applicable Specification Section.

D. Special tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such special tools until completion of the work, at which time they shall be delivered to the Owner.

E. The Contractor shall furnish and erect one or more steel wall cases with flat key locks and clips or hooks to hold each tool in arrangement.

1.13 LUBRICATION:

A. Where lubrication is required for proper operation of equipment, incorporate necessary and proper provisions in equipment in accordance with manufacturer's requirements. Where possible, lubrication shall be automated and positive.

B. Where oil is used, reservoir shall be of sufficient capacity to supply unit for 24 hr period.

C. Provide adequate and, as far as practicable, automatic means of lubrication for working parts. Arrange lubrication grease nipples, grease boxes and other lubrication devices so that they are readily accessible for routing greasing using grease nipples and Type 316 stainless steel or copper tubing extensions where required. Secure nipples and tubing to the equipment at appropriate locations. Indicate on the working drawings submitted, the types of lubricants to be used (must be readily available in State of Utah). Use grease nipples of a consistent type, Alemite button head type or equivalent. Provide grease gun(s) of the appropriate size(s) and pressure(s).

D. Provide a one (1) year supply of all lubricants necessary for the routine, daily operation of the equipment. All lubricants to be readily available in State of Utah. Provide a complete schedule of all the lubricant including the manufacturer name, type, name and local address and phone number of where each lubricant can be purchased for each piece of equipment.

1.14 NAMEPLATES:

A. With the exceptions mentioned below, each piece of equipment shall be provided with a nameplate of non-corrodible metal, securely fastened in place and clearly and permanently inscribed with the manufacturer's name, model or type designation, serial number, principal rated capacities, electrical or other power characteristics, and similar information.

B. This requirement shall not apply to standard, manually operated hydrants or to gate, globe check and plug valves.

C. Each process valve shall be provided with a substantial tag of non-corrodible metal securely fastened in place and inscribed with an identification number in conformance with the Valve Identification Schedule indicated on the drawings or furnished later by the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT:

A. Material and Equipment Incorporated into Work:

1. Conform to applicable specifications and standards.

2. Comply with size, make, type, and quality specified or as accepted by Submittal.

B. Manufactured and Fabricated Materials and Equipment:

1. Design, fabricate, and assemble in accordance with engineering and shop practices standard with industry.

2. Manufacture like parts of duplicate units to standard sizes and gauges, to be interchangeable.

3. Two or more items of same kind shall be identical, by same manufacturer.

4. Material and equipment shall be suitable for service conditions.

5. Equipment capabilities, sizes, and dimensions shown or specified shall be adhered to, unless variations are specifically accepted, in writing.

6. Equipment shall be adapted to best economy in power consumption and maintenance. Parts and components shall be proportioned for stresses occurring during continuous or intermittent operation, and for additional stresses occurring during fabrication or installation.

7. Design so working parts are readily accessible for inspection and repair, easily duplicated, and replaced.

8. Design structural members of equipment for anticipated shock and vibratory loads.

9. Design machinery such that working parts are readily accessible for inspection and repair, and that each part is suitable for the service required.

C. Do not use material or equipment for purpose other than for which it is designed or specified.

PART 3 - EXECUTION

A. General:

1. Provide on-site services of Supplier's representatives for equipment provided by Contractor during construction, installation, equipment startup, and training of Owner's personnel for equipment or plant operation as specifically required in Specification section for equipment or system.

2. Include and pay costs for Supplier's services.

3. Work day is defined as 8 hr period during Owner's or Contractor's typical calendar day. Work day for purposes of this section does not include travel to or from Site.

4. Specifications include minimum mandays to provide basis for bidding. If additional time is required to perform services Contractor shall include that time in Contract Price.

B. Installation Services:

1. Where installation services are called for in Specifications, provide competent and experienced technical representatives of manufacturers of material or equipment and systems to resolve assembly or installation procedures attributable to, or associated with, equipment furnished.

2. After equipment is installed, representatives shall perform initial equipment and system adjustment and calibration to conform to Specifications and manufacturer's requirements and instructions.

3. Provide “Certificate of Installation Services” stating proper adjustments have been made to equipment or system and equipment or system is ready for startup and system demonstration. Use Form 01 61 00-1 and furnish 2 copies to Engineer.

C. Training:

1. Comply with Section 01 78 24.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

FORM 01 61 00-1
EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTALLATION SERVICES

Owner - _____

Project - _____

Contract No. _____

AECOM No. _____

EQUIPMENT SPECIFICATION SECTION_____

EQUIPMENT DESCRIPTION_____

I_____, Authorized representative of
(Print Name)

_____
(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.
on

Date:_____ Time:_____

CERTIFIED BY:_____DATE:_____
(Signature of Manufacturer's Representative)

FORM 01 61 00-2
EQUIPMENT MANUFACTURER'S CERTIFICATE OF POST STARTUP SERVICES

Owner - _____

Project - _____

Contract No. _____

AECOM No. _____

EQUIPMENT SPECIFICATION SECTION_____

EQUIPMENT DESCRIPTION_____

I_____, Authorized representative of
(Print Name)

_____
(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

Post Startup Services for the subject project (has) (have) been performed in a satisfactory manner, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit(s) on

Date:_____ Time:_____

CERTIFIED BY:_____DATE:_____
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGMENT OF POST STARTUP SERVICES

(I) (We) the undersigned, authorized representatives of the Owner and/or Plant Operating Personnel have received Post Startup Services for the equipment as required by the contract on:

_____ Date: _____

END OF SECTION

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SECTION 01 71 13
MOBILIZATION AND DEMOBILIZATION

This specification changes a portion of APWA Standard Specification Section 01 71 13. All other provisions of the Section remain in full force and effect.

Add the following paragraph:

1.5 **SUBMITTALS**

A. Project Video Recording: Video record the project area prior to commencing construction in accordance with Section 01 32 33 Construction Video. The ENGINEER's representative shall be present during recording. The recording shall be performed on foot, noting all salient existing features in the project area and the location of the recording shall be clearly indicated. "Drive-by" video recording will not be accepted. The video recording shall be submitted to the ENGINEER a minimum of 5 days prior to starting construction.

END OF SECTION

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SECTION 01 73 29

CUTTING, CORING AND PATCHING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Section Includes:

1. Alterations to existing buildings or structures.

2. Cutting, coring, and patching.

B. All cutting, coring, and rough patching shall be performed by the Contractor. Finish patching shall be the responsibility of the Contractor and shall be performed by the trade associated with the application of the particular finish.

C. Work Includes:

1. Alterations:

a. Cutting, moving or removal of items as shown on Drawings.

b. Cutting, moving or removal of items not shown to be cut, moved or removed, but which must be cut, moved or removed to allow new Work to proceed. Patch or reinstall Work or items which are to remain in finished Work after cutting, moving or removal, and make joints and finishes match adjacent or similar Work.

c. Removal of existing surface finishes as needed to install new Work and finishes.

d. Removal of abandoned items and removal of items serving no useful purpose, such as piping and electrical conduit.

e. Repair or removal of dangerous or unsanitary conditions.

f. Removal of unsuitable or extraneous materials not marked for salvage, such as abandoned furnishings, debris, grease buildup, rotted wood, rusted trench covers, and deteriorated concrete and masonry.

2. Cutting and Patching:

a. Uncovering Work for installation of ill-timed Work.

b. Removal and replacement of defective Work and Work not conforming to Contract Documents.

c. Uncovering Work to provide observation by Engineer or inspection or tests by others of covered Work.

d. Removal of samples of installed materials for testing.

e. To make several parts fit properly.

3. Temporary enclosures and services.

1.02 REFERENCES:

A. American Society for Testing and Materials International (ASTM):

1. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

1.03 ALTERATIONS, CUTTING, AND PROTECTION:

A. Survey and record condition of existing facilities to remain in-place that may be affected by alteration operations. After alteration work is complete, survey conditions again and restore existing facilities to pre-alteration condition.

B. Perform Work of moving, removal, cutting, and patching with trades qualified to perform Work in manner causing least damage to each type of Work.

1. Cut finish surfaces such as masonry, tile, plaster or metals, by methods to terminate surfaces in straight line at natural point of division.

C. Protect existing finishes, equipment, and adjacent Work which is to remain, from damage.

1. Protect existing and new Work from weather and extremes of temperature.

a. Maintain existing interior work area above 60 degrees F (15 degrees C).

b. Provide weather protection, waterproofing, heat, and humidity control as needed to prevent damage to remaining existing and new Work.

D. Provide shoring, needling, and bracing to keep building(s) or structures structurally secure and free of damaging deflection for installation of new structural members.

E. Do not pile material to endanger building or structure.

1.04 HOLES IN EXISTING CONCRETE:

A. When the Contractor is required to make new holes in existing concrete for piping, conduit, cables, or equipment, the Contractor shall accurately and carefully mark out the locations and the extent of cutting required and coordinate with the trade(s) involved. The Contractor shall make new holes using one of the methods described below:

1. Prior to drilling any openings, the Contractor shall determine the location, if any, of existing services concealed in and/or behind the construction to be drilled. X-ray the walls or slabs, if required to determine the location.

2. The Contractor shall chip with an electric hammer with chisel point. Adjust the location of holes as necessary to avoid electrical conduits if encountered. Cut reinforcing steel after permission is received.

1.05 SECURITY:

A. When keys to locked areas are needed to provide access to areas to perform Work, obtain from Owner. Return keys at end of each day's Work.

1.06 PROTECTION AND CONTINUITY OF UTILITIES AND OPERATIONS:

A. Protect existing utilities so they will continue to function during and after construction.

B. Where interference with such facilities occurs, cooperate with Owner of facility and, if necessary, alter facility to eliminate interference.

C. Service Continuity:

1. Provide and maintain continuous electrical, plumbing, and HVAC services to functioning portions of process, building, facilities, or areas during hours normally in use.

2. Temporary outages are permitted during cutover Work at such times and places as can be pre-arranged with Owner. Keep such outages to minimum number and length of time. Make no outages without prior acceptance.

3. Include costs for temporary equipment, materials, and Work required in Contract Price.

4. Remove temporary equipment and materials when no longer required or at completion of Work.

D. Plant Operation:

1. Maintain continuity of pump station operation to functioning portions of existing pump station.

2. Temporary shutoff is permitted during cutover Work at such times and places as can be pre-arranged with Engineer and Owner. Keep such shutoffs to minimum number and length of time and, once Work has started on temporary shutoff, continue until Work is complete. Make no shutoffs without prior acceptance. Shutoff of existing sewer lines is not permitted and will require bypass pumping.

3. Include costs for temporary piping and Work required in Contract Price.

4. Remove temporary piping when no longer required or at completion of Work.

1.07 TEMPORARY ELECTRICAL AND MECHANICAL SERVICES:

A. Comply with Section 01 50 00.

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Concrete repair shall adhere to Section 03 01 30.

2.02 SALVAGED MATERIALS:

A. Salvage sufficient quantities of cut or removed material to replace damaged Work of existing construction or patch new Work when material not readily obtainable on current market.

2.03 PRODUCTS FOR PATCHING, EXTENDING, AND MATCHING:

A. Provide same products, salvaged materials, types of construction or finish as that in existing structure, as needed to patch, extend or match existing Work.

1. Generally, Contract Documents will not define products or standards of workmanship present in existing construction, determine products by inspection and necessary testing and workmanship by use of existing as sample of comparison.

PART 3 - EXECUTION

3.01 GENERAL:

A. All cutting and coring shall be performed in such a manner as to limit the extent of patching.

B. All holes cut through concrete and masonry walls, slabs or arches shall be core drilled unless otherwise accepted. No structural members shall be cut without acceptance of the Structural Engineer of Record and all such cutting shall be done in a manner directed by him. No holes may be drilled in beams or other structural members. All work shall be performed by mechanics skilled in this type of work.

C. Rough patching shall be such as to bring the cut or cored area flush with existing construction unless otherwise shown. Finish patching shall match existing surfaces.

3.02 PREPARATION:

A. Where new work conceals existing surfaces or spaces Contractor shall remove foreign substances such as accumulated dirt, dust, grease, sludge, and odoriferous material before concealing existing surfaces.

B. Where surfaces are to remain exposed Contractor shall remove foreign substances described above.

3.03 TEMPORARY ENCLOSURES:

A. Exterior: Provide temporary weathertight enclosure for successive areas of building as Work progresses, to provide:

1. Acceptable working conditions.

2. Weather protection for materials.

3. Effective temporary heating.

4. Prevention of entry by unauthorized persons.

B. Relocate as required by progress of construction, by storage or Work requirements, and to accommodate requirements of Owner and other contractors employed at site.

C. Remove temporary materials, equipment, and services:

1. When construction needs can be met by use of permanent construction.

2. At completion of Project.

3.04 REMOVAL, RELOCATION AND SECURING MATERIALS AND EQUIPMENT:

A. Where existing materials and equipment are removed or relocated, remove materials no longer used such as studs, straps, conduits, ducts, wires, anchors, piping and supports. Remove or cut off concealed or embedded materials such as conduit, boxes, anchors, piping or other materials to not less than 3/4-inches below finished surface.

B. Materials that cannot be removed shall be secured to adjacent structure to prevent coming loose.

C. Repair affected surfaces to conform to type, quality, and finish of adjacent surfaces.

3.05 CUTTING:

A. Inspect existing conditions of Work, including components subject to damage or movement during cutting, patching, excavating or backfilling.

B. After uncovering Work, inspect conditions affecting installation of new materials.

C. Do not cut or notch structural members without specific written acceptance of Engineer.

D. Cutting shall be performed with a concrete saw and diamond saw blades of proper size.

E. Corners of square or rectangular openings shall be cored. Do not overcut corners of openings. Corners shall be chipped out square, if required, so as not to cause cracking at the corners.

F. Provide for control of slurry generated by sawing operation on both sides of element.

G. When cutting reinforced concrete, the cutting shall be done so as not damage bond between the concrete and reinforcing steel left in structure. Cut shall be made so that steel neither protrudes nor is recessed from face of the cut.

H. Adequate bracing and/or shoring of area to be cut shall be installed prior to start of cutting. Check area during sawing operations for cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.

I. Provide equipment of adequate size to remove cut panel.

3.06 CORING:

A. Coring shall be performed with an accepted non-impact rotary tool with diamond core drills. Size of holes shall be suitable for pipe, conduit, sleeve, equipment or mechanical seals to be installed.

B. Provide protection for existing equipment, utilities and critical areas against water or other damage caused by drilling operation.

C. Slurry or tailings resulting from coring operations shall be removed from the area following drilling.

3.07 PATCHING:

A. Prepare surfaces to receive cementitious repair mortar in accordance with manufacturer’s instructions.

B. Mix the cementitious repair mortar material components in accordance with the manufacturer's instructions. Concrete surfaces should be surface saturated dry (SSD) with no standing water prior to mortar application.

C. Work a wet scrub coat of the mortar per the manufacturer's recommendations into the pores and voids in the substrate and over the substrate prior to mortar application by trowel.

D. Apply the cementitious repair mortar using a steel trowel to work the material into the surface. Fill voids from deepest to shallowest areas as the application work proceeds. Strictly follow the manufacturer's application requirements.

E. Once the repair areas are filled with repair mortar, strike off the mortar level with the surrounding concrete substrate. Do not leave a broom finish. Finish with a steel trowel until closed up at the surface and flat.

F. Cure the repair mortar in strict accordance with the manufacturer's instructions.

3.08 CLEANING:

A. Perform periodic and final cleaning as specified in Section 01 74 23, and:

1. Clean Owner-occupied areas daily.

2. Clean spillage, overspray, and heavy collection of dust in Owner-occupied areas immediately.

B. At completion of alterations work in each area, provide final cleaning and return space to condition suitable for use by Owner.

C. Remove debris from site each day. Removed material, except that listed or marked by Owner for retention, becomes property of Contractor.

3.09 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 01 74 23

CLEANING UP

PART 1 - GENERAL

1.01 SUMMARY:

A. Execute cleaning during progress of Work and at completion of Work as indicated and in compliance with Contract Documents.

B. Refer to specification sections for specific cleaning for Products or Work.

1.02 DISPOSAL REQUIREMENTS:

A. Conduct cleaning and disposal operations to comply with local codes, ordinances, regulations, and anti-pollution laws. Do not burn or bury rubbish or waste materials on Project site. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains. Do not dispose of wastes into streams or waterways.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Use only those cleaning materials which will not create hazards to property and persons or damage surfaces of material to be cleaned.

B. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

PART 3 - EXECUTION

3.01 CLEANING DURING CONSTRUCTION:

A. At all times maintain areas covered by the contract and adjacent properties and public access roads free from accumulations of waste, debris, and rubbish caused by construction operations.

B. During execution of work, clean site, adjacent properties, and public access roads and dispose of waste materials, debris, and rubbish to assure that buildings, grounds, and public properties are maintained free from accumulations of waste materials and rubbish. Unneeded construction equipment shall be removed and all damage repaired so that the public and property owners will be inconvenienced as little as possible.

C. Wet down dry materials and rubbish to lay dust and prevent blowing dust.

D. Cover or wet excavated material leaving and arriving at the site to prevent blowing dust. Clean the public access roads to the site of any material falling from the haul trucks.

E. Where material or debris has washed or flowed into or been placed in existing watercourses, ditches, gutters, drains, pipes structures, work done under this contract, or elsewhere during the course of the Contractor's operations, such material or debris shall be entirely removed and satisfactorily disposed of during the progress of the work, and the ditches, channels, drains, pipes, structures, and work, etc., shall, upon completion of the work, be left in a clean and neat condition.

F. On or before the completion of the work, the Contractor shall, unless otherwise especially directed or permitted in writing, tear down and remove all temporary buildings and structures built by him; shall remove all temporary works, tools, and machinery or other construction equipment furnished by him; shall remove, acceptably disinfect, and cover all organic matter and material containing organic matter in, under, and around privies, houses, and other buildings used by him; shall remove all rubbish from any grounds which he has occupied; and shall leave the roads and all parts of the premises and adjacent property affected by his operations in a neat and satisfactory condition.

G. Provide on-site containers for collection and removal of waste materials, debris, and rubbish in accordance with applicable regulations.

3.02 FINAL CLEANING:

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.

d. Remove tools, construction equipment, machinery, and surplus material from Project site.

e. Remove snow and ice to provide safe access to building.

f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

h. Sweep concrete floors broom clean in unoccupied spaces.

i. Vacuum clean concrete/tile floors in occupied spaces.

j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.

k. Remove labels that are not permanent.

l. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

m. Vacuum inside and outside of all new and existing electrical panels, MCCs, variable speed drives, etc., which have been affected by dust or dirt due to construction activities.

n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.

o. Replace disposable air filters and clean permanent air filters. Vacuum clean exposed surfaces of diffusers, registers, and grills.

p. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.

q. Leave Project clean and ready for occupancy.

C. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 81 13.01.

D. Electrical Contractor shall touch-up paint or repaint damaged finishes on electrical items delivered to Project with finish coat of paint. Engineer will make final determination of items to be repainted or touched-up.

E. Prior to substantial completion or Owner occupancy, Contractor with Engineer and Owner**,** shall conduct inspection of sight-exposed interior and exterior surfaces and work areas to verify Work and site is clean.

3.03 CLEANING OF WASTEWATER TANKS:

A. Wet wells, tanks, and basins shall be washed down and swept before wastewater is allowed to enter.

END OF SECTION

SECTION 01 77 00

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following as indicated and in compliance with Contract Documents:

1. Substantial Completion procedures.

2. Final completion procedures.

3. Warranties.

4. Final cleaning.

5. Repair of the Work.

6. Specific closeout and special cleaning requirements for the Work in those Sections.

7. Approved Operation and Maintenance Manuals

8. Record Drawings

9. Spare Parts

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

D. Certificates of Release: From authorities having jurisdiction.

E. Certificate of Insurance: For continuing coverage.

F. Schedule of maintenance materials.

1.04 SUBSTANTIAL COMPLETION PROCEDURES:

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 20 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.

2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.

3. Submit closeout submittals specified in individual Divisions 02 through 33 Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

4. Submit maintenance material submittals specified in individual Divisions 02 through 48 Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number where applicable.

a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Engineer’s signature for receipt of submittals.

5. Submit test/adjust/balance records.

6. Submit sustainable design submittals required in Specification 01 81 13.01.

7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 20 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.

2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner’s personnel of changeover in security provisions.

3. Complete startup and testing of systems and equipment.

4. Perform preventive maintenance on equipment used prior to Substantial Completion.

5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Division 01 Section "Training."

6. Advise Owner of changeover in heat and other utilities.

7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.

8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

9. Remove labels that are not permanent labels.

10. Complete final cleaning requirements, including touchup painting.

11. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 20 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

2. Results of completed inspection will form the basis of requirements for final completion.

1.05 STARTING OF SYSTEMS:

A. Conform to the requirements of Section 01 78 23, Section 01 78 24 and Section 01 78 25.

B. Coordinate schedule for start-up of various equipment and systems.

C. Notify Engineer seven days prior to start-up of each item.

D. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

E. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.

F. Verify wiring and support components for equipment are complete and tested.

G. Execute start-up under supervision of applicable manufacturer's representative in accordance with manufacturers' instructions.

H. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, approve equipment or system installation prior to start-up, to supervise placing equipment or system in operation, and to train the Owner's staff.

I. Submit a written report in accordance with Section 01 33 00 that equipment or system has been properly installed and is functioning correctly.

1.06 DEMONSTRATION AND INSTRUCTIONS:

A. Conform to the requirements of Sections 01 78 23, 01 78 24 and 01 78 25.

B. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at designated location.

D. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

E. Required instruction time for each item of equipment and system is specified in individual sections.

1.07 PROJECT RECORDS DOCUMENTS:

A. The Contractor shall provide Record Documents in accordance with Section 01 78 39.

B. Certificates of Substantial Completion and Final Completion shall not be issued until record drawings are reviewed and verified to be complete, and the Contractor has satisfied all requirements for Substantial Completion and Final Completion of the package Work.

1.08 EQUIPMENT INVENTORY SPREADSHEET

A. As part of the Owner's asset management program, the Contractor shall complete all fields for the equipment inventory file for each piece of equipment and device provided under this Contract, as a requirement for Substantial Completion. An electronic format of the equipment inventory spreadsheet will be provided to the successful General Contractor.

1.09 PROTECTING INSTALLED CONSTRUCTION:

A. Protect installed Work and provide special protection where specified in individual specification sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

1.10 SPARE PARTS AND MAINTENANCE PRODUCTS:

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections.

B. Deliver to location as directed by Owner; obtain receipt prior to final payment.

C. Coat parts to protect from moisture.

D. Crate in containers designed for prolonged storage suitable for handling with hoisting equipment containers.

E. Stencil on containers:

1. Manufacturer/supplier name

2. Unit name

3. Spare part name

4. Manufacturer catalogue number

5. Other identifying information

6. Precautionary information

1.11 FINAL COMPLETION PROCEDURES:

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to General Conditions.

2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.12 LIST OF INCOMPLETE ITEMS (PUNCH LIST):

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order.

2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

3. Include the following information at the top of each page:

a. Project name

b. Date

c. Name of Engineer

d. Name of Contractor

e. Page number

4. Submit list of incomplete items in the following format:

a. MS Excel electronic file. Engineerwill return annotated file.

b. PDF electronic file. Engineer will return annotated file.

1.13 SUBMITTAL OF PROJECT WARRANTIES:

A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents in accordance with Specification 01 78 36.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 FINAL CLEANING:

A. General: Perform final cleaning in accordance with Section 01 74 23.

B. Construction Waste Disposal: Comply with waste disposal requirements in 01 81 13 .01

3.02 REPAIR OF THE WORK:

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

   a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

3.03 ADJUSTING:

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes procedural requirements for providing, compiling and submitting operation and maintenance data required for this project.

B. The SLCWRF utilizes a computerized maintenance management system (CMMS) for asset management. This software (Nexgen) allows for the import of asset data if setup properly. To aid in this process, the FORM (FORM 01 78 23 sample provided at the end of specification) has been updated as an electronic PDF such that the data may be exported after the form has been filled out. Electronic versions of this form will be provided to the Contractor for completion. The FORM is generic and the CMMS software is setup by equipment classes where asset data differs by equipment class. As a result, a version of the FORM is provided for each equipment class. Examples of equipment classes are pump, valve, motor, etc. The Contractor shall fill out a form for each asset. Not all equipment that will require an asset FORM may be listed on the P&ID, assets that need to be tracked in the CMMS system are determined by DPU and a FORM will be provided to the Contractor.

1.02 SUMMARY:

A. This section includes administrative and procedural requirements for preparing operation and maintenance manuals and the CMMS asset management forms, including the following:

1. General contents of data.

2. Specific data for each equipment and system.

3. Manual for materials and finishes.

4. Assembly.

1.03 DEFINITIONS:

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

C. The term ‘Supplier’ shall be considered interchangeable with the term ‘Manufacturer’ when Manufacturer is directly supplying equipment to Contractor.

1.04 SUBMITTALS:

A. O&M Manual Content: Operations and maintenance manual submittal requirements are specified in individual Specification Sections for the Products for which they must be supplied. Submit reviewed manual content formatted and organized by this Section.

1. Engineer and Owner will comment on whether content of operations and maintenance submittals are acceptable.

2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Initial O&M Manual: Submit draft copy of each manual electronically for review and approval prior to shipment of major process or electrical equipment. Engineer will comment on whether general scope and content of manual are acceptable. Engineer shall have the discretion on what equipment constitutes 'major process or electrical equipment'.

C. Pre-Final Manual Submittal: Submit each manual electronically in final form prior to training and requesting inspection for Substantial Completion.

1. Equipment supplier shall revise each manual to comply with Engineer's comments and address any revisions requested by Engineer.

D. Submit one (1) hardcopy and final electronic manual after training, startup, testing and commissioning which includes any revisions made to the equipment during this period to reflect the conditions in the field.

E. CMMS Asset management forms once completed by suppliers and verified to be accurate and complete by Contractor.

1.05 FORMAT (O&M MANUAL HARDCOPY):

A. Prepare data in the form of an O&M instructional manual.

B. Binders: Commercial quality, 8-1/2 x 11-inch three-hole post type binders with hardback, 3-inch maximum binder size. When multiple binders are used, correlate data into related consistent groupings. Three ring binders are not acceptable.

C. Arrange contents by Specification Section numbers and sequence of Table of Contents of this Project Manual.

D. Provide tabbed fly leaf for each separate product and system, with printed description of product and major component parts of equipment. Insert type tab labels must be secured or bonded to prevent the labels from falling out.

E. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.

F. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages and insert into clear plastic envelopes that can be secured into the three-hole post binders. Data Sleeve: Provide each binder with a separate dedicated data sleeve for holding a copy of the final O&M manual on a flash drive. Flash drives placed directly into the binder cover sleeve shall not be acceptable.

1.06 FORMAT (O&M MANUAL ELECTRONIC DOCUMENTATION):

A. The Contractor must provide Operation and Maintenance Manual information specific to the configuration of the project in electronic form. Documents should be formatted like a web site complete with index page and Table of Contents. The electronic format must be such that the Owner is able to load the files onto a server to provide online access via any standard web browser. The Contractor shall make use of HTML (for text based documents) and PDF (for CAD type drawings) file formats.

B. The electronic O&M data must be organized in a logical manner to aid operation in troubleshooting and information retrieval. PDF type files shall be bookmarked to each major section for ease of navigation and all text within the document must be searchable. Photos or scans included within the O&M data which cannot be searched will not be acceptable.

1.07 QUALITY ASSURANCE:

A. Preparation of data shall be performed by personnel:

1. Trained and experienced in O&M of described equipment.

2. Familiar with requirements of this section.

3. Skilled as technical writers to the extent required to communicate the essential data to the Reader.

4. Skilled as drafters competent to prepare any required drawings.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 GENERAL CONTENTS OF O&M MANUAL DATA:

A. Each individual manual shall contain equipment data pertaining to not more than one Specification section number as indicated in the Contract Documents.

B. Title Sheet: First page in data listing following:

1. Title: "OPERATION AND MAINTENANCE INSTRUCTIONS".

2. Title of Project: As shown on Contract Documents.

3. Name(s) of applicable building(s) or structure(s) in which equipment is located.

4. Name of equipment as described in Contract Documents.

5. Supplier's name, address, and telephone number.

6. Supplier's purchase order number, manufacturer's shop order number or other such numbers required for parts and service ordering.

7. Manufacturer's name, address, and telephone number.

8. Name, address, and telephone number for local source of supply for parts and service.

C. Equipment List: Immediately following title sheet containing the following:

1. Table of Contents: Immediately following equipment list. Arrange in logical, systematic order and shall include as minimum bookmarked dividers. Each page shall be numbered.

2. Tabbed Dividers: Insert tabbed section dividers between each major section

a. Provide title of section on each tab.

b. Provide table of contents for each tabbed section, arranged in systematic order.

3. Equipment Data Sheets: Provide catalog sheets showing configuration, manufacturer's specifications, models, options, and styles of equipment and major components being provided. Product data sheets will show project specific information with inapplicable information deleted by crossing out or removal. Include in tabbed section(s).

4. Text:

a. Include only those sheets applicable to Project.

b. Each sheet shall:

(1) Identify specific equipment or part installed.

(2) Identify text applicable to equipment or part installed.

(3) Do not include inapplicable information or neatly strike it out.

c. All text must be searchable. Scans or photos will not be acceptable.

5. Drawings:

a. Supplement text with drawings to clearly illustrate following:

(1) Equipment and components.

(2) Relations of component parts of equipment and systems.

(3) Control and flow diagrams.

b. Actual drawings of equipment from manufacturer. "Typical" drawings are not acceptable, unless they accurately illustrate actual installation for this contract.

c. Drawings must be clear and generated by their native software. Documents must be searchable. Scans or photos will not be acceptable.

6. Specially written information, as required to supplement text for particular installation.

a. Provide explanation of interrelationships of equipment and components, and effects one component has on another or entire system.

b. Provide overall instructions and procedures for equipment tying in instructions and procedures for separate components into unified instructional package.

c. Provide glossary of any special terms used by the manufacturer if applicable.

d. Organize in consistent format under separate headings for different O&M procedures.

e. Provide logical sequence of instructions in order of O&M action required for each procedure.

3.02 CMMS REQUIREMENTS FOR EQUIPMENT:

A. Each asset form shall already contain the following information provided by the Engineer:

1. Project Name
2. Contract Number
3. Equipment Tag
4. Contractor
5. Equipment Tag
6. Equipment Name
7. Equipment Description
8. Equipment Class, which shall include but not be limited to:

a. Actuator
b. Air Dryer
c. Air System
d. Backflow
e. Blower
f. Boiler
g. Chemical Feed System
h. Chiller
i. Chlorinator
j. Chlorine Ring
k. Compressor
l. Condensate Trap
m. Control Panel
n. Conveyor
o. Cover
p. Crane
q. Cyclone
r. Diffuser
s. Digester
t. Drive Unit
u. Electrical Equipment
v. Elevator
w. Engine
x. Equipment
y. Expansion Tank
z. Fan
aa. Filter
bb. Flame Arrestor Unit
cc. Flare
dd. Gate

ee. Gearbox
ff. Generator
gg. Genset
hh. Grinder
ii. Grit Chain
jj. Grit Washer
kk. Hatch
ll. Heat Exchanger
mm. Heater
nn. Hopper
oo. HVAC Component
pp. HVAC
qq. Instrumentation Element
rr. Instrumentation
ss. Lab Equipment
tt. Mixer
uu. Mixing System
vv. Motor
ww. Odor Control UnitOpener
xx. Overhead Door
yy. Process Tank
zz. Pump
aaa. Radiator
bbb. Receiver Tank
ccc. Rotary Drum Thickener
ddd. Safety Valve
eee. Samplers
fff. Scrubber
ggg. Security
hhh. Street Lighting
iii. Structures
jjj. Super Structure
kkk. Tank
lll. Valve
mmm. Vaporizer
nnn. Vibrator

9. Parent ID
10. Equipment Main Location
11. Equipment Sub Location 1, which shall include:
    a. Primary Treatment
12. Equipment Sub Location 2, which shall include:
    a. 10 Influent Pump Station

13. Equipment Sub Location 3, which shall include but not be limited to:

    a. 0802 Stand-by Power

    b. 1001 Influent Pump Station

14. Equipment Sub Location 4 (Further location detail when necessary)

15. Equipment Sub Location 5 (Further location detail when necessary)

B. Each asset form shall have the following information completed by the Contractor:

1. MANUFACTURER: The company name that manufactured the asset

2. MODEL NUMBER: The model or part number of the asset

3. SERIAL NUMBER: The unique serial number of the asset as tracked by the manufacturer.

4. PROCESS: The process for which the asset is serving. For example, the BSS Feed Pump would be BSS (Biosolids, Secondary). If the asset does not serve a process, then leave it blank.

5. CLASSIFICATION: If the asset is rated for a Class I Division 1 or Class I Division 2 location then make the appropriate selection. Otherwise, leave as Unclassified.

6. SERVICE: If the asset is to be in or out of service (typically in service)

7. O&M LINK / URL: Provide a link or URL to the O&M Manual for the Asset.

8. CONDITION: Since the equipment is new this should be set to a 1 (SLCDPU uses a 1-5 numbering scheme with 1 being new and 5 being beyond repair).

9. PURCHASE DATE: Enter the date that the OWNER takes ownership of the asset.

10. INSTALL DATE: Enter the date of substantial completion associated with the asset.

11. WARRANTY EXPIRES: Enter the date for when the vendor warranty expires. Expiration date shall be formatted (month(XX)-day(XX)-year(XXXX))

12. PURCHASE COST: Enter the price to purchase the asset. Separately list costs such as shipping, O&M manual requirements, and startup, commissioning, and testing.

13. VENDOR: Enter the name of the company from which the asset was purchased (this is often a local distributor and not the manufacturer). Enter the additional vendor contact information (point of contact, email, phone number, mobile number, and address).

14. EQUIPMENT SUMMARY: The next section of information varies for each equipment class. For example, the pump class asks for flow, head, RPM, suction diameter, discharge diameter, etc. Leave items that are not applicable blank.

15. MAINTENANCE SUMMARY: The CONTRACTOR is to enter each maintenance operation associated with the asset. An example might be greasing a pump or changing oil or performing an inspection. List each Maintenance Operation required and provide the list of tasks required to perform the maintenance. Refer to specific information in Manufacturer's Manual, if applicable. Where applicable, refer by number to the "Lubricant List" on the last page of the FORM for Lubrication Operation. List the frequency of the operation and/or if it should be by a meter (number of hours in operation or number of miles traveled).

16. LUBRICANT LIST: List all lubricants required to perform maintenance on the asset throughout the life of the asset. List the lubricant type and enter its name, viscosity, and recommended manufacturer.

17. SPARE PARTS LIST: Enter all spare parts recommended for the asset. Enter the vendor from which to purchase the part, the part number, a description of the part, the number of units in a package when purchasing the part, the quantity of spares required and the unit cost. Identify which spare parts are being provided by the CONTRACTOR as part of the contract.

18. ADDITIONAL DATA AND REMARKS: Provide any additional data and remarks about the asset that would be beneficial to the WRF staff. Attach additional sheets if necessary.

C. Each asset form shall have the following information completed by the Owner:

1. CRITICALITY: The criticality of the asset relative to the WRF's operation. This is a scale of 1-5 where 1 is the most critical and 5 is not critical.

2. CREW: The WRF staff has several different crews for performing maintenance. Once each asset has its maintenance operations identified, the OWNER will assign the appropriate crew to each operation.

D. For each asset and system include:

1. Completed Equipment Data Form typewritten on Form 01 78 23-2. An electronic copy of Form 01 78 23-2 will be provided to the Contractor for each asset. Contractor shall be responsible for distribution to suppliers and completion of forms.

2. Description of equipment and component parts:

a. Function.

b. Normal operating characteristics.

c. Limiting conditions.

d. Performance curves.

e. Engineering data.

f. Test as applicable.

g. Complete nomenclature and model number of replaceable parts including keyed labeled exploded diagram.

h. Complete nameplate data.

i. Owner's tag (or asset) numbers for equipment as indicated on the Contract Drawings.

3. Operating Procedures:

a. Startup and break-in.

b. Normal operating instructions.

c. Regulation and control.

d. Stopping and shutdown.

e. Emergency instructions.

f. Summer and winter operating instructions, as applicable.

g. Special operating instructions.

4. Maintenance Procedures:

a. Routine maintenance operations.

b. Guide to troubleshooting.

c. Disassembly, repair, and reassembly instructions.

d. Alignment, adjusting, and checking instructions.

5. Servicing and Lubrication Schedule:

a. List of lubricants required and quantity to be applied.

b. Schedule of lubrication.

c. Schedule for other routine maintenance.

6. Manufacturer's printed instructions regarding safety precautions for both (a) protection of personnel operating equipment and systems and (b) prevention of damage to equipment and systems.

7. Description of sequence of operation of controls.

8. Assembly drawings and diagrams required for maintenance.

9. Manufacturer's parts list and illustrations:

    a. Predicted life of parts subject to wear.

    b. Items recommended to be stocked by the Owner as spare parts and quantities of same.

10. Accepted control diagrams such as ladder diagrams, instrumentation loop diagrams, and electrical schematics.

11. Bill of material.

12. Other data as required under applicable Specification sections.

E. Each electric and electronic system, as applicable to equipment such as switchgear, motor control centers, panel boards, switchboards, starters, breakers, and relays shall include:

1. Description of System and Component Parts:

    a. Function.

    b. Normal operating characteristics.

    c. Limiting conditions.

    d. Performance curves.

    e. Engineering data.

    f. Rating tables.

    g. Tests, as applicable.

    h. Complete nomenclature and model number of replaceable parts.

    i. Complete nameplate data.

    j. Owner's Tag (asset) numbers for equipment as indicated on the Contract Drawings.

2. Circuit Directories of Panel Boards:

    a. Electrical service.

    b. Controls.

    c. Communications.

3. Complete instrumentation

    a. Loop diagrams.

    b. Tabulated listing of components in each control circuit or loop.

4. Operating Procedures:

    a. Routine and normal operating instructions.

    b. Sequences required.

    c. Special operating instructions.

5. Maintenance Procedures:

    a. Routine maintenance operations.

    b. Guide to troubleshooting.

    c. Disassembly, repair, and reassembly instructions.

    d. Adjustment and checking instructions.

6. Manufacturer's printed instructions regarding safety precautions for both:

    a. Protection of personnel operating equipment and systems.

    b. Prevention of damage to equipment and systems.

7. List of original all of the manufacturer's components, spare parts with diagram, and recommended quantities to be maintained in storage by the Owner.

8. Other data as required under pertinent sections of Specifications.

F. Prepare and include additional data when need for such data becomes apparent during instruction of Owner's personnel. Differences between the equipment O&M manual and the manufacturers training session shall result in the training and/or O&M Manual being corrected.

3.03 MANUAL FOR MATERIALS AND FINISHES:

A. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Provide information for re-ordering custom manufactured products.

B. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

C. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

D. Additional Requirements: As specified in individual product specification sections.

E. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

3.04 ASSEMBLY OF O&M MANUALS:

A. Assemble one (1) set.

B. Remove bindings of individual manuals.

C. Insert index tabs labeled with the respective piece of equipment to separate individual manuals.

D. Provide a Table of Contents at the front of the document showing the equipment items in the order in which they appear. Each equipment items shall include the functional name, applicable specifications section, and the plan listing, if any.

E. The preventive maintenance schedule shall be bound in the front of each section immediately following the Table of Contents. The schedule shall be identified with respect to the piece of equipment it is referring to.

F. Sheet Size: 8-1/2 x 11 sheets.

G. Drawings may be on 11 x 17-inch sheets folded to 8-1/2 x 11-inches. .

H. Engrave on covers and end of binder, title OPERATIONS AND MAINTENANCE INSTRUCTIONS, name of Project, Owner's project number, date of Contract, and volume number with subject matter of contents.

I. Electronic files shall be named in the following format (name of equipment)_O&M Manual.

FORM 01 78 23-2 EQUIPMENT DATA FORM	Page 1 of 5
PROJECT NAME	WRF Expansion - Solids Train 1 - Dewatering
CONTRACT NUMBER	524905376
CONTRACTOR	Sundt/PCL
EQUIPMENT TAG	
EQUIPMENT NAME	
EQUIPMENT DESCRIPTION	
EQUIPMENT CLASS	VALVE
PARENT ID	
EQUIPMENT MAIN LOCATION	
EQUIPMENT SUB LOCATION 1	
EQUIPMENT SUB LOCATION 2	
EQUIPMENT SUB LOCATION 3	
EQUIPMENT SUB LOCATION 4	
EQUIPMENT SUB LOCATION 5	
MANUFACTURER	
MODEL NUMBER	
SERIAL NUMBER	
PROCESS	
CLASSIFICATION	Unclassified
SERVICE	In Service
O&M LINK / URL	
CRITICALITY *	1
CONDITION	1
PURCHASE DATE	
INSTALL DATE	
WARRANTY EXPIRES	
PURCHASE COST	
* By Owner	

SAMPLE

FORM 01 78 23-2 EQUIPMENT DATA FORM	Page 2 of 5
VENDOR	
VENDOR CONTACT FIRST NAME	
VENDOR CONTACT LAST NAME	
VENDOR EMAIL	
VENDOR PHONE NUMBER	
VENDOR MOBILE NUMBER	
VENDOR ADDRESS 1	
VENDOR ADDRESS 2	
VENDOR CITY	
VENDOR STATE	
VENDOR ZIP CODE	
VENDOR COUNTRY	

VALVE DATA	
EQUIPMENT SUB CLASS	Ball
CONNECTION TYPE	Bolted Flange
VALVE SIZE (IN)	
BODY TYPE	
PRESSURE RATING (PSI)	
SEAT MATERIAL	
PACKING MATERIAL	
PACKING SIZE (IN)	
INTERIOR COATED	
OPERATOR MANUFACTURER	
OPERATOR TYPE	
OPERATOR MODEL NUMBER	
OPERATOR SIZE (IN)	
OPERATING TORQUE (LBF-FT)	
CLOCKWISE TO OPEN (Y/N)	
FLUID	
FLUID TYPE 2	
ADDITIONAL VALVE INFO	
ADDITIONAL OPERATOR INFORMATION	

SAMPLE

FORM 01 78 23-2 Page 3 of 5 EQUIPMENT DATA FORM							
MAINTENANCE SUMMARY							
EQUIPMENT TAG							
EQUIPMENT NAME							
List each Maintenance Operation required and provide the list of tasks required to perform the maintenance. Refer to specific information in Manufacturer's Manual, if applicable. Where applicable, refer by number to the "Lubricant List" on the last page of this form for Lubrication Operation. List the frequency of the operation and/or if it should be by a meter (number of hours in operation or number of miles traveled).							
MAINTENANCE OPERATION 1							
DESCRIPTION							
FREQUENCY		METER		CREW			
TASK #	DESCRIPTION			TASK #	DESCRIPTION		
1				7			
2				8			
3				9			
4				10			
5				11			
6				12			
MAINTENANCE OPERATION 2							
DESCRIPTION							
FREQUENCY		METER		CREW			
TASK #	DESCRIPTION			TASK #	DESCRIPTION		
1				7			
2				8			
3				9			
4				10			
5				11			
6				12			
MAINTENANCE OPERATION 3							
DESCRIPTION							
FREQUENCY		METER		CREW			
TASK #	DESCRIPTION			TASK #	DESCRIPTION		
1				7			
2				8			
3				9			
4				10			
5				11			
6				12			

SAMPLE

FORM 01 78 23-2 Page 4 of 5 EQUIPMENT DATA FORM							
MAINTENANCE SUMMARY (CONTINUED)							
EQUIPMENT TAG							
EQUIPMENT NAME							
MAINTENANCE OPERATION 4							
DESCRIPTION							
FREQUENCY		METER		CREW			
TASK #	DESCRIPTION			TASK #	DESCRIPTION		
1				7			
2				8			
3				9			
4				10			
5				11			
6				12			
MAINTENANCE OPERATION 5							
DESCRIPTION							
FREQUENCY		METER		CREW			
TASK #	DESCRIPTION			TASK #	DESCRIPTION		
1				7			
2				8			
3				9			
4				10			
5				11			
6				12			
MAINTENANCE OPERATION 6							
DESCRIPTION							
FREQUENCY		METER		CREW			
TASK #	DESCRIPTION			TASK #	DESCRIPTION		
1				7			
2				8			
3				9			
4				10			
5				11			
6				12			

SAMPLE

FORM 01 78 23-2 Page 5 of 5 EQUIPMENT DATA FORM					
LUBRICANT / RECOMMENDED SPARE PARTS LIST					
EQUIPMENT TAG					
EQUIPMENT NAME					
LUBRICANT LIST					
REFERENCE NUMBER	LUBRICANT TYPE (MILITARY STANDARD)	RECOMMENDED LUBRICANT AND MANUFACTURER			
Lubricant No.	List general lubricant type.	List specific lubricant name, viscosity, and manufacturer			
1		NAME:			
		VISCOSITY:			
		MFR:			
2		NAME:			
		VISCOSITY:			
		MFR:			
3		NAME:			
		VISCOSITY:			
		MFR:			
SPARE PARTS LIST					
VENDOR	PART NO. **	DESCRIPTION	UNIT	QUANTITY	UNIT COST
ADDITIONAL DATA AND REMARKS					
** Identify parts provided by this contract with two asterisks Note: Attach additional sheets if necessary, identify each sheet at top with equipment number and name.					

SAMPLE

END OF SECTION

SECTION 01 78 24

TRAINING

PART 1 - GENERAL

1.01 SUMMARY:

A. Section includes administrative and procedural requirements for instructing the Owner's personnel, including the following:

1. Instructor manual
2. Trainee manual
3. Facilities for training
4. Schedule
5. Preparation
6. Instruction
7. Training contents
8. Demonstration and training video recordings
9. Field quality control
10. Training documentation

B. Payment for work covered by this section shall be included in the lump sum cost of the Supplier’s Proposal.

1.02 DEFINITIONS:

A. The term ‘Supplier’ shall be considered interchangeable with the term ‘Manufacturer’ when Manufacturer is directly supplying equipment to Contractor.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Submit an electronic copy of the outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

a. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of the live instructional module.

b. Submit a draft training outline for review by Engineer and Owner. Supplier shall incorporate all comments into training schedule.

c. Submit final training course outline for review.

d. After final course outline is accepted by Engineer, submit student notes and instructor guides for review.

2. Qualification Data for Instructor.

a. Submit resumes, including three outside references, for each instructor proposed for training program. The qualifications of the instructor shall include:

(1) Type of training instructor has received for the specific equipment the training module will cover, including dates and who provided the training.

(2) Training Work experience including the employers name and address, dates of employment and type of training provided and to whom.

b. Engineer will review resumes. Based upon review of resumes, Engineer will approve, request additional information, or reject proposed instructors for training program.

c. If proposed instructor is rejected, Contractor shall submit resume and references on alternate instructor for acceptance.

3. Within 7 days after each training module, submit list of participants and length of instruction time.

4. Submit electronic copy of each training module within seven calendar days following the delivery of each training module.

   a. Provide an applied label with the following information:

      (1) Name of Project

      (2) Training Session Name

      (3) Name of Construction Manager

      (4) Name of Contractor

      (5) Date of training

   b. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format.

1.04 QUALITY ASSURANCE:

A. Instructor Qualifications:

1. A factory-authorized service representative, complying with requirements in Section 01 45 00, Article 1.2, experienced in operation and maintenance procedures and in providing training for the products and systems installed under this Contract.

1.05 COORDINATION:

A. Contractor to coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of the Owner's personnel.

B. Contractor to coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Contractor to coordinate content of training modules with content of accepted emergency, operation, and maintenance manuals. Do not submit instruction program(s) for review until the operation and maintenance data required under Section 01 78 23 has been reviewed and accepted Engineer.

PART 2 - PRODUCTS

2.01 INSTRUCTOR MANUAL:

A. The Contractor shall prepare an Instructor Manual for each curriculum that includes all of the information specified below and written at the journeyman level for electrician

specialists, mechanical specialists and instrument technicians, and for wastewater treatment plant operators, or other disciplines, depending upon the target audience.

B. The Instructor Manual shall be consistent with the nomenclature and contents of the accepted Contractor's O&M Manuals required in Section 01 78 23. The O&M Manuals cannot be substituted for the Instructor Manual.

C. The purpose of the Instructor Manual is to define the concepts and information that will be taught to each target audience and to describe the methods and materials to be used during the training. The Instructor Manual is designed to provide specific guidance to the Instructor regarding all aspects of the training program. The Instructor Manual shall include:

1. Description of the equipment
2. Parts and equipment graphics
3. Safety procedures
4. Startup checks and procedures
5. Overview of routine operation, including startup and shutdown and operating parameters
6. Routine, preventive, and corrective maintenance procedures
7. Lubrication (schedule and type)
8. Assembly and disassembly procedures
9. Troubleshooting procedures
10. Parts list
11. Special maintenance practices
12. Emergency shutdown

D. All manuals shall be presented in electronic format per the requirements of Specification Section 01 33 00. All equipment shall be cross-referenced to the equipment tag identification numbers.

E. Each Instructor Manual shall contain:

1. Instructor Manual cover page
2. Instructor Manual table of contents

3. Lesson Plan which shall include:

    a. Lesson Plan cover page

    b. Lesson Plan summary

    c. Lesson Plan text, including:

        (1) Identity of the target audience (a separate Lesson Plan is required for each target audience, such as mechanical O&M personnel, electronic/electrical O&M personnel, etc.)

        (2) Length of the training program and each topic to be covered

        (3) Performance and/or training objectives

        (4) Outline of the material to be covered

        (5) Training strategies to be used and interaction with the trainees

        (6) Audio visual and/or support materials required, and when used or referred to during instruction

        (7) A list of resource and/or reference materials

4. A copy of all training aids, including electronic files.

5. A copy of trainee materials (handouts, reference materials, etc.) in electronic format.

F. The Supplier shall submit the equipment manufacturer's lesson plans for acceptance by the Engineer no less than ninety (90) days prior to the date that the training is to take place.

G. With the exception of cutaway models or other items expressly exempted by the Engineer, all training aids and trainee materials contained in the Instructor Manual or used in the delivery of training shall become the property of the Owner and may be duplicated by the Owner for its own use.

H. The Supplier shall provide required acceptance and/or copyright releases obtained from those who own proprietary and/or copyrighted materials provided by the Contractor so that the materials can be reproduced by the Owner.

2.02 TRAINEE MANUAL:

A. Program Structure:

1. Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required in the individual Specification Sections.

B. Training Manuals:

1. The Supplier shall submit a Trainee Manual for each curriculum that includes all of the information specified below and written at the journeyman level for electrician specialists, mechanic specialists and instrument technicians, and for wastewater treatment plant operators, or other disciplines, depending upon the target audience.

2. The Trainee Manual shall be consistent with the nomenclature and content of the accepted Contractor O&M Manuals required in Specification Section 01 78 23. The O&M Manual cannot be substituted for the Instructor Manual or Trainee Manual.

3. The purpose of the Trainee Manual is to provide an organized package of information for use by trainees during the training sessions and as reference material for operation and maintenance in the future. The Trainee Manual shall include:

a. Description of the equipment

b. Parts and equipment graphics including “exploded” views

c. Safety procedures

d. Pre-startup checks

e. Startup procedures

f. Operation and monitoring procedures including normal operating parameters, and the operating limits of the equipment

g. Shutdown procedures

h. Troubleshooting procedures

i. Non-routine emergency procedures

j. Safety/Protective equipment required by Trainees

4. All manuals shall be presented in electronic format per the requirements of Specification Section 01 33 00. All equipment shall be cross-referenced to the equipment tag identification numbers.

5. Training Manual Format:

   a. Size: 8-1/2 inch by 11 inch

   b. Text: Manufacturer's printed data, or neatly typewritten, including:

      (1) Table of Contents

      (2) Pretest

      (3) Learning Objectives

      (4) General Operations

      (5) Theory

      (6) Specific Equipment Information

   c. Drawings:

      (1) Provide suitable for printing on 11 x 17 inch paper

   d. Cover: Identify with typed or printed title "Training Manual"

      (1) Title of Project

      (2) Identify separate structure or system as applicable

      (3) Identify general subject matter covered in Manual

   e. All documents shall be searchable and generated with a computer in the native software format. Scanned or photographed images will not be acceptable.

C. Training Modules:

1. Develop a learning objective and teaching outline for each module. Include a description of the specific skills and knowledge that each participant is expected to master.

2. For each module, include instruction for the following as applicable to the system, equipment, or component:

    a. Basis of System Design, Operational Requirements, and Criteria: Include the following:

        (1) System, subsystem, and equipment descriptions

        (2) Performance and design criteria if the training provider is delegated design responsibility

        (3) Operating standards

        (4) Regulatory requirements

        (5) Equipment function

        (6) Operating characteristics

        (7) Limiting conditions

        (8) Performance curves

    b. Documentation: Review the following items in detail:

        (1) Emergency manuals

        (2) Operations manuals

        (3) Maintenance manuals

        (4) Project record documents

        (5) Identification systems

        (6) Warranties and bonds

        (7) Maintenance service agreements and similar continuing commitments

    c. Emergencies: Include the following, as applicable:

        (1) Instructions on meaning of warnings, trouble indications, and error messages.

        (2) Instructions on shutdown.

        (3) Shutdown instructions for each type of emergency.

(4) Operating instructions for conditions outside of normal operating limits.

(5) Sequences for electric or electronic systems.

(6) Special operating instructions and procedures.

d. Operations: Include the following, as applicable:

(1) Start-up procedures.

(2) Equipment or system break-in procedures.

(3) Routine and normal operating instructions.

(4) Regulation and control procedures.

(5) Control sequences.

(6) Safety procedures.

(7) Instructions on stopping.

(8) Normal shutdown instructions.

(9) Operating procedures for emergencies.

(10) Operating procedures for system, subsystem, or equipment failure.

(11) Seasonal and unattended operating instructions.

(12) Required sequences for electric or electronic systems.

(13) Special operating instructions and procedures.

e. Adjustments: Include the following:

(1) Alignments.

(2) Checking adjustments.

(3) Noise and vibration adjustments.

(4) Economy and efficiency adjustments.

f. Troubleshooting: Include the following:

(1) Diagnostic instructions.

(2) Test and inspection procedures.

g. Maintenance: Include the following:

(1) Inspection procedures.

(2) Types of cleaning agents to be used and methods of cleaning.

(3) List of cleaning agents and methods of cleaning detrimental to product.

(4) List of lubrication products, procedures, and intervals.

(5) Procedures for routine cleaning

(6) Procedures for preventive maintenance.

(7) Procedures for routine maintenance.

(8) Instruction on use of special tools.

h. Repairs: Include the following:

(1) Diagnosis instructions.

(2) Repair instructions.

(3) Disassembly; component removal, repair, and replacement; and reassembly instructions.

(4) Instructions for identifying parts and components.

(5) Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.01 FACILITIES FOR TRAINING:

A. Use Owner's designated training facilities for specified field training programs.

B. Facilities include installation sites, which shall be used for hands-on training programs.

C. Coordinate use of Owner's facilities with Owner and Engineer.

3.02 SCHEDULE:

A. Coordinate training periods Engineer and Supplier's representatives.

1. Training shall be limited to no more than three days per week. No training shall be conducted on Mondays or Fridays.

2. The Supplier shall coordinate the manufacturer's training services with the Owner and the Engineer, providing a minimum of fourteen (14) days prior notice of training, subject to the acceptance of the Engineer and the Owner.

3. In order to provide training for an adequate number of the Owner operation and maintenance personnel, a minimum of two 8-hour training days shall be provided for each item of equipment at the site, unless otherwise specified in the specifications.

4. The Supplier shall deliver all training material to the Engineer and the Owner a minimum of fourteen (14) days prior to the scheduled training.

5. The Contractor shall maintain a calendar of training events which defines each submission for each vendor training curriculum. Calendar shall be updated as required.

6. Reschedule canceled training sessions 7 calendar days in advance.

7. Failure of supplier's or manufacturer's representative to appear for scheduled training, failure to notify Engineer 48 hours in advance of need to cancel scheduled training, or failure to arrive within 30 minutes of start of scheduled training shall result in reimbursement of Owner and Engineer for time lost by Owner's operating personnel and Engineer in waiting for arrival of manufacturer's representative. Except in case of failure to arrive on time, time will not exceed one hour for each Owners employee scheduled to receive training and the Engineer. Failure to arrive on time will be reimbursed by actual time late, up to one hour, after one hour training will be rescheduled.

B. Training Procedures:

1. The instructor shall arrive at the training site at least one hour before training is scheduled to be delivered in order to review the Instructor Manual with the Engineer, Owner and complete final preparations for presentation of the training session. The instruction shall comply with all safety requirements, including wearing a hard hat, safety shoes, and other safety and/or personal protective equipment.

a. Information presented in the training program shall be based on the Instructor and Trainee Manuals.

b. The Engineer will monitor and evaluate the performance of the instructor and the quality of the training session. Unacceptable sessions are those where the accepted lesson plan was not presented, where inadequate time was taken to present lesson plan or the training was not understood by the trainees. The adequacy of the training shall be determined solely by the Engineer. Contractor shall repeat any training sessions deemed unacceptable, at no additional cost to the Owner.

c. A safety briefing shall be conducted by the instructor prior to use of any equipment.

C. Training shall be completed minimum of 14 days before commissioning on each piece of equipment or unit process begins.

D. Owner's personnel will require training, both for operating and maintenance functions. These individuals shall be trained in small groups at times and dates agreed upon by the Owner.

3.03 PREPARATION:

A. Assemble educational materials necessary for instruction, including documentation and training modules. Assemble training modules into a training manual organized in coordination with requirements of this Section and in Section 01 78 23.

B. Set up instructional equipment at instruction location.

3.04 INSTRUCTION:

A. Prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Owner will furnish the Contractor with names and positions of participants after the final course outline is accepted.

C. Manufacturer's Training Location and Reference Material:

1. Conduct training on-site in the completed and fully operational facility using the actual equipment in-place.

2. Conduct training using final operation and maintenance data submittals as training aides.

D. Cleanup:

1. Collect used and leftover educational materials and remove from the Project site if unwanted by the Owner.

2. Remove instructional equipment.

3. Restore systems and equipment to condition existing before initial training use.

3.05 TRAINING CONTENT:

A. Maintenance of Instrumentation:

1. Training Requirements:

a. Describe overall function of each instrument and control loop installed under this Contract.

b. Locating probable source of malfunction in instrumentation equipment determining symptoms of trouble, establishing probable cause and effecting solution.

c. Taking appropriate preventive and corrective maintenance procedures necessary to keep instrumentation system in proper operating condition, including calibration and testing.

2. Course Materials:

a. Pertinent portions of submittals specified in specifications such as calibration data and maintenance instructions.

b. Detailed course outlines and troubleshooting guides for field use. Troubleshooting guides shall include symptoms, probable causes and solutions for all cases of trouble described during training program.

3. Training program shall not include any time specified for system start-up instruction or acceptance testing.

B. Maintenance of Process Equipment:

1. Training Requirements:

a. Describe functions of process equipment.

b. Component preventive and corrective maintenance activities required to keep unit equipment in good operating conditions.

c. Instruct trainees in locating probable source of equipment malfunctions, determining symptoms of trouble, establishing probable cause, and effecting solution.

2. Course Materials:

a. Pertinent portions of operation and maintenance manuals as well as alignment tolerances, lubrication schedules, vibration analysis instructions and parameters, and special calibration test and procedures.

b. Detailed course outlines and troubleshooting guides for each piece of equipment. Trouble-shooting guides shall include symptoms, probable causes, and solutions for trouble described during training program.

3. Method of training maintenance personnel shall include Contractor using Owner's equipment to demonstrate trouble-shooting, preventive and corrective maintenance procedures.

C. Operation of Process Equipment:

1. Training Requirements:

a. Being able to implement start-up and shutdown procedures for each piece of equipment individually, as well as start-up and shutdown of systems comprising equipment. This instruction shall include normal operation, alternative operations, and emergency operations.

b. Understand functions of instrumentation, describing individual components and how each component is used in monitoring and controlling equipment and processes for the instrumentation supplied by the manufacturer.

c. Understand operating modes possible as result of modifications and installations.

d. Locating probable source of system inefficiency, determining symptoms, establishing probable cause, and re-stabilizing system efficiency for systems.

e. Precautions for safe operation of equipment, instrumentation, and control system.

f. Emergency procedures for equipment and systems during pump malfunction, chemical spills, and other extreme conditions.

2. Course Materials:

a. Pertinent portions of Operations and Maintenance Manuals, including start-up and shutdown procedures; descriptions of equipment and

instrumentation functions and modes of operations, control, and monitoring; troubleshooting instructions and process control instructions.

b. Detailed course outlines and operations guides for equipment and processes for field use. Operations guides shall include general operating procedures, start-up and shutdown procedures, optimization procedures, and emergency operating procedures.

3. Methods of training Owner's operations personnel shall include field training program at Owner's site consisting of classrooms and hands-on training using Owner's equipment and systems.

3.06 DEMONSTRATION AND TRAINING VIDEO RECORDINGS:

A. General:

1. The Owner has engaged a qualified commercial videographer to record demonstration and training sessions in video recordings.

2. Coordinate all training with Owner's videographer.

3. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

4. At beginning of each training module, record each chart containing learning objective and lesson outline.

3.07 FIELD QUALITY CONTROL:

A. Manufacturer's Training Effectiveness:

1. Instructor shall be clear and audible on the electronic media or the sessions will need to be redone at no additional cost to the owner.

2. Effectiveness of training shall be determined by Engineer as "Satisfactory" or "Unsatisfactory".

3. Unsatisfactory evaluations shall include recommendations for corrective action and the training session must be given again at no cost to the owner.

3.08 TRAINING DOCUMENTATION:

A. On completion of his training, the manufacturer's or supplier's representative shall submit to Engineer a complete signed Form 01 78 24-1 Demonstration his training is complete.

B. If the Owner approves the training, the acceptance will be documented in a completed Form 01 78 24-2.

C. Differences between the equipment O&M manual and the manufacturers training session shall result in the training and/or O&M Manual being corrected.

FORM 01 78 24-1
EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTRUCTION

Owner – Salt Lake City – Department of Public Utilities

Project – New Water Reclamation Facility

SLCDPU Contract No. _____ [**Fill in Contract No**.]

Construction Package _____

EQUIPMENT SPECIFICATION SECTION_____

EQUIPMENT DESCRIPTION_____

I_____, Authorized representative of
(Print Name)

_____
(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

installed for the subject project (has) (have) been installed in a satisfactory manner, (has) (have) been satisfactorily tested, (is) (are) ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit(s) on

Date:_____ Time:_____

CERTIFIED BY:_____DATE:_____
(Signature of Manufacturer's Representative)

FORM 01 78 24-2
OWNER'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

(I) (We) the undersigned, authorized representatives of the _____ and/or Plant Operating Personnel have received classroom and hands-on instruction on the operation, lubrication, and maintenance of the subject equipment and (am) (are) prepared to assume normal operational responsibility for the equipment:

_____ Date: _____

_____ Date: _____

_____ Date: _____

END OF SECTION

SECTION 01 78 25

PLANT TESTING, STARTUP AND COMMISSIONING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide planning, functional completion testing, startup and commissioning as indicated and specified. Section includes:

1. Pump Station Checkout Plan

2. Functional Completion Testing

3. Startup

4. Commissioning

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. B31.1: Power Piping Code

B. American Water Works Association (AWWA):

1. C600: Installation of Ductile-Iron Water Mains and Their Appurtenances

1.03 DEFINITIONS:

A. The Pump Station Checkout Plan (the Plan) incorporates all aspects of functional completion testing, startup, and training to ensure the facility operates properly and meets design intent and performance.

B. Functional Completion Testing is testing of the equipment and unit process systems to confirm that construction and installation has been completed in anticipation of initial startup of the equipment and unit process systems. Functional Completion Testing includes:

1. Physical Checkout shall be defined as the process of physically inspecting products after they have been installed in the Work to determine if the Products have been properly and completely installed, and are ready for Field and/or Functional Testing. The requirements for Physical Checkout are contained in the pertinent technical specification(s) (if applicable) and in Paragraph 1.08 of this Section.

2. Field Testing shall be defined as testing that is performed by the Contractor, with Supplier assistance, on Products after they have been installed in the Work, and after conducting physical checkout, for the purpose of proving that the tested Products meet the requirements of the pertinent technical specifications. Administrative and minimum technical requirements for field testing are specified in Paragraph 1.08 of this Section, while additional technical requirements are contained in PART 3 of the pertinent technical specification(s). The test criteria are specified in Paragraph 1.08 of this Section.

C. Startup shall be defined as the operation of equipment or unit process systems using clean water, air, or other fluids and gases as necessary to demonstrate the operation of the equipment or unit process systems with other equipment that is a part of, or a treatment process for the Facility. Administrative and minimum technical requirements for startup are specified in Paragraph 1.09 of this Section, while additional technical requirements are contained in PART 3 of the pertinent technical specification(s).

D. Commissioning shall be defined as the operation of equipment or unit process systems using process liquids or process solids, plant support equipment, and plant utilities to demonstrate equipment or unit process systems are capable of processing water or wastewater at specified flows and conditions for a sustained period of operation as required by this section or equipment or unit process systems specifications. Administrative and minimum technical requirements for Commissioning are specified in Paragraph 1.10 of this Section, while additional technical requirements are contained in PART 3 of the pertinent technical specification(s).

E. Reliability Testing is defined as a test performed as an extended operation of the constructed facilities to confirm that the equipment and unit process systems work together as a complete Facility under continuous operation for the specified period. The Reliability Test shall be conducted after all the major equipment and unit process systems have successfully completed Startup. Supplier's Representative, sometimes referred to in the technical specifications as a Factory-Trained Service Representative, shall be defined as a person, or persons provided by the Supplier, who is qualified by having the training and experience, to provide technical and/or process related advice, and/or assistance, relating to the installation or utilization of the Products provided by that same Supplier, for installation and utilization in the Work.

1.04 ROLES AND RESPONSIBILITIES:

A. The Contractor shall provide all outside services, materials, labor, supplies, test equipment and other items necessary to perform the Functional Completion Testing and Startup. Commissioning shall be conducted by others once the new WRF is operational. In addition, the Contractor shall arrange for and provide the participation or assistance of survey crews, quality control technicians, Supplier's representative(s), and required governmental agency representatives.

B. The Contractor shall provide the services of the Supplier's representative(s) as follows:

1. Assistance during installation as specified in PART 3 of the specifications in Division 2 through 44 and as specified herein.

2. Field Testing as specified in PART 3 of the specifications in Divisions 2 through 44, and as specified herein.

3. Startup as specified in PART 3 of the specifications in Divisions 2 through 44, and as specified herein.

C. The Supplier's representative's activities required by this Section are in addition to the requirements for vendor training and other services specified elsewhere in the Contract Documents. Timing for the performance of these services is to be defined in the Contractors Checkout Plan, specified herein.

D. The Engineer will review and comment on the Contractor's deliverables, participate in the physical inspection activities, witness the shop and field testing, witness functional testing, maintain the permanent record of all testing results, and provide verification of conformance to the specifications. The Engineer's right to perform inspections, witness tests or monitor or assess the Work and activities does not relieve the Contractor of its obligation to comply with the requirements of the Contract Documents nor does it imply completion of the Work.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Submit a Plant Checkout Plan for the facility in accordance with the requirements of Section 01 33 00. Submit a Functional Test Plan in accordance with the requirements of Section 01 33 00.

1.06 QUALITY ASSURANCE:

A. Preparation of the plant checkout plan, functional completion testing and startup shall be performed by personnel:

1. Trained and experienced in O&M of the described equipment.

2. Familiar with the requirements of this section.

1.07 PUMP STATION CHECKOUT PLAN:

A. The Contractor shall be responsible for preparing, coordinating, and executing the Plan.

1. The Contractor shall use the resources of the equipment and unit process systems suppliers in this work, particularly for specific equipment and unit process systems.

2. An initial draft of the Plan shall be submitted as indicated here:

    a. The initial draft Plan for the Facility shall be completed and submitted by the Contractor to the Engineer for review as defined in Section 01 33 00. The Engineer will require 45 days to review the submittal and return with any exceptions noted.

    b. The Contractor shall incorporate the Engineer's comments into the revised Plan within 30 days of receiving comments, and reissue the Plan to the Engineer and Owner.

    c. The Contractor shall regularly schedule meetings with the Engineer and Owner to review and coordinate activities required by the Plan.

B. The Contractor shall provide a dedicated field staff to support the Plan activities. A single point of contact for the Contractor shall be responsible for day to day activities and shall be the primary contact with the CM or Resident Engineer regarding Plan activities. Support staff shall include but not be limited to designated mechanical, electrical and instrumentation and control engineers and technicians, and operating staff.

C. The Plan shall define:

1. The logical and systematic performance of functional completion testing, startup, and reliability testing including:

    a. A chronological schedule of all testing and inspection activities.

    b. A checklist of all inspection and testing activities broken down by location, discipline, system, and device or item.

    c. All blank forms proposed by the Contractor for verification or recording of the functional completion testing, startup, and reliability testing**.**

    d. An index which cross references the forms to their intended application(s).

    e. A list of all supplier certifications, including those required by the applicable technical specifications. Provisions shall also be included for retesting, in the event it is required.

2. A list of participants in functional completion testing, startup, and reliability testing**.**

3. A list of special test equipment required for functional completion testing, startup, and reliability testing.

4. Sources of the test media (water, power, air.) for functional completion testing.

5. The proposed method of delivery of the media to the equipment to be tested during functional completion testing, startup, and reliability testing.

6. Temporary or interim connections for the sequencing of multiple units during functional completion testing, startup, and reliability testing.

7. Ultimate disposal of the test media after functional completion testing, startup, and reliability testing.

D. The plan shall be reviewed by the Engineer, modified or revised as necessary by the Contractor, then re-reviewed by the Engineer. The Contractor shall continue to update the Plan, working in conjunction with the Engineer, prior to the start of the scheduled equipment checkout and functional testing activities as specified in Paragraph 1.08 herein. Each specific element of the plan must receive review or comment by the Engineer, two weeks prior to the actual commencement of testing as defined herein.

E. The Contractor shall designate, in the Plan, an individual of the Contractor, to coordinate and manage the activities defined in the Plan.

1.08 FUNCTIONAL COMPLETION TESTING:

A. Functional Completion Testing shall be completed as construction and installation of equipment is completed to demonstrate that the equipment is ready for equipment and unit process systems startup.

1. Functional Completion Testing shall be done in a coordinated manner based on the Plan prepared by the Contractor.

a. The Owner's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.

b. Additional witnesses, such as the Engineer, may be present to represent the Owner.

2. Functional Completion Testing procedures and documentation forms shall be developed by the Contractor. The procedures shall include a listing of items inspected for Functional Completion Testing.

3. If any equipment or unit process systems do not meet Functional Completion Testing requirements, it shall be the responsibility of the Contractor and/or equipment suppliers to make the necessary corrections or replacements and repeat the test.

4. The equipment and unit process systems shall not be started up or put into service until the Functional Completion Testing is completed as evidenced by a completed Functional Completion Testing certificate for the equipment or subsystem.

5. Modifications to the equipment and unit process systems required to meet Functional Completion Testing requirements shall be provided, and all retesting shall be performed at no additional cost to the Owner.

6. A Functional Completion Testing Certificate shall be prepared by the Contractor for each piece of equipment or unit process and submitted to the Engineer and Owner for review.

1.09 STARTUP:

A. Startup activities for the Facility shall not be initiated until the requirements of Functional Completion Testing are completed for the equipment or unit process systems.

B. The requirements of this section shall be satisfactorily completed for all systems/equipment prior to beginning Reliability Testing.

C. The Contractor shall be responsible for startup.

1. The Owner's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.

2. Additional witnesses, such as the Engineer, may be present to represent the Owner.

D. For equipment or unit process systems that do not meet the specified Startup requirements, it shall be the responsibility of the Contractor and/or equipment or unit process systems suppliers to make the necessary corrections or replacements and repeat Startup at no additional cost to the Owner.

E. Startup Reports for each piece of equipment or unit process shall be completed and submitted by the Contractor to the Engineer and Owner for review as defined in Section 01 33 00.

1.10 COMMISSIONING:

A. Commissioning activities for the Facility shall be conducted by others once the new WRF Facility is operational.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 PUMP STATION CHECKOUT PLAN:

A. The Plan shall include the following items as a minimum:

1. Cover Sheet with Plant identification, title, date and other information as needed to properly identify the specific information for the Facility.

2. Status and revisions sheet with appropriate dates and signatures spaces to document the development and status of the document.

3. Table of Contents including Appendix.

4. Equipment and systems descriptions with anticipated break down for individual startup activities. This section shall define the individual "packages" for startup activities for the equipment or unit process systems.

5. Schedule of events for startup and other activities covered by the Plan.

   a. The schedule shall define dates for completing activities for equipment and unit process systems.

   b. The schedule shall be the Contractor's best estimate of time sequence at the time of issuance.

   c. The Contractor shall submit monthly schedule updates to the Plan.

   d. The schedule shall follow the required sequencing as specified herein.

6. Sign-off sheets consisting of certification forms or completion reports required by the specifications shall be included in the Plan. Standard forms shall be developed by the Contactor for this purpose.

7. Reports, test results and other supporting data shall be collected by the Contractor for documentation of the specific details leading to the certification or completion.

3.02 FUNCTIONAL COMPLETION TESTING:

A. Provide 30 days written notice to the Engineer for each functional completion test so that the Engineer, may witness the functional completion tests. The Engineer may witness the performance of any or all functional completion testing, at their option.

B. Testing shall be conducted in accordance with the accepted Plan using applicable standard techniques reviewed by the Engineer and Owner.

1. Local and remote instrumentation may be used to record test data where it is determined the devices have been calibrated and sufficient to obtain necessary data.

C. The Contractor shall develop standard data sheets to document Functional Completion Testing requirements have been met for all equipment and unit process systems included in the Plan.

1. As equipment testing is completed the appropriate data sheet shall be completed and signed by the responsible party and submitted to the Engineer for review and acceptance.

2. Data values shall be stated in the engineering units noted in the equipment specifications.

D. A detailed Functional Completion Test plan shall be prepared and submitted to the Engineer for review and comment as noted paragraph 1.08 above.

1. The plan shall be prepared by the Contractor in conjunction with the equipment or subsystem supplier and shall become a part of the overall Plan.

E. In the event no reference to procedures is made, or no procedures for startup are contained in a technical specification for the following test parameters, the following shall be the checkout requirements. Should these requirements conflict with the Supplier's recommendations or in any way be less stringent than the Supplier's requirements, they shall be superseded by the Supplier's requirements for checkout testing.

1. Measurement of wearing ring clearances for all pumps requiring assembly, so equipped:

a. Take two readings taken opposed to each other by 90 degrees.

b. All measured clearances shall be within Supplier's specifications for new installations. Replace and recheck rings found to be out of round or out of specified tolerance.

2. Measurement of Impeller Bore for all pumps requiring assembly:

a. Take two readings opposed to each other by 90 degrees.

b. All measured clearances shall be within Supplier's specifications for new installations. Replace and recheck impellers found to be out of round or out of specified tolerance.

3. Measurement of shaft runout for all rotating equipment requiring assembly:

   a. Remove bearings from the shaft. Support shaft on pedestal rollers or in a lathe.

   b. Check each shoulder on the shaft.

   c. Take two readings for each shoulder, opposed to each other by 90 degrees.

   d. All measured clearances shall be within Supplier's specifications for new installations. Replace and recheck shafts found to be out of round or out of specified tolerance.

4. Vibration Measurements:

   a. Provide vibrational signature testing and documentation for each piece of direct drive or close coupled rotating equipment with a motor HP of 100 or above and a rated operating speed in excess of 1999 RPM.

   b. Unless specified otherwise, the current edition of the Hydraulic Institute Standard, "Acceptable Field Vibration Limits" shall be the standard for vibrational testing.

   c. Take all specified vibrational readings in three directions: vertical, horizontal, and axial.

   d. Provide vibrational measurements in the following engineering units:

      (1) Displacement in thousandths of an inch (mils), peak to peak.

      (2) Velocity in inches per second (ips), peak to peak.

      (3) Acceleration in feet per second per second (lg=32.3 ft/sec./sec.) zero to peak.

      (4) Spike energy in g-SE.

      (5) The vibrational readings shall be less than the device rotating frequency, and within the operating band specified by the Supplier.

      (6) Amplitude Allowable Maximums:

RPM	Amplitude inches peak to peak:
3,000 and above	0.001
1,500 - 2,999	0.002
1,000 - 1,499	0.0025
999 and below	0.003

5. Belt Drives:

    a. All belts shall ride within the sheave and not slip to the bottom of the groove(s).

    b. Belt tension shall be in accordance with Supplier's recommendations.

    c. Pulley alignment shall be within Supplier's recommendations.

6. Gear Drives and Reducers:

    a. Check gears for lash at no less than three points around the gear.

    b. Rotate gears a full 360 degrees while checking alignment.

7. Coupling/Shaft Alignment:

    a. Perform all final alignments and checks with a dial indicator or a laser device. Feeler gauges and straight edges are not acceptable.

    b. Eliminate soft foot conditions prior to aligning.

    c. When checking for final soft foot, any displacement in excess of 0.002" must be corrected.

    d. When checking for pipe strain, any displacement in excess of 0.002" requires piping realignment.

    e. Alignments will not be regarded as final until the grout is set and all piping has been attached. Demonstrate that alignment is not changed by attachment of piping.

    f. Shim the driving element, never the driven element.

    g. Take bracket sag corrections into account when using a dial indicator. Bracket sag shall be determined on a rigid pipe.

    h. Mount a dial indicator to the driven element so that it can be rotated. Rotate both elements while aligning.

    i. When aligning three coupled elements, align gear reduction elements with the driven element first, then align the driver to the gear reduction element.

    j. Check all four alignments, i.e., angular alignment in the vertical and horizontal planes, and parallel alignment in the vertical and horizontal planes.

k. The acceptable alignment accuracy for flexible couplings is +0.005 inches, or the Supplier's specifications, whichever is more stringent.

l. The dial indicator must be perpendicular to the alignment surface.

m. Number hold down nuts prior to tightening. Loosen in reverse order. Tighten in ascending order.

n. Use only clean, deburred shims. Clean the machine base and feet from rust or burrs prior to alignment.

8. Measurement of Noise (dB):

a. Eliminate noise sources generated by adjacent construction activity prior to testing.

b. Establish a background noise level prior to testing.

c. Perform noise level testing on each installed device as required by the technical specifications.

d. The maximum noise level exposure is 85 dBA over eight hours continuous for office, shop, and other areas where the Owner's personnel will be performing their assigned duties.

9. Hydrostatic Testing:

a. AWWA C600 standards latest edition are the standards for all hydrostatic testing.

b. Visually inspect all welds prior to testing, for cracks, undercut on surface greater than 1/32-inches deep, lack of fusion on surface, reinforcement greater than Table 127.4.2 located in ANSI B31.1 Power Piping, and incomplete penetration (when accessible). Repair or rework as directed by the Engineer.

c. At no time during hydrostatic testing shall any part of the piping system be subjected to a stress greater than 90 percent of its yield strength at test temperature.

d. After 10 minutes of full hydrostatic test pressures, make an examination for leakage of all joints, connections, and all regions of high stress, such as around openings and thickness transition sections.

e. Unless otherwise specified, the minimum required hydrostatic test pressure shall be 1.5 times the design pressure as specified and as indicated.

f. Pressure holding time shall be 10 minutes plus the time required to inspect for leakage.

g. Maximum pressure shall not exceed the maximum rated pressure for any component in the system being tested.

10. Electrical Equipment:

a. The testing standards for electrical components are those contained in Section 26 05 10 and the pertinent technical specification(s).

F. Where required by the equipment specifications, the Contactor shall furnish an authorized, competent representative of the equipment or unit process supplier to supervise and coordinate the Functional Completion Testing program.

1. Instrument readings and other test data shall be tabulated by the Contractor.

G. Documentation Requirements:

1. Certificates are required for all Functional Completion Testing for equipment and unit process systems. Contents of the certificate shall be at a minimum:

a. Contractor Review Comments, and Approval Page. This page shall include Certification by the preparer that he/she is the person responsible for the test data and the data is authentic and accurate. This page shall include a listing and signature of all witnesses to the test

b. Equipment Suppliers Review Comments, and Approval Page. This page shall include Certification by the equipment or unit process systems suppliers that the equipment or unit process systems are properly installed and suitable for startup.

c. Engineer and Owner Review Comments, and Approval Page.

d. Process, Equipment, and P&IDs Involved in this Functional Completion Test

e. FCT Schedule

f. Test Descriptions/Procedures

(1) Equipment or unit process systems tested.

(2) Test dates.

(3) Electrical Inspection and Tests

(4) Test results.

(5) Any repairs or corrections required to obtain acceptable test results.

(6) Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

(7) Copies of calibration records for plant installed instrumentation

g. Certify Mechanics and Installation. Inspection and certification to be conducted by equipment representative. Inspect and certify that each piece of equipment meets the following requirements:

(1) Not damaged in transportation or installation.

(2) Properly installed with no undue force imposed from piping or supports.

(3) Is properly lubricated.

(4) Motor rotation is correct.

(5) Free of overheating.

(6) Free of vibration.

(7) Free of noise.

(8) Functions without overloading.

(9) Piping and other connections are completed.

(10) No leaks at equipment connections (static pressure testing).

h. Certify Electric Valve Mechanics and Installation

i. Inspect and certify that each valve meets the following requirements:

(1) Not damaged in transportation or installation.

(2) Properly installed with no undue force imposed from piping or supports.

(3) Is properly lubricated.

(4) Motor rotation is correct.

(5) Free of overheating.

(6) Free of vibration.

(7) Free of noise.

(8) Functions without overloading.

(9) Piping and other connections are completed.

(10) No leaks at equipment connections (static pressure testing).

j. Inspection and certification to be conducted by Contractor.

k. Instrumentation and Control Inspection and Tests

l. Inspect and certify instrumentation and control circuits for the following:

(1) Loop checks have been completed for all signal and control circuits.

(2) All instruments have been calibrated.

(3) All instrumentation tubing has been pressure tested and any leaks repaired.

(4) Manual modes function as intended.

(5) Protective interlocks function as intended.

(6) Remote modes function as intended.

(7) Automatic modes function as intended.

m. Instrumentation tests include the following:

(1) Complete loop checks for all signals and controls. Control panel operates process properly in automatic mode.

2. Tests certificates shall be submitted no later than 30 calendar days, after testing ends. The Engineer and Owner shall have no more than 30 calendar days to complete a review and return with any exceptions noted.

3.03 STARTUP:

A. Provide 30 days written notice to the Engineer for each startup procedure so that the Engineer, may witness the each startup procedure. The Engineer may witness the performance of any or all startup procedure, at their option.

B. Startup shall begin at the conclusion of Functional Completion Testing, when the equipment or unit process systems are subjected to full operation using a process flow substitute.

1. Startup activities shall be carried out with clean water or air, or other flows as required to show the equipment and unit process systems are functional.

2. Process flows or process solids shall not be used for Startup.

3. The various vendors, equipment suppliers and manufacturers shall provide on-site supervision and assistance for Startup services for the new facility.

C. The Contractor shall coordinate all startup activities for equipment and unit process systems in accordance with the accepted Plan. The Contractor shall develop a detailed Startup plan as part of that Plan that includes the following as a minimum:

1. Description of the overall, general startup process.

2. List of equipment and unit process systems included for Startup activities.

3. Detailed startup sequence of activities.

4. Equipment and system boundaries as shown using marked-up P&IDs.

5. Listing of staff and responsibilities for activities.

D. Startup Requirements: The following are minimum requirements for completion of Startup activities:

1. Startup shall show that the equipment or unit process systems are suitable for continuous operation using clean water and other fluids or gases (no process fluids or solids) and that the flows and operating parameters are in compliance with specified design conditions.

a. Startup shall also demonstrate that local and remote instrumentation and controls are functioning properly and communicating with each other properly.

b. Equipment or unit processes shall be operated for a minimum of 2 days without interruptions in service.

c. If the startup fails, the contractor will be responsible for redoing the startup testing at no additional costs to the owner.

E. Documentation Requirements:

1. A Startup certificate shall be prepared and submitted to the Engineer for review and returned with any exceptions noted. The reports shall include, but not be limited to, the following:

2. Contents of the certificate shall be at a minimum:

   a. Contractor Review Comments and Approval Page. This page shall include Certification by the preparer that he/she is the person responsible for the test data and the data is authentic and accurate. This page shall include a listing and signature of all wittiness's to the test. Certification by the Contractor that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance.

   b. Equipment Suppliers Review Comments and Approval Page. This page shall include Certification by the equipment or unit process systems suppliers that the equipment or unit process systems have been started up properly and operated within the design parameters. Certification by the equipment or unit process systems supplier that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance.

   c. Engineer Review Comments, and Approval Page.

   d. Process, Equipment, and P&IDs Involved in this startup test.

   e. Startup Schedule

   f. Test Descriptions/Procedures

      (1) Equipment or unit process systems tested.

      (2) Test dates.

      (3) Electrical Inspection and Tests

      (4) Test results.

      (5) Any repairs or corrections required to obtain acceptable test results.

      (6) Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

g. Appendix:

(1) A summary of all data used in the calculations, including source, formulas with all terms defined.

(2) Calculations for all data submitted, fully defined.

(3) Copies of all raw field data sheets, including those indicating sampling point locations, and notes.

(4) Production and/or operational data.

(5) Calibration procedures and work sheets for sampling equipment.

(6) Copies of calibration records for instrumentation.

END OF SECTION

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SECTION 01 78 27

RELIABILITY TEST

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies the Reliability Test work required as a basis for completion of the project.

1. The Reliability Test is an extended operation test as part of the overall Completion Testing requirement.

2. The Reliability Test shall be scheduled as specified herein and in accordance with Section 01 78 25.

B. An extended operation Reliability Test shall be completed for the constructed facilities to confirm that the equipment and unit process systems provided by this contract work together as a complete Facility under continuous operation for the specified time period.

1. The Reliability Test shall be conducted after all the major equipment and unit process systems have successfully completed in accordance with Plant Testing Startup and Commissioning in accordance with Section 01 78 25.

C. The Contractor will provide guidance for managing, supervising, and directing the Owner's designated operating and maintenance staff during the Reliability Test.

1. The Contractor shall provide the services of equipment and systems suppliers to assist.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 RELIABILITY TEST PLAN:

A. A detailed test plan shall be prepared and submitted to the Engineer for review and returned with comments prior to commencing the Reliability Test in accordance with Section 01 33 00. The plan shall be prepared by the Contractor in conjunction with the equipment or unit process suppliers with review by the Engineer. Minimum requirements of the Reliability Test Plan shall be:

1. A description of the schedule of events.

2. A description of the instrument readings required and frequency of readings.

3. A detailed layout showing the valves, pumps, instruments, generators, etc. that will be operated/opened closed and cycled through.

3.02 RELIABILITY TESTING:

A. For the Reliability Test, the Influent Pump Station systems shall be operated to obtain stable operating conditions, typical of normal operation of the facility. Each side of the influent pump station shall be operated independently to demonstrate operability.

B. Reliability Test operating data, shall be collected and submitted to the Engineer and Owner on a daily basis for review.

1. Test data collected at a minimum shall include operating conditions for influent pumps and generators.

C. Contractor shall be responsible for including any temporary or permanent connections necessary to recirculate water between the forcemains to demonstrate operability of the pump station.

D. Local and remote on-site instrumentation equipment shall be used to obtain necessary data to document operating parameters. Where local instrumentation is available, manual logging of the data shall be done in conjunction with the instrumentation readings to verify remote instrumentation readings. The operating data will be used by the Engineer to determine the successful completion of the test.

1. The Facility shall be operated continuously for the period of 5 days to demonstrate sustainable, reliable operation while recirculating W1 or W3 water.

a. For the Reliability Test, plant data shall be collected and recorded to show that the Facility was operated in accordance with normal ranges and performance parameters for the facility.

b. Components of the systems shall be those items associated with the system being operated and not a part of other idle systems. The systems to be run to demonstrate a successful Reliability Test are:

(1) Influent Pumps

(2) Control Valves/Flow Metering Instruments

(3) Backup Generators

c. Up to 4-12 hour shutdown periods for maintenance will be allowed during the test period. Shutdowns that occur because of utility power outages, acts of God, or failure of support systems not part of this contract, are exempt from the allowed shutdown periods. Operation of standby equipment or processes shall not be allowed unless part of the constructed system. If more than the allowed shut downs occur, corrective measures shall be taken by the Contractor and the test shall be re-run in its entirety at no additional cost to the Owner.

3.03 TEST COORDINATION:

A. The Contractor will provide guidance for managing, supervising, and directing the Owner's designated operating and maintenance staff during the Reliability Test.

1. The Contractor shall work closely with the equipment or unit process systems suppliers to aid in coordination of required plant functions involving systems not furnished by the supplier of the equipment or unit process systems suppliers. This shall include but is not limited to support equipment, utilities, and support processes.

B. The Contactor shall furnish authorized competent representatives of the equipment or unit process systems suppliers to attend and assist with the Reliability Test.

1. The equipment and unit process systems shall not be solely operated by these representatives.

2. All modifications to operations must be through the Contractor and any changes in operation recommended by these representatives shall be thoroughly explained and documented to the operating staff.

3.04 TEST FAILURE:

A. Pump Station operating data shall be used to determine that the Facility has successfully completed the Reliability Test. If at any time the daily data does not indicate acceptable operation, the Engineer will notify the Contractor to change or modify operation to bring the operation back into acceptable ranges.

B. In the event that the Reliability Test was not successfully completed, the Contractor shall repeat the test at no additional cost to the Owner.

3.05 LETTER OF COMPLETION:

A. After review and return with any exceptions noted of Reliability Testing data reports, the Engineer shall provide a Letter of Completion (with exceptions noted) to the Contractor for the Facility.

END OF SECTION

SECTION 01 78 36

WARRANTIES AND BONDS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.

1.02 DEFINITIONS:

A. Standard Product Warranties are pre-printed written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

C. Standard Product Warranties and Special Warranties shall start on the date established as the date of Substantial Completion.

1.03 RELATED WORK:

A. Refer to Conditions of Contract for the general requirements relating to warranties and bonds.

B. General closeout requirements are included in Section 01 77 00.

C. Specific requirements for warranties for the Work and products and installations that are specified to be warranted, are included in the individual Sections of Division 2 through 46.

D. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

1.04 SUBMITTALS:

A. Submit written warranties to the Owner prior to the date fixed by the Engineer for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Owner.

B. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Owner within fifteen days of completion of that designated portion of the Work.

C. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Engineer for acceptance prior to final execution.

D. Refer to individual Sections of Divisions 2 through 46 for specific content requirements, and particular requirements for submittal of special warranties.

E. At Final Completion, compile a pdf file of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Contract Documents and submit under a separate cover. Provide bookmarks embedded into the pdf for easy access.

F. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Contract Documents, with each item identified with the number and title of the specification Section in which specified, and the name of the product or work item.

G. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.05 WARRANTY REQUIREMENT:

A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise

available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

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SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide project record documents as indicated and in compliance with Contract Documents.

B. Maintain at site one record copy of:

1. Drawings.

2. Project Manual.

3. Addenda.

4. Change orders and other modifications to Contract.

5. Engineer's Field Orders, Work Change Directives, Written Amendments, or clarifications.

6. Returned Shop Drawings and other submittals.

7. Field test records.

8. Construction photographs.

9. Associated permits.

10. Certificates of inspection and approvals.

1.02 SUBMITTALS:

A. At Substantial Completion:

1. Deliver pdf marked up set of Drawings to Engineer for use in preparation of record drawings.

B. Submit with transmittal letter containing following:

1. Date

2. Project title and number

3. Contractor's name and address

4. Title of record document

5. Signature of Contractor or authorized representative

1.03 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sustainability Standards Certifications.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 MAINTENANCE OF DOCUMENTS AND SAMPLES:

A. Store record documents in electronic format.

1. Provide secure storage space for storage of samples.

B. Maintain record documents in electronic format accessible via cloud storage system for Engineer and Owner to access at any time. Do not use record documents for construction purposes.

C. Make record documents and samples available for inspection by Engineer or Owner.

D. Failure to properly maintain record documents may be reason to delay portion of progress payments until records comply with Contract Documents.

3.02 RECORD DOCUMENTS:

A. General:

1. Maintain complete set of Drawings and Project Manual, including Addenda, annotated to show changes made during construction.

2. Label document “PROJECT RECORD”.

3. Record information concurrently with construction progress:

a. Do not conceal Work until information is recorded.

b. Record changes made by Field Order, Change Order or Work Change Directive and identify document number.

c. Record changes made by Change Order, Work Change Directive or order for minor change in Work and identify document number.

4. Give particular attention to concealed equipment and materials that would be difficult to measure and record at later date.

B. Drawings:

1. Graphically depict changes by modifying or adding to plans, details, sections, elevations, or schedules. Contractor may be required to generate sketches to accurately depict what was build and acceptance shall be at the discretion of the Engineer if sufficient information is provided.

2. Make changes on each sheet affected by changes.

3. Dimensions:

a. Depths of various elements of foundation in relation to finish first floor datum.

b. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

4. Location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure.

5. Details not on original Drawings.

6. Location and identification of exposed interior piping, including those shown schematically on Drawings.

7. Size of equipment and location including connections.

8. Standard details shall be modified to depict actual construction activities if consistently modified for the project. Isolated locations with a change from a standard detail shall be individually annotated separately.

9. Electrical and Instrumentation:

   a. Horizontal and vertical locations and size of underground cable, conduit, and duct runs dimensioned from established building lines.

   b. Plan locations, alignments, and size of interior concealed and exposed feeders and conduits. This shall include conduits and feeders cast into concrete.

   c. Size and location of access panels.

   d. Variations from original Drawings.

C. Specifications:

1. Mark Specification sections to show substantial variations in actual Work performed in comparison with text of Specifications and modifications.

2. Include variations in products delivered to site and from manufacturer's installation instructions and recommendations.

3. Give particular attention to substitutions and selection of options and similar information.

4. Note related record drawing information and Product Data.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 01 81 13.01

SUSTAINABLE DESIGN REQUIREMENTS – ENVISION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Envision is a sustainability certification framework that includes 64 sustainability and resilience credits organized around five categories: Quality of Life (QL), Leadership (LD), Resource Allocation (RA), Natural World (NW), and Climate and Resilience (CR). There are five levels of achievement under each credit. The levels of achievement in order of increasing point value are Improved, Enhanced, Superior, Conserving, and Restorative. Envision is designed for infrastructure projects and will be applied campus-wide for the NEW WRF. The project is pursuing Platinum certification under the Envision v3 framework. Documentation of sustainability practices from design through operations is the basis of framework requirements.

B. Section includes general requirements and procedures for compliance with certain Envision credits needed for the Project to obtain Envision Platinum certification based on the Institute for Sustainable Infrastructure (ISI) Envision Certification program, meaning at least 50 percent of total applicable points must be met under Envision Version 3, 2018.

C. The following Envision credits require compliance during construction:

1. QL1.3 Improve Construction Safety

2. QL1.6 Minimize Construction Impacts

3. QL3.3 Enhance Local Views and Character

4. LD1.4 Pursue Byproduct Synergies

5. RA1.1 Support Sustainable Procurement Practices

6. RA1.2 Use Recycled Materials

7. RA1.4 Reduce Construction Waste

8. RA1.5 Balance Earthwork on Site

9. RA2.2 Reduce Construction Energy Consumption

10. RA3.3 Reduce Construction Water Consumption

11. NW2.1 Reclaim Brownfields

12. NW2.3 Reduce Pesticide and Fertilizer Impacts

13. NW2.4 Protect Surface and Groundwater Quality

14. NW3.1 Enhance Functional Habitats

15. NW3.2 Enhance Wetland & Surface Water Functions

16. NW3.4 Control Invasive Species

1.02 REFERENCES:

A. Institute for Sustainable Infrastructure (ISI) (https://sustainableinfrastructure.org/): Envision – Version 3

1.03 ADMINISTRATIVE REQUIREMENTS:

A. The Contractor shall respond to questions and requests from the Engineer, the Owner, and ISI regarding Envision credits or other sustainability requirements that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on the Contractor's procedures until ISI have made their determinations on the Project's Envision certification application. Document responses as informational Submittals.

B. Contractor should assign a person as the Envision Coordinator. This person can have other project responsibilities but shall be the point person for all project Envision-related questions/reporting. The Envision Coordinator shall:

1. Ensure compliance with the sustainability requirements document in this and subsequent sections.

2. Provide monthly reporting of inventories related to sustainable procurement (RA1.1), recycled materials (RA1.2), construction waste diverted (RA1.4), earthwork (RA1.5), and energy (RA2.2) and potable water consumption during construction (RA3.3).

3. Compile sustainability submittal documentation from applicable Manufacturers.

4. Provide a monthly log of sustainable requirements evaluated and implemented during the course of the entire project.

C. Provide Envision Action Plan within 30 days of Notice to Proceed and include the following:

1. Envision Coordinator Contact Information

2. Construction Management Plan for complying with identified Envision credits

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sustainability Standards Certifications.

C. Envision Coordinator: Notify the Engineer of changes in personnel performing the Envision Coordinator function.

D. The Owner reserves the right to reject products and assemblies based on incomplete or inaccurate submittals.

1.05 ENVISION CRITERIA:

A. QL 1.3 Improve Construction Safety:

1. Targeted Level of Achievement: Conserving

a. Contractor makes strong commitments to monitor and improve health and safety for onsite construction operations.

b. Documentation is created to track health and safety performance, promote best practices during construction, and to correct any deficiencies.

c. Safety and security competency training for all field personnel are conducted as specified in project safety plan. Contractor provides minimum training requirements.

d. Contractor has a specific site and project security plan. Contractor provides minimum training requirements.

e. Contractor provides programs that promote health and wellbeing.

B. QL1.6 Minimize Construction Impacts:

1. Targeted Level of Achievement: Conserving

a. A Construction Management Plan is implemented to address the temporary inconveniences associated with construction. Plan is informed by stakeholder engagement.

b. The Construction Management Plan addresses four types of construction impacts: noise, safety/wayfinding, access/mobility, or lighting.

c. The Construction Management Plan includes robust feedback mechanisms and performance monitoring and reporting for construction impacts.

C. QL3.3 Enhance Local Views and Character:

1. Targeted Level of Achievement: Restorative:

a. The Construction Management Plan identifies how the Northwest Oil Drain will be protected during construction.

D. LD1.4 Pursue Byproduct Synergies:

1. Targeted Level of Achievement: Conserving

a. The project includes short-term byproduct reuse during construction, e.g., beneficially reusing or repurposing traditional waste streams (Long-term reuse of effluent, heat, and gas will occur during operation.)

E. RA1.1 Support Sustainable Procurement Practices:

1. Targeted Level of Achievement: Enhanced

a. A minimum of 15 percent (by weight, cost, or volume) of the purchased materials shall follow sustainable practices as identified by Salt Lake City Policy 6.01.07 Sustainable Procurement, and SLCDPU New Water Reclamation Facility (WRF) Project EXHIBIT S – Support Sustainable Procurement Practices.

F. RA1.2 Use Recycled Materials:

1. Targeted Level of Achievement: Superior

a. A minimum of 25 percent (by weight, cost, or volume) of the purchased materials shall be considered recycled materials with recycled content and/or reused existing structures or materials.

G. RA1.4 Reduce Construction Waste:

1. Targeted Level of Achievement: Enhanced

a. A Construction Waste Management Plan is implemented that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on site or commingled.

b. A minimum of 50 percent (by weight or volume) of the waste materials shall be recycled, reused and/or salvaged.

H. RA1.5 Balance Earthwork on Site:

1. Targeted Level of Achievement: Enhanced

2. Contractor meets one of the following:

(1) 100 percent of fill and excavated materials are sourced or reused within 10 miles of the site; or

(2) Excavated material moved off site and/or fill brought onto the site does not exceed 50 percent of total site soil handling.

I. RA2.2 Reduce Construction Energy Consumption:

1. Targeted Level of Achievement: Improved

a. Planning reviews are used to identify and analyze options for reducing energy consumption during construction.

J. RA3.3 Reduce Construction Water Consumption:

1. Targeted Level of Achievement: Superior

a. Planning reviews are used to identify and analyze options for reducing water consumption during construction.

b. At least five (5) potable water conservation strategies are implemented.

K. NW2.1 Reclaim Brownfields:

1. Targeted Level of Achievement: Conserving

a. The project is located on a site classified as a brownfield or is known to contain contamination.

b. Active remediation, or a combination of active and passive remediation, is performed to reduce human exposure and to remove or break down contamination on the site.

L. NW2.3 Reduce Pesticide and Fertilizer Impacts:

1. Targeted Level of Achievement: Superior

a. Fewer, little, or no fertilizers or pesticides will be used on the project site during construction and operation.

(1) Exceptions are allowed for the controlled use of fertilizer for initial landscaping establishment.

(2) Exceptions are allowed for the controlled use of pesticides for removal of existing invasive species.

M. NW2.4 Protect Surface and Groundwater Quality:

1. Targeted Level of Achievement: Restorative:

a. Contractor determines potential impacts to surface water or groundwater quality, including temperature, during construction.

b. Contractor reduces the risk of quality degradation to surface water and/or groundwater during construction.

N. NW3.1 Enhance Functional Habitats:

1. Targeted Level of Achievement: Superior

a. Efforts are made to avoid and minimize impacts to existing terrestrial habitats.

b. Mitigation measures ensure that existing habitat functions including quantity, quality, and connectivity are maintained and two or more of these ecosystem functions are enhanced compared to existing conditions.

O. NW3.2 Enhance Wetland & Surface Water Functions:

1. Targeted Level of Achievement: Superior

a. Actively protect three ecosystem functions including hydrologic connection, water quality, aquatic/riparian habitat, and sediment transport/sedimentation.

P. NW3.4 Control Invasive Species:

1. Targeted Level of Achievement: Restorative

a. Best practices are used to prevent unintentional introduction of known invasive species to the site.

b. The Construction Management Plan includes provisions for preventing the introduction of invasive species (plant or animal).

c. The Construction Management Plan establishes a program that controls minor infestations of invasive species on site before and throughout construction.

d. Contractor establishes and implements a program that controls minor infestations of invasive species on site before and throughout construction.

e. Contractor guards against future infestations by supporting the establishment of native and/or noninvasive species.

1.06 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Sustainable Design Submittals.

B. QL1.3 Improve Construction Safety:

1. Contractor shall submit documentation of strong commitments to monitor and improve health and safety for onsite construction operations.

2. Contractor shall submit documentation of tracking health and safety performance, promoting best practices during construction, and correcting any deficiencies.

3. Contractor shall submit documentation of safety and security competency training programs.

4. Contractor shall submit documentation of a specific site and project security plan.

5. Contractor shall submit documentation of programs that promote health and wellbeing.

C. QL1.6 Minimize Construction Impacts:

1. Contractor shall submit a Construction Management Plan that addresses concerns from stakeholders associated with the temporary inconveniences of construction and mitigation measures for at least four of the following: noise, safety/wayfinding, access/mobility, or lighting. The Construction Management Plan shall include robust feedback mechanisms and performance monitoring and reporting for construction impacts.

2. Programs to monitor and inform impacted stakeholders on project performance in addressing construction impacts shall be documented.

D. QL3.3 Enhance Views and Local Character:

1. Contractor shall submit a Construction Management Plan that addresses how the Northwest Oil Drain will be protected during construction.

E. LD1.4 Pursue Byproduct Synergies:

1. Contractor shall submit a Construction Waste Management Plan that, at a minimum, identifies the materials to be diverted from disposal and how the materials will be beneficially reused/repurposed, including the final destination of the materials.

2. Contractor shall submit an inventory of waste materials that have been recycled, reused, or salvaged including a general description of each type/category of

construction and demolition materials generated, location and percentage of materials reused/repurposed by weight or volume.

3. Contractor shall submit an inventory and description of other actions taken to beneficially reuse conventional waste streams during construction, if not already captured in other submittals.

F. RA1.1 Support Sustainable Procurement Practices:

1. Contractor shall submit an inventory of purchases with supporting calculations of the percentage of total project materials by cost, weight or volume that align with the sustainable procurement practices including a description of the materials, the Manufacturer or Supplier of the material, and evidence of the disclosure requirements.

G. RA1.2 Use Recycled Materials:

1. Contractor shall submit an inventory of total materials used on the project by weight, volume, or cost (this must be consistent for all inventories).

2. Contractor shall submit an inventory of materials containing recycled content including the name of the product, name of the manufacturer, the weight, volume, or cost of the material (consistent for all materials), and the percentage of recycled content (either post-industrial or post-consumer recycled content).

3. Contractor shall submit an inventory of existing materials or structures that have been reused or salvaged including the location and weight, volume, or cost. In determining weight, volume, or cost, the project team may refer to standard equivalents.

H. RA1.4 Reduce Construction Waste:

1. Contractor shall submit a Construction Waste Management Plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on site or commingled.

2. Contractor shall submit an inventory of waste materials that have been recycled, reused, or salvaged including a general description of each type/category of construction and demolition materials generated, location and percentage of materials diverted by weight or volume.

I. RA1.5 Balance Earthwork on Site:

1. Contractor meets one of the following requirements:

a. Contractor shall submit documentation showing how the project balanced cut and fill on site and calculations of the percentage of excavated materials remaining on site; or

b. Contractor shall submit documentation showing the destination of any materials moved off site and their proximity to the project site (must be within 10 miles).

J. RA2.2 Reduce Construction Energy Consumption:

1. Contractor shall submit documentation that one or more planning reviews were conducted to identify and analyze options for reducing energy consumption during construction.

K. RA3.3 Reduce Construction Water Consumption:

1. Contractor shall submit documentation that one or more planning reviews were conducted to identify and analyze options for reducing potable water consumption during construction.

2. Contractor shall submit documentation that the project has implemented water conservation strategies during construction as specified in the Envision V3 manual.

3. Contractor shall submit calculation of potable water saved (gallons) for each strategy as compared to not implementing the strategy over the construction duration.

L. NW2.1 Reclaim Brownfield:

1. Contractor shall submit evidence of contamination on site. Documentation shall include information delineating the lateral and vertical extents of impact and the concentrations of the identified contamination of concern.

2. Contractor shall submit a mitigation and remediation plan that has been approved by the appropriate regulatory agencies.

3. Contractor shall submit construction phase monitoring and remediation plans to ensure contaminant mobilization is minimized and in compliance with applicable federal, state, and local exposure requirements and planned development.

M. NW2.3 Reduce Pesticide and Fertilizer Impacts:

1. Contractor shall submit documentation indicating the necessity, benefits, and term of use for any fertilizers or pesticides used on the project site.

N. NW2.4 Protect Surface and Groundwater Quality:

1. Contractor shall submit documentation explaining potential impacts to surface water and/or groundwater quality, their risk, and consequences.

2. Contractor shall submit documentation demonstrating that spill and leak prevention and response plans are in place.

3. Contractor shall submit documentation of project construction decisions intended to reduce the risk of surface water and/or groundwater quality degradation.

O. NW3.4 Control Invasive Species:

1. Contractor shall submit a Construction Management Plan to prevent the introduction of invasive species. The plan includes best practices to ensure that construction materials and equipment used on site are free of invasive species and seeds.

2. Contractor shall submit documentation of control, containment or suppression activities during construction for any major infestations of invasive species found on site.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 ENVISION CREDITS:

A. QL 1.3 Improve Construction Safety:

1. Contractor shall comply with project safety plan.

2. Contractor shall track health and safety performance and correct any deficiencies that are identified during construction as specified by the project safety plan.

3. Contractor shall implement safety training for all field personnel as specified by the project safety plan.

B. QL1.6 Minimize Construction Impacts:

1. Contractor shall implement procedures and policies to minimize construction impacts as specified by the Construction Management Plan.

C. LD1.4 Pursue Byproduct Synergies:

1. Contractor shall comply with the Construction Waste Management Plan.

2. Contractor shall reuse or repurpose existing structures or materials when possible.

D. RA1.1 Support Sustainable Procurement Practices:

1. Contractor shall select materials that align with Salt Lake City Policy 6.01.07 Sustainable Procurement guidelines, and SLCDPU New Water Reclamation Facility (WRF) Project Exhibit S – Support Sustainable Procurement Practices.

E. RA1.2 Use Recycled Materials:

1. Contractor shall select recycled materials, materials with recycled content, and/or reused existing structures or materials in accordance with recycled materials requirement.

F. RA1.4 Reduce Construction Waste:

1. Contractor shall recycle, reuse and/or salvage waste materials in accordance with the waste reduction requirement.

G. RA1.5 Balance Earthwork On Site:

1. Contractor shall source fill and/or reuse cut from sites that meet credit requirements.

H. RA2.2 Reduce Construction Energy Consumption:

1. Contractor shall attend planning reviews to identify and analyze options for reducing energy consumption during construction.

I. RA3.3 Reduce Construction Water Consumption:

1. Contractor shall attend planning reviews to identify and analyze options for reducing water consumption during construction.

2. Contractor shall implement five (5) water conservation strategies identified during planning reviews.

J. NW3.1 Enhance Functional Habitats:

1. Contractor shall manage wetlands restoration efforts during construction.

K. NW3.2 Enhance Wetland & Surface Water Functions:

1. Contractor shall manage wetlands restoration efforts during construction.

L. NW3.4 Control Invasive Species:

1. Contractor shall implement the programs and policies for controlling invasive species throughout construction as specified by the Construction Management Plan.

END OF SECTION

DIVISION 02

EXISTING CONDITIONS

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SECTION 02 01 20

PROTECTING EXISTING UNDERGROUND UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. The Contractor must protect all existing underground utilities within the work limits and along adjacent property that may be impacted through construction activities, regardless of if these utilities are shown on the contract documents, including but not limited to:

1. The existing forcemains between the existing IPS and the WRF.

2. The existing overhead power lines along Reclamation Rd.

3. Compaction.

4. Alternative support methods.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Record drawings to include record survey coordinates and elevations.

2. Proposed locations for any potholes per Section 02 32 19.

1.03 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.04 PROJECT/SITE CONDITIONS:

A. Pipelines will be indicated on the drawings, but the right is reserved to the Owner, acting through the Engineer, to make such modifications in location as may be found desirable to avoid interference with existing utilities.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Except as indicated, or as specifically authorized by the Engineer, where existing utilities to remain must be removed, reconstruct utilities with new material of the same size, type, capacity, and quality as that removed.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Comply with the requirements in Section 01 14 14.

B. Notify Bluestakes of Utah at least 72 hours before digging operations are scheduled to begin.

C. Review pothole data provided by Owner.

D. Potholes: Excavate potholes per Section 02 32 19 to field verify the locations, depth of bury, diameter, and pipe material of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Engineer if conflicts are encountered.

1. When excavating within 3 feet of existing forcemains, these test pits must be hand-dug.

3.02 PREPARATION:

A. Where utilities are parallel to or cross work, but do not conflict with work, notify the Utility Owner at least 48 hours in advance of construction at the crossing. Coordinate the construction schedule with the Utility Owner.

3.03 PROCEDURES:

A. Protect in Place: Protect utilities in place, unless abandoned, and maintain the utility in service, unless otherwise indicated or specified.

B. Damage to Utilities to Remain: If existing utilities to remain are damaged, immediately notify Utility Owner, and repair to Owner's satisfaction.

3.04 PROTECTION OF THRUST BLOCKS:

A. Protect thrust blocks on existing waterlines or sewer force mains in place or shore to resist the thrust by a means accepted by the Engineer and reconstruct. If the thrust blocks are exposed or rendered to be ineffective in the opinion of the Engineer, reconstruct them to bear against firm unexcavated or backfill material.

END OF SECTION

SECTION 02 01 30

CONNECTIONS TO EXISTING BURIED PIPELINES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Connecting to Existing Buried Pipelines

1. Tapping existing buried ductile iron, and PVC pipelines.

2. Line stopping.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B16.1: AN Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800

B. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A325: Standard Specification for Structural Bolts, Steel, Heat-Treated 120/105 ksi Minimum Tensile Strength

3. A536: Standard Specification for Ductile Iron Castings

4. B62: Standard Specification for Composition Bronze or Ounce Metal Castings

5. B584: Standard Specification for Copper Alloy Sand Castings for General Applications

C. American Water Works Association (AWWA):

1. C110: Ductile Iron and Gray Iron Fittings

2. C153: Ductile-Iron Compact Fittings for Water Service

3. C223: Fabricated Steel and Stainless Steel Tapping Sleeves

4. C509: Resilient Seated Gate Valves for Water Service

5. C515: Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service

6. C550: Protective Interior Coatings for Valves and Hydrants

7. C800: Underground Service Line Valves and Fittings

D. Manufacturer's Standardization Society (MSS):

1. SP-60: Connecting Flange Joint Between Tapping Sleeves and Tapping Valves

2. SP-113: Connection Joint Between Tapping Machine and Tapping Valve

E. NSF International (NSF):

1. 61: Drinking Water System Components Health Effects

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Manufacturer’s catalog data for products to be used.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.05 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Tapping Sleeves (for tapping outlets 4-inch to 12-inch diameter) for Ductile Iron and PVC Pipe:

1. Manufacturers:

a. Smith-Blair

b. Mueller

c. Romac

2. Products:

a. Complies with AWWA C223.

b. 18-8 Type 304 stainless steel.

c. Bolts, Nuts, and Washers: Type 304 Stainless Steel, coated to protect from galvanic corrosion.

d. Outlet: Recessed for tapping valve per MSS-SP 60.

e. Pressure Rating: To match or exceed rating of existing piping.

f. Certified to meet NSF 61 standard for potable water pipes only.

B. Tapping Valves (4-inch to 12-inch diameter):

1. Manufacturers:

a. Mueller (US Pipe)

b. EJ Prescott

c. American Flow Control

2. Products:

a. Conforms to AWWA C509 or AWWA C515.

b. Ends: Conform to ANSI B16.1, Class 125, and MSS SP-60 and MSS SP-113.

c. Wedge: Iron, fully encapsulated in rubber.

d. Stem: Non-rising.

e. Bonnet and Stuffing Box: 304 stainless steel.

f. Nuts and Bolts: 304 stainless steel.

3. Coating:

a. Fusion bonded epoxy, conforming to AWWA C550.

b. Certified to meet NSF 61 standard for potable water pipes only.

C. Tapping or Service Saddles (4-inch diameter and smaller) for Ductile Iron and PVC Pipe:

1. Manufacturers:

a. Ford Meter Box 202BSD

b. Smith-Blair

c. Romac 202NS

d. Mueller

2. Products:

a. Conforms to AWWA C800 and NSF 61.

b. Body: Bronze or , 85-5-5-5 Cast Red Brass per ASTM B584 or B62 or ductile iron meeting ASTM A536 with 10-12 mil fusion bonded black nylon

c. Outlet: Threaded NPT.

d. Gasket: Buna-N, conforming to NSF 61.

e. Straps: 18-8, Type 304 Stainless Steel.

(1) Single at least 3-inches wide or multiple each 1.5-inches wide.

(2) Double at least 2-inches wide each.

f. Studs, Nuts, and Washers: Type 304 Stainless Steel, coated to protect from galvanic corrosion.

g. Pressure Rating: To match or exceed rating of existing piping.

D. Line Stop Fittings:

1. Manufacturers:

a. ADS, Hydra-Stop

b. Furmanite, IPSCO Flo-Stop

2. Products:

a. Type 304 Stainless Steel split sleeve.

b. Seals: Rubber gasket constructed of Buna-N.

c. Bolts and Nuts: Steel, ASTM A325.

3. Rubber Stopper:

a. Fully expandable rubber, minimum 100 psi pressure rating, or

b. Carbon steel pivoting head with Buna-N sealing element, minimum 100 psi pressure rating.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Line Stopping: Expose the existing pipeline and determine the pipe wall thickness prior to ordering the line stop materials. If wall thickness cannot be visually ascertained, utilize pipe thickness testing using ultrasonic technology.

B. Tapping: Expose the existing pipeline to be tapped. Verify material of construction and outside diameter prior to ordering tapping materials.

3.02 PREPARATION:

A. Coordinate work to be performed with pipeline Owner.

3.03 INSTALLATION:

A. Line Stopping:

1. Install concrete and support thrust blocking before installing the temporary pressure tapping machinery and valve.

2. After tapping and line stopping operations have been completed, seal the tee fitting with an ASTM A36 steel pin-locked completion plug with Buna-N O-ring seal.

3. Close the fitting with a blind flange meeting the requirements of AWWA C110.

4. Repair any damage that occurs to line stop fitting, accessories, or existing pipeline.

5. Dispose of water and/or sewer and existing pipeline at no additional cost to Owner.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 02 32 13

SOIL BORINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide labor, materials, tools and equipment for making borings, including drilling boreholes, taking and preserving soil samples, keeping records, submitting logs and shipping soil samples, as indicated and in compliance with Contract Documents.

B. Wells (permanent or temporary) drilled to a depth greater than 30 feet shall be completed by a licensed Utah Licensed Well Driller, registered with the State, and appropriately abandoned. Complete the work in accordance with applicable state laws, rules, as required.

C. Drill borings at locations, to depths and sizes indicated.

1. Obtain samples of soil samples of type, sizes and recovery indicated.

2. Advance borings through obstructions unless terminated by the Engineer.

a. Relocate borings for convenience and with permission of Engineer.

b. Seal abandoned borehole if required by Engineer.

3. Determine depth to groundwater at boring locations.

4. Perform in situ testing at 5 foot intervals as coordinated with the Engineer.

5. Decontaminate equipment as indicated or as deemed necessary by the Engineer.

D. Complete boreholes as required by Engineer.

1. Install monitoring wells, see Section 02 32 25

2. Seal borehole, or backfill boring as indicated and when authorized by Engineer.

3. Complete boreholes as required by Engineer.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. D1586: Penetration Test and Split Barrel Sampling of Soil.

2. D1587: Thin Wall Tube Sampling of Soils.

3. D2488: Description and Identification of Soils (Visual-Manual Procedure)

4. D3550: Ring-Lined Barnel Sampling of Soils

5. D4220: Preserving and Transporting Soil Samples.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Mail no later than one day after completion of each boring and other subsurface exploration, one copy of signed field log to Engineer at indicated address.

C. After receiving and addressing boring log comments from Engineer, submit three copies of completed typed final boring logs referenced to ground surface with soil strata, together with notes, remarks and pertinent information at the completion of the work. All completed logs neatly type written on 8-1/2-inch by 11-inch paper.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Split Spoon and Drive Tube Samples: Recovery of less than 6 inches of the driven length of undisturbed soil is not an acceptable sample and a second sample is required immediately below unsuccessful recovery, after first advancing the borehole to undisturbed material.

C. Undisturbed Tube Samples:

1. Produce samples suitable for laboratory examination and testing.

2. Samples having less than 50 percent recovery of undisturbed soil is not an acceptable sample and a second sample is required immediately below the unsuccessful recovery, after first advancing the borehole to undisturbed material.

D. Classify soil samples in accordance with ASTM D2488.

1.05 DELIVERY, STORAGE AND EQUIPMENT:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Unless otherwise coordinated with the Engineer deliver or ship samples prepaid to:

1. Address:

AECOM
Attention: Rob Snow, PE
756 East Winchester Street, Suite 400
Salt Lake City, UT 84107

C. Package and transport split spoon and driven tube samples in accordance with ASTM D4220, Group A or B.

D. Package and transport undisturbed tube samplers in accordance with ASTM D4220, Group C or D.

E. Package and transport in accordance with ASTM D5079.

F. Protect jar samples from freezing, overheating, disturbances and breakage.

G. Protect tube samples from vibration, freezing, overheating and disturbance, shield from direct sunlight and store vertically in wooden or Styrofoam containers acceptable to the Engineer.

1.06 SITE CONDITIONS:

A. The site conditions are granular fills overlying generally soft clays with minor sand layers. Much of the fill is undocumented. Use rotary wash or hollow stem auger drilling methods.

B. Potholing may be required to remove obstructions.

C. Potable water for drilling is available to the Contractor on site from the Owner.

1. Coordinate with the Owner and Engineer.

2. Provide means of conveyance from the source to the drill site.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Undisturbed Tubes:

1. Piston and Push Sample Tubes (ASTM D1587):

a. Provide 3-inch O.D., 30-inch long piston sample tubes or 2-inch O.D., 20-inch long push sample tubes as indicated.

b. Provide a sharp cutting edge and positive inside clearance and 16 gage wall thickness.

c. Provide inside diameter of cutting edge 1/64-inch less than O.D. of sampler tube or as deemed necessary by Engineer.

d. Welds may not project from the seam.

e. Provide smooth hard lacquer or teflon coating.

f. Dented or damaged tubes are not acceptable and shall be removed from the site by the Contractor.

B. Sealing Wax: Provide microcrystalline wax such as Gulf Petrowax.

C. Plastic Cap: Provide tight fitting plastic caps for the ends of tubes.

D. Tape: Provide friction tape to attach plastic caps to ends of tubes.

E. Fill Material: Provide non-compressible fill material, such as sand, to backfill the tube between top of the sample and the top cap.

F. Portland Cement (Type I or II) for grout backfill.

G. Sand: Standard washed concrete fine aggregate in accordance with ASTM C33.

H. Bentonite: Chips of compressed bentonite clay, maximum 3/8-inch diameter.

2.02 EQUIPMENT:

A. Drilling Equipment: Provide following as indicated:

1. Truck mounted rig consisting of drilling equipment for advancing rotary wash or hollow stem auger pipe as required for taking required samples

B. Casing: Provide minimum 3-inch I.D. steel, flush jointed pipe or hollow stem augers.

C. Split Spoon Sampler (ASTM D1586):

1. Provide standard 24 inch long, 1-3/8-inch I.D. and 2-inch O.D. split barrel sampler, equipped with check valve, basket shoe sample retainer, as indicated.

D. Piston Tube Sampler: Provide the following as indicated or equal:

1. Stationary piston consisting of thin wall tube sampler containing a close fitting piston operated by a separate piston rod and sampler head with spring and piston rod check.

2. Advance tube to a depth of 24-inches hydraulically. Advancing thin wall tubes by means other than a piston operated sampler is not allowed unless accepted by Engineer.

E. Hammer:

1. 140 pound weight to drive standard split spoon sampler.

2. 300 pound weight to drive steel casing, and 3-inch non-standard split spoon sampler.

PART 3- EXECUTION

3.01 BOREHOLE:

A. Advance borehole to sampling depth by:

1. Spinning casing

2. Hollow stem auger

B. When obstructions are encountered above specified depth, advance casing or borehole past such obstructions.

C. Cased Holes:

1. Spin casing vertically through earth or other materials to such depth below ground surface as required to obtain samples or as deemed necessary.

2. Remove all materials from inside casing to depth sampled using water and acceptable chopping bits or augers.

a. Allow reuse of wash water:

(1) By use of settling basin, or

(2) With permission of Engineer.

b. Size pump used for recirculation of wash water so as to remove all material from inside casing.

D. When using hollow stem augers:

1. Advance augers with plug in place to sampling depth, or

2. Advance augers without plug to sampling depth and cleanout inside casing as described.

E. After drilling and sampling to required depth, install monitoring well (see Section 02 32 25), or backfill boring, as deemed necessary by Engineer.

F. Conduct in-situ testing every five feet as coordinate with the Engineer.

G. Remove casing or auger upon completion of the hole.

1. Do not remove until:

a. Groundwater levels have been measured, or perforated pipe installed.

b. Engineer has authorized such removal.

3.02 SAMPLING:

A. General:

1. Take samples at ground surface and 5-foot intervals or change of strata unless deemed necessary by Engineer.

2. Obtain samples by driving or pushing sampler into undisturbed material below bottom of borehole as deemed necessary by the Engineer or indicated.

B. Split Spoon Samples:

1. Drive standard split spoon sampler to full depth with a 140-pound hammer having a free-fall of 30 inches in conformance with ASTM D1586. Drive 3-inch split spoon sampler to full depth with 300 pound hammer having a free fall of 24-inches in conformance with ASTM D3550.

2. Record number of blows for each 6 inches of penetration.

3. Describe sample in accordance with ASTM D2488.

4. Preserve representative sample(s) in 8-ounce glass jars (ASTM D4220).

5. If earth is very compact and cannot be sampled using split spoon sampling method coring methods may be required to obtain sample.

6. Refusal is defined as a rate of advance of less than 12 inches per 120 blows or 1-inch per 50 blows when driven with a 140-pound hammer free-falling 30 inches.

a. Refusal not accepted as termination of borehole above bottom elevation given or as deemed necessary.

C. Drive Tube Samples:

1. Drive 2-inch I.D. thin wall minimum of 18 inches with 140-pound hammer free-falling 30 inches in conformance with ASTM D3550.

2. Record number of blows for each 6 inches of penetration.

3. Allow sampler to remain at rest for at least 5 minutes to develop friction between sample and tube.

4. Shear the sample with two complete rotations of the tube.

D. Undisturbed Tube Samples:

1. Press 3-inch O.D. thin wall tube to depth of 24 inches below bottom of borehole without rotation in one continuous operation under steady pressure at rate of not less than 1 foot per second in conformance with ASTM D1587.

2. Allow sampler to remain at rest for at least 5 minutes to develop friction between sample and tube.

3. When thin wall sampler is withdrawn from borehole, establish atmospheric pressure at top of sample just below piston.

4. Detach piston head mechanism in manner to cause minimum disturbance to sample.

5. Preserving Tube Samples (ASTM D4220):

a. After retrieving sample, remove 1 inch of sample from bottom of tube to make up jar sample.

b. Remove all disturbed material from top of the tube.

c. Seal ends of tube with wax placed in increments to prevent voids to a total thickness of at least 1 inch.

d. Fill void between wax and end of tube with noncompressible material, such as sand.

e. Seal ends with plastic cap, friction tape and microcrystalline wax. Do not heat wax to more than few degrees above its melting point.

f. Mark tube samples to indicate upper end of sample, sample interval, date collected, and sample recovery.

g. Store samples in accepted containers, in a vertical position and a protected location.

3.03 BACKFILLING BOREHOLE:

A. At the completion of the boring and with permission of the Engineer backfill the boring with a Bentonite/Portland Cement Grout.

1. Mix grout using not more than 6 gallons of water per 94 pound bag of Portland Type I/II Cement. Use 3 to 5 pounds of bentonite powder per bag of cement. Mix water with bentonite prior to adding cement. Mix grout well until free of lumps.

2. Pump cement through a tremie pipe discharging at the bottom of the hole while the casing or augers are still in the ground.

3. When the grout has displaced all fluid inside of the casing and appears at the surface, discontinue pumping and remove tremie pipe.

4. Remove casing or augers in increments. If level of grout falls below the bottom of the casing or augers discontinue removing auger, and continue grouting operations, until grout is again at ground surface.

B. Revisit borehole 24 hours after grouting operation, and backfill the settled top portion with grout.

C. For borings above the water table, backfill the boring using alternating lifts of clean sand and bentonite chips, with permission of the Engineer.

1. Add water to hydrate the bentonite chips.

D. If borings are made through asphalt surfaces, backfill the top 3-inches of the borehole with a black-top patch, tamped into place. Patch should be flush with the existing paved surface.

3.04 RECORDS:

A. As work progresses, drill crew foreman keeps complete, neat, accurate and legible record of each boring that contains the following.

1. Date and time

2. Engineer, Contractor, Inspector, and Drill Foreman

3. Boring number

4. Ground elevation at hole (established by the Engineer)

5. Type of borehole, auger or casing size, sample type(s), blows per foot for driven casing.

6. Height of drop and weight of drop hammer for taking drive samples, and size of drill rod.

7. Results of all boring details arranged on boring log showing stratification, thickness, and classification of materials penetrated, sample locations, type, number, length, recovery, and number of blows required for each 6-inch penetration of the sampler.

8. Depth of groundwater table at each hole prior to removing casing and 24 hours after removing casing.

9. Any unusual groundwater condition such as artesian flow or zones of loss of circulation.

10. Total depth of borehole

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 02 32 14

VIBRATION MONITORING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide vibration monitoring as indicated and in compliance with Contract Documents.

1. Furnish, install, maintain, monitor, and remove vibration monitoring equipment as specified and as indicated.

2. Monitor vibrations, air blast overpressures and noise levels originating from construction operations as indicated or specified.

3. Modify construction operation procedures if existing operation creates vibration, air blast overpressure, or noise exceeding specified amounts.

4. Vibration monitoring for blasting shall conform to the requirements of this specification section and the requirements of all applicable Local and State Authorities.

1.02 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00.

B. Retain the services of an independent vibration consulting firm with the following in-house personnel to conduct the following vibration monitoring requirements:

1. Preparation, signing and stamping of monitoring plans and daily reports, and overseeing monitoring and interpretation of monitoring equipment shall be performed by personnel with the following qualifications:

a. Be a State of Utah Registered Professional Engineer.

b. Have a minimum of 5 years' experience in the vibration consulting field.

c. Have successfully completed at least 5 projects with vibration-inducing operations, air blast overpressures, and noise levels equal to or more severe than those to be encountered.

2. Installation, monitoring and interpretation of monitoring equipment shall be performed by personnel with the following qualifications:

   a. Have at least 3 years' experience in the operation of monitoring equipment proposed for use and interpretation of records produced by such equipment.

   b. Have installed, operated, monitored and interpreted equipment and records on at least 3 projects with vibration-inducing operations, air blast overpressures, and noise levels from similar construction activities.

3. Performed and maintained calibration records on all instruments used to monitor the blasting program.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Qualifications of the independent vibration consulting firm's Professional Engineer as specified in subparagraph 1.02.B.1 including the names of the 5 successful projects with names, current addresses, and telephone numbers of persons in charge of representing the owners or the owners at the time of monitored vibration-inducing operation, air blast overpressures, and noise levels.

2. Qualifications of the vibration consulting firm's personnel to install, operate and interpret the monitoring equipment as specified in subparagraph 1.02.B.2 including the name of the personnel and the names of the 3 projects per person which they installed, operated, monitored, and interpreted monitoring equipment with names, current addresses and telephone numbers of persons in charge of representing the owners or the owners at the time of monitored vibration-inducing operations, air blast overpressures, and noise levels.

3. Two weeks prior to commencement of blasting or other vibration inducing operations, submit in writing the plan for monitoring operations and equipment to be used to assure compliance with the vibration, air blast overpressure, and noise limitation. As a minimum, this plan shall provide for the following:

   a. Recommended vibration limiting methods to meet the specified peak particle velocity limitations and locations for taking measurements.

   b. Manufacturer's brochures and written operation instructions for seismograph recording equipment intended to be used for each vibration occurrence.

4. Daily reports, while blasting or performing other vibration-inducing operations, detailing each source of vibration, location of monitoring, and the vibration records highlighting peak particle velocities. For blasting, include the air blast overpressure records as well as a plot of particle velocity versus scaled distance.

All daily reports shall be stamped and signed by the Vibration Consulting Firm's Professional Engineer.

PART 2 - PRODUCTS

2.01 EQUIPMENT:

A. Provide a low frequency sensitive three-component seismic recording instrument with wave paper trace, variable trigger level setting, peak particle velocity memory operation (in inches/second) and air blast overpressure and sound level readout capability that meets the following criteria:

1. Seismic Frequency Range: 2 to 200 Hertz (plus or minus 3 dB)

2. Acoustic Frequency Range: 2 to 200 Hertz (plus or minus 1 dB)

3. Velocity Range: 0.02 to 4.0 inches per second

4. Sound Range: 90 to 140 dB linear

5. Transducer: Three mutually perpendicular axes: radial, transverse, and vertical

6. Recording: Time-history of waveform capability

B. Manufacturers:

1. Instantel, Inc., Kanata (Ottawa) Ontario, Canada

2. Slope Indicator Co., Seattle, WA

3. Thomas Instruments, Inc., Spoffard, NH

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Furnish specified instrumentation to be installed, operated and interpreted by the vibration consulting firm's personnel, as specified below and indicated.

B. Monitor vibrations and record the entire particle velocity wave train, not just peak velocities. Obtain accurate, legible seismometer records of monitored vibrations.

C. Perform all blasting and other vibration-inducing operations so that vibrations reaching adjacent structures and facilities are within specified limits.

D. Monitor vibrations by measuring the peak particle velocity in the vicinity of work. Peak particle velocity is defined as a maximum vector sum of three velocity components,

measured concurrently in mutually perpendicular directions at any point by an instrument. The peak particle velocity as measured by the vibration consulting firm's personnel on or at the location as specified in the submitted vibration monitoring plan, shall not exceed the limits specified below:

Type of Concrete	Age of Concrete (Hrs)	Peak Particle Velocity In./Sec
Mass Concrete (footings, mats, slab-on-grade, fill concrete, etc.)	0 – 10 11 and over	1.0 2.0
Concrete Structures (walls, columns, elevated slabs, etc.)	0 – 11 11 – 24 24 and over	0.5 1.0 2.0
Existing Structures, Residences or Utilities		0.5

E. Air blast over pressures resulting from the blasting shall be recorded. Operate the instruments to make a permanent record for each blast.

F. In the event any recordings indicate that vibration or air over pressure limits are being exceeded, immediately suspend all blasting and other vibration-inducing operations and submit a report to the Engineer. Revise operations to reduce vibrations and submit a copy of the revised procedure to the Engineer at no additional cost to the Owner.

G. If evidence of displacement or damage to utilities, equipment, or structures is observed or reported, immediately notify the Engineer and discontinue operations creating the vibrations. Revise operation to reduce vibrations and submit a copy of the revised procedure to the Engineer.

H. Restore or replace utilities, equipment, or structures damaged by vibrations or air blast overpressures at no additional cost to the Owner.

3.02 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 02 32 19

SUBSURFACE UTILITY LOCATING (POTHOLING)

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes materials and procedures for performing pothole operations to locate existing underground utilities.

B. The work described in this section shall be considered on a case by case basis as proposed by Contractor. Engineer has procured potholing services and included the findings as part of the design provided to Contractor.

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 38-02: Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data.

B. Canadian Standards Association (CSA):

1. S250: Mapping of Underground Utility Infrastructure

C. American Public Work Association (APWA) Utah Chapter

1. APWA 2017 Manual of Standard Plans and Specifications

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

B. Submit request for pre-marking of pothole locations at least three calendar days prior to the commencement of field activities.

C. For Work to be completed outside the WRF property and on public rights-of-way, submit a traffic control/protection plan at least 3 calendar days prior to the commencement of field activities.

D. Submit proposed method of potholing, including description of equipment to be used, and schedule for potholing for acceptance at least 14 calendar days prior to the commencement of field activities. Obtain Owner's approval of pothole locations prior to commencement of field activities.

E. Submit field logs to the Owner within two working days after the completion of pothole excavations in each area. Include dates of potholing operations and any additional discovered information or pertinent data. Include for each pothole excavation field log:

1. Pothole number.

2. Date of pothole.

3. Depths to top and bottom of utility (measured from existing grade over utility at pothole).

4. Miscellaneous Contractor's notes.

5. Reference distance to above ground structure or permanent reference point from located utility.

6. Photograph(s) record of each pothole.

F. Submit temporary steel cap and/or steel plate bridging shop drawings at least seven calendar days prior to the commencement of field activities.

G. Submit tamped sand and gravel design for pothole backfill at least 7 calendar days prior to the commencement of field activities.

H. Submit asphalt concrete mix design at least 7 calendar days prior to the commencement of field activities.

1.04 PROCEDURES:

A. Subsurface utility-locating (potholing) services shall conform to CI/ASCE 38-02. For the purpose of this scope, "locate" means to obtain the horizontal and vertical position of the utility line by excavating a circular test hole or narrow trench (where approved of and/or requested by the Owner). Construct test holes using vacuum excavation or comparable nondestructive equipment in a manner that will cause no damage to the utility.

B. Subsurface utility locating shall consist of test hole excavations at locations indicated on the pothole plans as approved by the Owner. Narrow trench excavations (slot potholes) may be required at locations approved by the Owner or to locate multiple parallel utilities.

1.05 TIME OF COMPLETION/SCHEDULE:

A. The Contractor shall diligently prosecute the work to completion after Notice to Proceed to allow Engineer sufficient time to make adjustments to the design, if needed, before the Contractor begins the Work.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Tamped Sand and Gravel Backfill at Test Holes and at Exploratory Trenches

1. Tamped sand and gravel backfill shall consist of Granular Borrow. Refer to APWA 2017 Standard Specifications Section 31 05 13 Common Fill.

B. Asphalt Concrete Pavement Repair at Exploratory Trenches and at Test Holes

1. Asphalt concrete paving shall conform to APWA Section 32 12 05.

2. Asphalt shall be PG58-28 DM 1/2. Asphalt content in the pavement shall be 5.5 percent to 6.0 percent.

3. Areas to be paved shall receive prime coat. Prime coat shall be per APWA Section 32 12 13.19.

4. Aggregate shall be minimum 8-inches per APWA Section 32 11 23.

5. Paving thickness shall match existing plus 1 inch and shall match existing grade.

PART 3 - EXECUTION

3.01 POTHOLING OPERATIONS:

A. Underground Service Alert Requirements: Comply with Blue Stakes of Utah requirements for notification prior to excavation. Contact Blue Stakes of Utah at 1-800-662-4111 (or dial 811) no less than two and no more than 7 days prior to the start of exploratory excavation. Verify whether or not a representative of each utility or agency will be present during excavation, and coordinate with said individual(s). Take any precautions required by the utility owner.

B. Furnish, install, maintain, and remove necessary traffic signs, barricades, lights, signals, cones, pavement markings, and other traffic control devices. Perform traffic control in accordance with Salt Lake City and OSHA Regulations for Construction Projects.

C. Conduct potholing operations in a manner that minimizes the damage potential to existing underground utilities in order to ensure that the existing facilities will remain in operation without interruption. Contractor shall be responsible for, and repair to pre-existing condition (at Contractor's expense) any existing underground utilities damaged by potholing operations.

D. Backfill and repair test hole excavations immediately after obtaining the measurement data. Backfill and repair trench excavations requiring use of temporary steel plate bridging within four working days. Promptly provide notice to the Engineer for

scheduling field survey activities. Advise Owner of number of pothole excavations completed and number remaining.

E. Coordinate and cooperate with and facilitate field data collection by Engineer's surveyor. Pothole excavations shall sufficiently expose subsurface utilities to allow surveyor to easily determine and measure the following data:

1. Elevation at top and bottom of utility.

2. Elevation of existing grade over utility at pothole.

3. Coordinates at surface.

4. Utility type.

5. Outside diameter of utility or width of duct banks.

6. Utility material and condition.

F. Location and Depiction of Existing Utilities: Existing utility plans shall be present and utilized during potholing activities. The plans shall be compared to utility/agency paint markings following Underground Service Alert notification as well as locations premarked by the Owner's surveyor. If discrepancies are found between the plans and paint markings, promptly notify the Owner prior to commencement of any excavation.

3.02 EXCAVATION:

A. Protect utilities or underground structures from damage during potholing. Immediately report any damaged utilities to the affected utility's owner and the Owner. Repair immediately any damaged utilities in accordance with the respective utility owner's requirements. Neatly cut and remove existing pavement. Excavate test holes in such a manner as to prevent any damage to wrappings, coatings, or other protective coverings, utilizing vacuum excavation or hand digging.

B. Methods: Backhoe excavation is not permitted except for trench excavations**.** Use the following methods for pothole excavations:

1. Hand Digging: Hand digging is the method of excavating a pothole by manual means with hand-held, nonmechanical equipment such as a shovel.

2. Vacuum Excavation: Vacuum excavation shall consist of air or water pressure to break up the soil and a vacuum device to collect the spoil. Determine if air or water vacuum excavation shall be used depending upon specific site and environmental characteristics. Soil type such as heavy clay may require water vacuum excavation. Utilize air vacuum excavators if mud from water vacuum excavators cannot be disposed properly. Use air vacuum excavators if damage to utilities, such as cutting through cables, will occur with the use of water vacuum excavators.

   a. Air: Air vacuum excavators shall utilize a high velocity air stream to penetrate, expand, and break up the soil. Remove the loosened particles of soil and rock from the excavation through the use of a vacuum.

   b. Water: Water vacuum excavation systems shall excavate the pothole using high-pressure water to reduce and loosen the soil. Remove the wet soil and mud slurry to a spoil tank using a vacuum.

C. Size of Test Hole Excavation: Maximum test hole size shall be 8 inches in diameter at surface, unless indicated otherwise, or approved by Engineer due to subsurface conditions.

D. Size of Exploratory Trench Excavation: Trench width and length shall be as approved by the Engineer. Width and length may be affected by existing subsurface conditions. Trench depth shall be as required to accurately locate subsurface utilities.

3.03 TEMPORARY STEEL PLATE BRIDGING, WITH A NONSKID SURFACE (WHERE REQUIRED FOR APPROVED TRENCHES)

A. Provide steel plate bridging with a nonskid surface and shoring to preserve unobstructed traffic flow. In such cases, the following conditions shall apply:

   1. Steel plates used for bridging shall extend a minimum of 12 inches beyond the edges of the trench.

   2. Install steel plate bridging to operate with minimum noise.

   3. Shore the trench to support the bridging and traffic loads.

   4. Use temporary paving with cold asphalt concrete to feather the edges of the plates.

   5. Secure bridging against displacement by using adjustable cleats, shims, or other devices.

B. Install steel plate bridging and shoring using the following method:

   1. Attach approach plate(s) and ending plate (if longitudinal placement) to the roadway by a minimum of two dowels predrilled into the corners of the plate and drilled 2 inches into the pavement. Butt subsequent plates to each other. Compact

fine graded asphalt concrete to form ramps, maximum slope 8.5 percent with a minimum 12-inch taper to cover all edges of the steel plates. When steel plates are removed, backfill the dowel holes in the pavement with either graded fines of asphalt concrete mix or concrete slurry.

C. Maintain the steel plates, shoring, and asphalt concrete ramps.

D. Unless specified, use of steel plate bridging at any given location shall not exceed four consecutive working days in any given week. Cover backfilling of excavation with a minimum of 3 inches of temporary layer of cold mix asphalt concrete.

E. The following table shows the required minimal thickness of steel plate bridging required for a given trench width. In addition, plate thickness shall be sufficient for all anticipated loads.

Trench Width (feet)	**Minimum Plate Thickness (inches)**
1	1/2
1-1/2	3/4

F. The Contractor may use standard steel plate with known coefficient of friction equal or exceeding 0.35.

G. Use a "Rough Road" sign with black lettering on an orange background in advanced of steel plate bridging. This is to be used along with any other required construction signing.

3.04 POTHOLE REPAIR:

A. After excavating a test hole or trench, provide and install a temporary steel cap (over test hole) or temporary steel plate bridging (over trench) to facilitate data gathering by Owner's surveyor.

B. Following data gathering by surveyor, remove temporary steel caps and/or steel plate bridging, and backfill excavation with accepted material as follows:

1. Test Hole Excavations: Sand-gravel backfill per Part 2 of this section. Bring to grade with asphalt cement pavement per Part 2 of this section. Match existing pavement thickness plus 1 inch.

2. Exploratory Trenches: Backfill per Part 2 of this section. Match existing pavement thickness plus 1 inch.

C. The finished surface of the repair shall be of like material and constructed to the same finished grade as the adjacent pavement. The finished surface shall be such that it does

not allow water to pond. There shall be no discernable difference in surface level at the joint between the existing pavement and the completed repair.

3.05 DISPOSAL OF CUTTINGS:

A. Dispose of cuttings on-site.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 02 32 25

GROUNDWATER MONITORING WELLS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide groundwater monitoring wells as indicated and in compliance with Contract Documents.

1. Scope includes all labor, materials, tools and equipment to install groundwater monitoring wells at locations indicated on drawings and as directed by the Engineer.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

2. D4448: Standard Guide for Sampling Ground-Water Monitoring Wells

3. D5088: Standard Practice for Decontamination of Field Equipment Used at Waste Sites

4. D5092: Standard Practice for Design and Installation of Ground Water Monitoring Wells.

5. D5521: Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers

6. D6452: Standard Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations

7. D6671: Standard Test Method for Mixed Mode I-Mode II Interlaminar Facture Toughness of Unidirectional Fiber Reinforced Polymer Matrix Composites

8. F480: Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80.

B. Environmental Protection Agency (EPA):

1. RCRA Groundwater Monitoring, Draft Technical Guidance, November, 1992.

2. Guide To Management of Investigation Derived Waste, 9345.3-03fs, January 1992.

C. USDA Natural Resources Conservation Service (NRCS):

1. Soil Texture classification

D. National Sanitation Foundation (NSF)/American National Standards Institute (ANSI):

1. Standard 14: Plastics Piping System Components, and Related Materials, January 14, 2002, Document No. NSF/ANSI 14-2002.

2. Standard 60: Drinking Water Treatment Chemicals – Health Effects (well drilling products)

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Monitoring Well Record Drawings. Document dimensions, depths, intervals:

a. Well Screen

b. Casing

c. Sand Pack

d. Bentonite Seal(s)

B. Provide digital boring log documenting soil types showing soil types, depth to rock, presence or absence of fill materials, Photoionization Detector Readings (PID), split spoon blow counts, and additional pertinent information.

C. Comply with Utah State Regulations.

1. Wells regulated by the State Engineer that are drilled to a depth of greater than 30 feet must be constructed by a currently licensed Utah Licensed Well Driller.

2. A Utah Licensed Well Driller or a Utah Licensed Pump Installer must perform installation and repair of pumps on wells regulated by the State Engineer

3. Utah regulated wells include:

a. Test Wells, Monitoring Wells, and Piezometers

b. Inclinometers and Dewatering Wells if they affect an established aquifer

D. Submit monitoring well record and construction data in accordance with applicable federal, State, and local laws and regulations.

E. Comply with the requirements specified in Section 01 81 13.01.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Follow standard practices ASTM D5092.

C. Install in accordance with specification. Provide personnel licensed or qualified in accordance with local, state, and federal regulations.

1.05 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Send typed logs to AECOM within 5 days of completion of work.

1. Mailing address:

AECOM
Attention: Rob Snow, P.E.
756 East Winchester Street, Suite 400
Salt Lake City, Utah 84107

1.06 PROJECT/SITE CONDITIONS:

A. Complete well installation and associated work in accordance with Health and Safety Plan (HASP). Read, understand, and sign HASP. Contractor is responsible for the safety of their employees.

B. Adverse weather conditions must be considered. Work will not be conducted during severe weather such as lightning and other hazardous conditions.

C. Consider subsurface utilities and overhead utility hazards. Prior to starting any subsurface work:

1. Ensure that Blue Stakes Utah (phone 811, https://www.bluestakes.org/requests/) has been properly notified and that all subsurface utilities have been identified and cleared.

2. Blue Stakes may not provide clearances for all utilities such as cable television or internet, local municipal water and sewer, or on industrial sites. It is the responsibility of the Contractor to ensure all underground services have been cleared.

3. Coordination with owner and appropriate utility companies MUST be accomplished;

4. Contractor and/or Owner MUST be referenced for responsibility for clearance of utilities in the contract. This applies to ALL subsurface work.

5. Note: Utility "One Call" clearance MUST be verified by owner, site plans, and other means of subsurface obstruction identification. "One Call" subsurface utility clearance often incorporates subcontractors that may or may NOT be accurate.

D. It is the responsibility of the contractor to provide water, power, and required support materials to drill and sample soil borings, to install groundwater monitoring wells, and to properly handle and contain all Investigation Derived Waste (IDW) according to EPA Guide To Management Of Investigation Derived Waste.

1.07 WARRANTY:

A. Contractor must warranty the quality of the well installation and associated work.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Install groundwater monitoring well for the purpose of measuring groundwater levels and water quality.

B. Decontaminate all drilling equipment as necessary prior to starting work and in between boreholes commensurate with the level of contamination. Properly contain all decontamination materials. Install only well materials certified by the manufacturer to be free of contaminants.

2.02 MATERIALS:

A. Sand: Clean, subangular to rounded quartz sand at least 99.0 percent SiO_2 by weight. To ensure freedom from organic impurities, loss on ignition (L.O.I.) should not exceed 0.1 percent. Well sand pack must be appropriately sized corresponding to the well screen size.

B. Well Screen: 10-foot length of flush-jointed, threaded, 2-inch inside diameter, Schedule 40, NSF-pw polyvinylchloride (PVC) pipe with 0.010-inch machined slots. Screen is to be capped at lower end.

1. Three slots are to be spaced at 120-degree intervals along the pipe circumference, with each slot 90 degrees in width. Vertical slot spacing will be 0.125 inches or less.

B. Casing: Flush jointed, threaded, 2-inch diameter, PVC, NSF-pw pipe with non-threaded cap.

C. Bentonite Chips: Pellets of compressed bentonite, maximum 3/8-inch diameter.

D. Protective "stick-up" Casing: 5-foot length, nominal 4-inch diameter steel pipe with vented locking steel cap. Cap shall slip over protective pipe a minimum of 3 inches and

shall be secured with a keyed-alike brass padlock that has a 5/16-inch diameter hardened steel shackle.

E. Flushmount Casing: Minimum 8-inch diameter, traffic resistant, watertight, steel maintenance hole with minimum 12-inch long galvanized skirt. Well shall be secured with a 2-inch diameter gasket security plug with a keyed-alike brass padlock that has a 5/16-inch diameter hardened steel shackle.

F. Concrete: A fine aggregate and cement premix blended with clean, potable water to form thick concrete slurry.

G. Portland cement for grout backfill.

PART 3 - EXECUTION

3.01 WELL INSTALLATION:

A. Daylight the area of the soils investigation using vac-truck or other methods approved by the Engineer to a depth of 4 feet below the existing ground surface.

B. Install in accordance with ASTM D5092.

C. After hole has been bored or backfilled to the proper depth as directed by the Engineer, place a 6-inch layer of clean sand in the bottom of the borehole.

D. Place clean well screen and riser in borehole.

E. Remove casing simultaneously whenever material is placed down hole.

1. Do not withdraw casing faster than material is placed to prevent collapse of hole.

2. Do not withdraw casing too slowly so that sand will bridge inside and lift well screen.

F. Place sand pack to 2 feet above top of well screen and tamp.

G. Place a 2-foot layer of bentonite chips above sand pack. Hydrate bentonite chips with clean potable water, for 2-hour (minimum).

H. Backfill and compact remaining annular space with grout by means of tremie method, or drill cuttings to a depth at which the base of protective casing or flushmount casing will be set.

I. Install centralizers as necessary to ensure the well is straight.

J. If protective “stick-up” casing is required:

1. Install 5-foot length of nominal 4-inch (minimum) inside diameter steel casing with overlapping locking cap extending to 2 feet above ground.

2. Place concrete around steel casing so that it extends to a depth of at least 3 feet and slopes away from the well at the surface.

3. Secure PVC well casing with vented PVC cap.

4. If flushmount casing is required:

a. Secure well with 2-inch diameter expandable security plug with brass lock.

b. Install minimum 8-inch diameter maintenance hole so that it is flush with the above ground surface.

c. Place concrete around maintenance hole extending from bottom of maintenance hole and tapering to a 2-foot diameter concrete pad that slopes away from the well at the surface.

K. Label well appropriately with a permanent non-corrosive tag or permanent markings (e.g., MW-1).

L. Place keyed alike corrosion resistant locks on expandable flush mounted locks or steel stick-up protective casing to deter vandalism. Consider the security requirements of the site and the well.

M. If wells are required in roads or on road shoulders install flush mounted cover. Install bollards with high visibility paint if appropriate to protect well stick ups.

3.02 WELL DEVELOPMENT:

A. After well installation, develop wells by pumping, as directed by the Engineer until water produced is free of particulates. Contain development water for disposal on site as directed by the Engineer.

B. Develop with suction pump if water level is within suction limit.

C. Develop with submersible pump, piston pump, or bailer if water level is too deep for suction pump.

D. Contain all development water and dispose of all development in an on-site facility as directed by the Engineer.

3.03 PROTECTION:

A. Protect wells as necessary in temporary condition (highway cones or other highly visibility markers) or permanently with steel bollards set in concrete if necessary in high traffic areas.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 02 32 29

DECONTAMINATION AND SAFETY PROCEDURES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Furnish labor, materials, tools and equipment for decontamination of all equipment and supplies used for drilling borings, taking samples and installing groundwater monitoring wells.

1.02 REFERENCES:

A. Environmental Protection Agency (EPA):

1. Guide to Management of Investigation Derived Waste (IDW), 9345.3-03fs, January 1992.

1.03 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Conduct decontamination of equipment and materials and comply with health and safety requirements in accordance with specification and to satisfaction of Engineer.

C. The Contractor shall evaluate the known and potential hazards.

1. The Contractor’s Health and Safety Plan shall at a minimum conform to the requirements set forth in the AECOM Site-Specific Health and Safety Plan.

2. The Contractor’s Health and Safety Plan shall include any site specific safety requirements required by the site Owner and Governing Authority.

PART 2 - PRODUCTS

2.01 EQUIPMENT:

A. Decontamination Equipment:

1. Portable steam cleaning equipment.

2. Pump sprayer for reagent grade solvent application, satisfactory to Engineer.

3. Water.

4. Lab grade detergent.

5. New brushes for scrubbing equipment.

6. Polyethylene plastic sheeting.

B. Safety Equipment:

1. Level D Protection.

a. Work clothing, including reflective vest and gloves.

b. Safety glasses.

c. Steel toed boots.

d. Hard hat.

2. Level C Protection:

a. Air-purifying respirators with organic vapor cartridges (full face piece).

b. Chemical protective gloves.

c. Chemical protective boots.

d. Chemical protective coveralls.

e. Hard hat and steel toed boots.

3. Level B Protection:

a. Self-contained breathing apparatus (full face piece).

b. Inner and outer chemical protective gloves.

c. Chemical protective boots.

d. Chemical protective coveralls.

e. Hard hat and steel toed boots.

PART 3 - EXECUTION

3.01 EQUIPMENT DECONTAMINATION PROCEDURES:

A. Drilling Equipment:

1. Decontaminate all equipment that contacts soils directly or indirectly, such as drive casings, drill rods, sampling equipment and storage areas on drill rig for such equipment, as follows:

a. Before first borehole has been started.

b. After completion of each borehole and prior to commencement of next borehole.

c. After last borehole of drilling program has been completed.

2. Decontamination procedures will be conducted as follows:

a. Steam clean equipment.

b. Spray equipment with reagent grade solvent, if deemed necessary by and to satisfaction of the Engineer.

c. Steam clean as final rinse.

3. Conduct decontamination of drilling equipment at decontamination areas designated by and to satisfaction of Engineer.

a. If required, construct decontamination pad as deemed necessary and to satisfaction of Engineer.

B. Sampling Equipment:

1. Wash sampling equipment before and after each use in water, then scrub sampling equipment in a water and lab grade detergent solution, and finally rinse equipment in clean water.

a. Add both a reagent grade solvent and deionized water rinse to the decontamination procedure if deemed necessary by Engineer.

C. Well Development Equipment:

1. Decontaminate all equipment that comes or will come into contact with well during development process, such as hoses or bailers, using hand or steam cleaning methods and reagent grade solvent, as deemed necessary by Engineer.

D. Investigation Derived Waste:

1. Containerize any Investigation Derived Waste (IDW) generated during drilling, sampling and well development activities that is deemed by the Engineer or Governing Authority to be contaminated, potentially contaminated, or surplus.

a. IDW materials may include but are not limited to soil cuttings, drilling fluids, decontamination fluids, purge water, and disposable personal protective equipment.

b. IDW materials shall be containerized in DOT approved, water tight 55-gallon drums that are suitable for temporary storage and eventual transport to a licensed disposal facility.

c. See IDW reference above.

3.02 MATERIALS DECONTAMINATION PROCEDURE:

A. Casing and Screens:

1. Clean with lab grade detergent, as deemed necessary by Engineer, immediately before installation in borehole.

3.03 HEALTH AND SAFETY PROCEDURES:

A. Health and Safety Meeting. All drilling crew personnel must attend a daily mandatory health and safety meeting led by the subcontractor's designated site safety officer prior to commencement of drilling activities. Subjects discussed during the meeting shall include:

1. Site safety.

2. Use of protective equipment (including fit test if necessary).

3. Decontamination procedures.

B. Equipment Availability:

1. Provide complete set of safety equipment for specified level of protection for each drilling crew member.

C. Air Quality Monitoring:

1. AECOM health and safety personnel will monitor air quality at top of borehole and at face level during drilling and well construction.

2. If monitoring indicates a potential health hazard as defined in the health and safety plan, all site personnel shall use protective equipment and clothing as appropriate to the level of protection until a hazard no longer exists.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 02 41 00

DEMOLITION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide demolition and alterations of existing conditions as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. United States Environmental Protection Agency (USEPA):

1. 832: Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

B. Salt Lake County:

1. Best Management Practices for Construction Activities.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Demolition Plan including locations for disposal and/or recycling of demolished material.

2. Sustainable Design Submittals.

3. Construction Waste Management Plan including goal for amount of waste to be recycled, i.e., 25 percent, 50 percent, etc.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Demolition Plan: Provide description of sequence, methods, and equipment used for demolition (including disposal) for review prior to beginning work.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 PREPARATION:

A. Survey Markers and Monuments:

1. Provide three reference points, established by a licensed land surveyor, for each survey marker or monument temporarily removed. Record locations and designations of survey markers and monuments prior to removal.

2. Store removed markers and monuments during demolition work, and replace upon completion of work. Reestablish survey markers and monuments in conformance with recorded reference points. Forward letter to Engineer, signed by a licensed land surveyor, verifying reestablishment of survey markers and monuments.

B. Burning of demolition debris is prohibited.

C. Protect existing structures, equipment, and appurtenances to remain.

D. Obtain permission from Engineer before abandoning or removing existing structures, materials, equipment and appurtenances.

E. Provide fire extinguishers in areas where demolition work is performed by use of an open flame. Exercise necessary precautions for fire prevention.

F. Maintain circulation of traffic within area at all times during demolition operations.

G. Confine apparatus, storage of materials, demolition work, new construction, and operations of workmen to areas that will not interfere with continued use and operation of entire facility. Provide and maintain lights, barriers, and temporary passageways for free and safe access.

H. Provide shoring or bracing where necessary to prevent settlement or displacement of existing or new structures. Do not overload floors.

I. Coordinate with the Engineer and Plant Electrician prior to demolition of electrical duct banks, light poles, and/or equipment and conduct “Make Safe” activities to ensure power is properly disconnected.

3.02 DEMOLITION:

A. Demolish and remove existing construction, utilities, equipment, and appurtenances.

B. Provide maximum practicable protection from inclement weather for materials, equipment, and personnel located in partially dismantled structures.

C. Protect persons and property throughout progress of work. Provide safe working conditions for personnel.

D. Wet down work during demolition operations to prevent dust from arising. Minimize spread of dust and airborne particles.

E. Complete demolition work on upper levels before disturbing supporting members on lower levels.

F. Cap or plug with concrete, pipes and other conduits which are abandoned in place.

G. All concrete and asphalt concrete designated to be demolished shall be disposed of at an approved recycled facility or reused on-site as reviewed and approved by the Engineer.

H. Removed materials, equipment, and appurtenances, not designated for relocation, become property of Contractor and shall be disposed of off-site at a location(s) approved by the Engineer.

3.03 SALVAGE:

A. Store equipment to be salvaged or relocated as approved by Engineer. Protect salvaged items from damage during work.

B. Salvage fire hydrants for future use by Owner. Store in vicinity of original location and place so as not to interfere with construction.

3.04 REPAIR/RESTORATION:

A. Repair or remove items that are damaged. Repair and install damaged items to condition at least equal to that which existed prior to start of work.

END OF SECTION

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DIVISION 03

CONCRETE

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SECTION 03 01 30

CONCRETE REPAIR

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide concrete repair as indicated and in compliance with Contract Documents.

B. Complete repair mortar system installation in accordance with these specifications and the mortar system manufacturer's instructions regarding surface preparation, application, inspection and requirements for safety.

C. Complete crack repair work in accordance with these specifications and crack repair material manufacturer's instructions.

D. Complete joint repair work in accordance with these specifications and the joint repair material manufacturer's instructions.

E. The areas of concrete repair shall be determined by the Engineer and shall include any location where acidic attack of the concrete surfaces has reached a depth of 1/2-inch or deeper and at any air voids, bugholes or poorly consolidated concrete areas where the specified filler/surfacer materials cannot be used for filling or surfacing of the concrete.

F. If repair work is required for an area indicated to receive protective lining or coating, provide such repair in accordance with the requirements of this specification and the related lining specifications.

G. The repair work specified herein is intended to cover the requirements for repair of concrete only, to a maximum depth of approximately 2-inch. If after blasting and cleaning, an area is discovered that requires a repair greater than 2-inch deep, or an area is discovered that requires repair or replacement of reinforcing steel notify the Engineer so that details may be provided to the Contractor to complete the repair.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 503.4: Standard Specification for Repairing Concrete with Epoxy Mortars

B. ASTM International (ASTM):

1. C33: Standard Specifications for Concrete Aggregates

2. C150: Standard Specification for Portland Cement

3. C321: Standard Test Method for Bond Strength of Chemical-Resistant Mortars

4. C882: Test Method for Bond Strength of Epoxy Resin Systems

5. D570: Test Method for Water Absorption of Plastics

6. D638: Test Method for Tensile Properties of Plastics

7. D695: Test Method for Compressive Properties of Rigid Plastics

8. D790: Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

9. D4262: L.R. Standard Test Method for pH of Chemically Cleaned or Acid Etched Concrete Surfaces

10. E337: L.R. Standard Practice Test Method for Measuring Humidity with a Psychrometer.

C. National Association of Corrosion Engineers (NACE):

1. 6D-173: "A Manual for Painter Safety"

2. 6F-163: "Surface Preparation of Steel or Concrete Tank Interiors"

3. TPC2: "Coatings and Linings for Immersion Service"

1.03 MEASUREMENT:

A. Crack Repair: The quantities in linear feet to be measured for payment shall be the actual length of cracks repaired by the methods and materials specified under.

1. Epoxy crack repair.

2. Flexible polyurethane crack repair.

3. Rigid polyurethane crack repair.

B. Spall Repair Depth 2-inch or Less: The quantities in square feet to be measured for payment shall be the actual square footage of spalled concrete repaired by the method and materials specified under spall repair.

C. Spall Repair Depth Greater than 2-inch: The quantities in cubic feet to be measured for payment shall be the actual cubic footage of spalled concrete repaired by the method and materials specified under spall repair.

D. Joint Repair: The quantities in linear feet to be measured for payment shall be the actual length of joints repaired by the methods and materials specified under joint repair.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Procedures proposed for the accomplishment of repair work. Include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations to be coordinated with other works in progress.

2. Manufacturer's recommendations and product data sheets for all repair materials including performance criteria, surface preparation, ambient condition requirements and applications, curing requirements, volatile organic compound (VOC) data, and safety requirements.

3. Material Safety Data Sheets (MSDS) for any materials brought on-site including all repair system materials, solvents and abrasive blast media.

4. Qualifications of foreman and epoxy gun operators and demonstration of meeting the minimum requirements specified.

5. Design Mixes: Provide concrete and cement mortar in conformance with Section 03 30 00 and as specified herein.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Furnish the names of all subcontractors proposed for use for this work including necessary evidence and/or experience records to ascertain their qualifications in the application of epoxy, polyurethane polymer-modified and cement-based compounds.

C. Include in accepted applicator qualifications:

1. A minimum of five (5) years' experience in applying epoxy, polyurethane and polymer-modified and cement-based compounds similar to those specified in this Section.

2. A letter from the manufacturer of the specified materials, on the manufacturer's letterhead, signed by an officer of the company, stating that the subcontractor/ applicator has been trained in the proper techniques for the preparation of the surface, and proper methods for mixing, placing, curing, and caring of the manufacturer's products. This letter shall further state that the subcontractor/applicator is on the manufacturer's approved list of contractors.

D. Adhere strictly to the manufacturer's recommendations regarding temperature at time of application for all work. Do not use epoxy materials when either the temperature of the concrete to be repaired or the ambient temperature is below 50 degrees F. 24 hours before, during, or for a period of 48 hours after the completion of the repair. Temporary heat may be used to meet the specified requirements.

E. Use new epoxy, repair materials and use within the shelf life limitations set forth by the manufacturer. Clearly mark the shelf life limitations of each container.

F. The Contractor is ultimately responsible for the concrete repair work. Inspections by the Engineer or others do not limit the Contractor's responsibility.

G. Make all parts of the work accessible for inspections by the Engineer. Correct any conditions not in conformance with the specifications at no additional cost to the Owner.

H. Provide a Representative on site at all times when work is ongoing to represent the Contractor and to have authority to receive and execute all instructions given by the Engineer.

I. Allow changes in the specified repair work methods only with the permission of the Engineer.

J. Provide technical field support or training services required by the accepted material manufacturers at no additional cost to the Owner.

K. Provide materials from a single manufacturer for all components of a single repair.

1.07 SERVICES OF MANUFACTURERS REPRESENTATIVES:

A. Provide the services of a qualified manufacturer's technical representative to instruct the Contractor's personnel in the mixing, proper use and application of the epoxy, polyurethane, polymer-modified and cement-based compounds.

B. Provide written certification from the manufacturers' representative that materials have been mixed and applied properly and surfaces to receive these products have been prepared properly, all in conformance with manufacturer's requirements.

C. Provide on-site time required for the manufacturer's representative to achieve a successful installation at no additional cost to the Owner.

1.08 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements in APWA Section 01 66 00.

B. Provide shelter to store materials in area or areas designated by the Owner solely for this purpose. Confine mixing, thinning, clean-up and associated operations and storage of repair mortar materials debris before authorized disposal, to these areas.

C. Mix all specified materials in the sheltered mixing operation and materials from direct sunlight and inclement weather. Protect facilities from staining and damage.

D. Do not dispose of waste materials on-site.

E. Store waste temporarily in closed, nonflammable containers until final disposal. Keep no rubbish in Contractor's area longer than 24 hours.

F. Deliver all materials to the job site in new, unopened containers. Each container shall bear the manufacturer's name and label. Labels on all material containers shall contain the following information:

1. Name of product.

2. Federal Specification Number if applicable.

3. Manufacturer's batch number.

4. Manufacturer's name.

5. Generic type of material.

6. Hazardous material identification label.

7. Shelf life date.

G. Clearly mark all containers indicating any safety hazards associated with the use of or exposure to the materials.

H. Handle and store materials to prevent damage or loss of label. Protection of materials is the Contractor's responsibility.

1.09 PROJECT/SITE CONDITIONS:

A. Environmental Requirements:

1. Comply with the repair material manufacturer's recommendations as to environmental conditions under which materials can be applied and cured.

2. Do not apply materials when dust is being generated.

B. Protection:

1. Cover or otherwise protect finish work or other surfaces not being repaired.

C. Ventilation:

1. Provide ventilation to meet product requirements prior to, during, and after application.

PART 2 - PRODUCTS

2.01 WATER:

A. The water used for mixing concrete repair products shall be clear, potable and free of deleterious substances.

2.02 AGGREGATE:

A. All aggregates shall conform to ASTM C33 and Section 03 30 00.

2.03 EPOXY BONDING AGENT:

A. Epoxy bonding agent shall conform to ASTM C881 Type I, II, IV or V; Grade 2 for epoxy resin adhesives, depending on the application. The class of epoxy bonding agent shall be suitable for all ambient and substrate temperatures.

B. Products:

1. Sika Corporation; Sikadur 32

2. The Euclid Chemical Company; Duralcrete

2.04 ANTI-CORROSION COATING:

A. Anti-corrosion coating shall be a three-component, epoxy-modified cementitious material.

B. Products:

1. Sika Corporation; Sika Armatec 110

2. Sto Concrete Restoration Division; CR 246

3. The Euclid Chemical Company; Duralprep

2.05 EPOXY CRACK REPAIR BINDER:

A. Epoxy crack repair binder shall be a two-component, 100 percent solids, high-modulus, low viscosity epoxy adhesive suitable for crack grouting by injection.

B. Products:

1. Sika Corporation; Sikadur 52

2. The Euclid Chemical Company; Duralcrete LV

3. BASF; SBC Concresive 1380

2.06 FLEXIBLE POLYURETHANE CRACK REPAIR MATERIAL:

A. Flexible polyurethane crack repair material shall be a one-component, water-activated polyurethane hydrophilic injection grout capable of 700 percent expansion. Polyurethane grout shall form a tough flexible foam seal that is impenetrable to water.

B. Products:

1. Prime Resins; Prime Flex 900 XLV

2. Avanti International; Scotch Seal 5600 Chemical Grout

2.07 RIGID POLYURETHANE CRACK REPAIR MATERIAL:

A. Rigid polyurethane crack repair material shall be a one-component, water-activated polyurethane hydrophobic injection grout capable of 700 percent expansion. Polyurethane grout shall form a tough rigid foam seal that is impenetrable to water.

B. Products:

1. De Neef Construction Chemicals; Hydro-Active Cut

2. Prime Resins; Prime Flex 920

3. Sika Corporation; Sikafix HH LV

2.08 EPOXY REPAIR MORTAR:

A. Epoxy Repair Mortar shall be two-component, 100 percent solids, 100 percent reactive epoxy resin system.

B. Spall repair mortar for use in horizontal applications.

1. Products:

a. BASF; Concresive Paste LPL

b. Sika Corporation; Sikadur 22 Lo-Mod

C. Spall repair mortar for use in vertical and overhead applications.

1. Products:

a. Sika Corporation; Sikadur 23 Lo-Mod Gel

2.09 SPALL REPAIRS USING NON-SHRINK CEMENTITOUS MORTAR:

A. Products:

1. BASF; EMACO S88 CI

2. BASF; Thorite

3. Sauereisen, Inc.; Underlayment F-120

2.10 SPALL REPAIRS USING POLYMER MODIFIED CEMENTITOUS MORTAR:

A. Repair spalls repair not requiring formwork using a two-component, polymer-modified cementitious mortar having a minimum 28-day compressive strength of 7,000 psi.

B. Spall repair mortar for use in horizontal applications.

1. Products:

a. Sika Corporation.; Sikatop 122 Plus

b. The Euclid Chemical Company; Duraltop Fast Set

C. Spall repair mortar for use in vertical applications.

1. Products:

a. Sika Corporation; Sikatop 123 Plus

b. The Euclid Chemical Company; Duraltop Gel

2.11 SPALL REPAIRS REQUIRING FORMWORK:

A. Repair spalls repair requiring formwork using a two-component, polymer-modified cementitious mortar/pea gravel mixture and shall have a minimum 28-day compressive strength of 6,000 psi. Mix each unit of mortar with Saturated Surface Dry (SSD) pea gravel to form the repair material following the manufacturer's recommendations.

B. Products:

1. Sika Corp.; Sikatop 111 Plus

2. The Euclid Chemical Company; Duraltop Flowable Mortar

2.12 WATERPROOF MEMBRANE PATCH:

A. Waterproof membrane patch shall be a hypalon sealing strip secured to the concrete substrate with an epoxy adhesive.

B. Install sealing system per manufacturer's recommendations.

C. Products:

1. Sika Corporation; Sikadur Combiflex

2.13 CEMENT BASED TEXTURED COATING:

A. Products:

1. Sika Corporation; Sikatop 144

2. The Euclid Chemical Company; Duraltop Coating

3. BASF; Thoroseal/Acryl 60

2.14 SEALANT:

A. Sealant shall be a two-component polyurethane sealant as specified in Section 03 15 00. Primers and bond breakers shall conform to the sealant manufacturer's recommendations.

2.15 EXPANSION JOINT FILLER:

A. Expansion joint filler shall be as specified in Section 03 15 00.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS:

A. Perform exterior work during dry weather and appropriate temperature conditions in accordance with the manufacturer's recommendations. Protect unfinished work during inclement weather with tarpulins or heavy gage polyethylene sheeting.

B. Perform work in spaces within structures at temperature and conditions suitable for proper curing in accordance with the manufacturer's recommendations.

C. Coordinate concrete rehabilitation work with other work being performed.

D. Remove scaling, broken, loose and disintegrating materials by use of hand tools or power driven saws, down to solid unyielding material.

E. Clean surfaces thoroughly of efflorescence, oils, grease and other objectionable material in area to be repaired in accordance with the manufacturer's recommendations.

3.02 EPOXY BONDING AGENT:

A. Use epoxy bonding agent to adhere fresh mortar to existing concrete. Roughen existing concrete surfaces prior to application of bonding agent. Concrete surface shall be clean and

sound, free of all foreign particles and laitance. Place repair material while bonding agent is still tacky or per the written instructions of the manufacturer. Reapply bonding agent if bonding agent cures prior to placement of repair material.

B. Conform to all the requirements of ACI 503.4, and as specified herein.

3.03 ANTI-CORROSION COATING:

A. Sandblast, clean and coat reinforcing steel that is cut or exposed during alteration and/or repair operations with an anti-corrosive coating.

B. Cover all exposed parts of the steel with the coating and apply according to manufacturer's recommendations.

3.04 EPOXY CRACK REPAIR:

A. Cracks on horizontal surfaces: When permitted by the Engineer, repair existing structural cracks by gravity feeding an epoxy crack repair binder into the prepared crack.

1. Grout concrete surface at the crack to form a minimum 1/4-inch wide by 1/4-inch deep V-notch and clean to remove all loose and foreign particles. Fill crack with clean, dry sand and pour epoxy crack repair binder into V-notch, completely filling crack.

2. As binder penetrates into crack, apply additional binder to the V-notch.

B. Cracks on vertical or horizontal surfaces: Repair existing structural cracks by pressure injecting an epoxy crack repair binder into the prepared crack per Section 03 64 23. Seal cracked surfaces and install injection ports per manufacturer's recommendations.

1. Do not cut reinforcement steel when drilling holes for injection ports. If rebar is encountered during drilling, abandon the hole and relocate. Patch the abandoned hole immediately with epoxy mortar flush with the surface of the existing concrete.

2. Once the surface sealing material has cured, inject crack with epoxy crack repair binder as directed by the manufacturer.

3. Remove injection ports upon satisfactory completion of crack injection and patch with epoxy mortar.

3.05 RIGID AND FLEXIBLE POLYURETHANE CRACK REPAIR:

A. Repair leaking cracks by pressure injecting with a waterproof hydrophilic or hydrophobic injection grout seal crack surfaces and install injection ports per manufacturer's recommendations.

B. Do not cut rebar when drilling holes for injection ports. If rebar is encountered during drilling, abandon the hole and patch immediately with epoxy mortar flush with the surface of the existing concrete.

C. Once the surface sealing material has cured, inject crack with waterproof hydrophilic or hydrophobic injection grout as directed by the manufacturer.

3.06 SPALL REPAIR:

A. Saw cut the perimeter of the repair area to a minimum depth of 1/4-inch below the surface of the concrete.

B. Chip all loose concrete in the repair area to remove loose and degraded concrete to a minimum of 1/4-inch or until a sound substrate is reached.

C. Clean the area and repair to the original dimensions with spall repair patching material according to the manufacturer's recommendations.

D. Make final finished surface of patches flat, level and even with the existing concrete surface. Do not feather repair mortar to meet existing concrete surface.

E. Finish final patches on horizontal surfaces consistent with the finish on the existing structure.

3.07 JOINT REPAIR:

A. Remove sealant, bond breaker and joint filler.

B. Remove unsound concrete on the joint faces.

C. Remove laitance and provide a clean dry surface.

D. Prepare an epoxy mortar by combining epoxy crack repair binder with aggregate following the manufacturer's instructions.

E. Restore surface to original dimensions by trowelling epoxy mortar onto the existing substrate in a manner to ensure bonding following the manufacturer's instructions.

F. Cure repair in accordance with the manufacturer's instructions.

G. Install new joint filler, bond breaker and sealant.

3.08 CEMENT BASED TEXTURED COATING:

A. Clean existing concrete areas requiring a textured coating and apply the cement based textured coating according to manufacturer's recommendations.

B. Complete other concrete rehabilitation prior to applying coating.

3.09 CURING:

A. Cure repair materials in accordance with manufacturer recommendations.

3.10 CLEANING:

A. Mechanically remove excess material from walls, floors, etc. after material has cured.

B. Clean excess materials caused by work under this section from existing surfaces by the use of power sanders. Vacuum surfaces to receive final cleaning and finishing specified under other sections of the specifications. Sand cracks flush to adjacent surfaces.

C. Remove misplaced sealants using methods and materials recommended by the manufacturers. Leave finished work and work area in a neat and clean condition.

3.11 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 03 05 10

LEAKAGE TESTING OF CONTAINMENT STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section describes the method of testing concrete containment structures for leakage. All containment structures shall be leak tested unless specifically exempted by the Engineer as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 350.1: Tightness Testing of Environmental Engineering Concrete Structures and Commentary.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Provide piping and equipment to test concrete structures for leakage as described herein.

PART 3 - EXECUTION

3.01 GENERAL:

A. Hydrostatically test reinforced concrete structures which will contain fluids to determine that they conform to leakage criteria specified herein and are free of detectable leaks. Do not hydrostatically test walls that are to be restrained or laterally supported by slabs until slab concrete has obtained the specified compressive strength.

B. Prior to testing, clean exposed surfaces by thoroughly hosing and removing surface laitance and loose matter from walls and slabs. Remove wash water and debris from the structures by means other than washing through plant piping. All potential leakage points shall be identified and repaired prior to filling the tank with water for the tightness test. Methods for repairing concrete shall be as described in Section 03 01 30.

C. No backfilling, floor finish, concrete or mortar fill, wall insulation, gasproofing or protective coatings, or permanent pipe connections shall be applied to or installed in any new containment structures until they have been subjected to loading for settlement and tested for leakage. Testing shall not be done until the concrete has reached its specified design strength.

3.02 PRELOADING TEST:

A. For the Preloading Test the Contractor shall maintain the liquid level in the structures at the design maximum water level for 72-hours.

3.03 LEAK TEST PROCEDURE:

A. Leakage testing shall meet the provisions of ACI 350.1 – Tightness Testing of Environmental Engineering Concrete Structures. The test criterion shall be HST-NML (no measurable loss) for fully lined prior to tightness test, secondary containment structures; HST-050 (0.050 percent per day) for other tanks as defined by ACI 350.1; HST-100 (0.100 percent per day) for concrete paved reservoirs and channels.

B. Leakage testing shall meet the provisions of ACI 350.1 – Tightness Testing of Environmental Engineering Concrete Structures. The test criterion shall be HST-050 (0.050 percent per day) for other tanks as defined by ACI 350.1.

C. During the test period, the excavation around the structure shall be kept dewatered by the Contractor. Dewatering shall maintain the groundwater level to below the top of the base slab. The Contractor shall temporarily seal all bottom openings and wall openings below maximum water level in the structures, furnish and fill the structures to the design maximum water level with clean water. The Contractor shall make his own arrangements for handling the water for testing and its transfer from one structure to another and its final disposal.

D. Filling rate shall not exceed 4-feet/24 hours of water depth with continuous monitoring. Filling shall be at a uniform rate.

E. Filling rate shall not exceed a rate as permitted by the Engineer of water depth with continuous monitoring. Filling shall be at a uniform rate.

F. During the leakage test period, the Engineer will inspect the structure for leakage or change in volume. If moist spots become visible, indicating the existence of minor leaks, or if the water level indicates hidden leakage, the Contractor shall furnish all materials and do all work necessary to locate the leaks and make the structure watertight to the complete satisfaction of the Engineer. No additional compensation will be allowed for such work.

G. If, in the opinion of the Engineer, during the course of the test weather conditions are such that it becomes difficult to accurately monitor the water level in the tank, the test shall be stopped, and started over again when weather permits, at no additional cost to the Owner.

H. On conclusion of the test, the Contractor shall pump or drain the water from the structure and dispose of it without damage to structures or surrounding facilities.

I. The water tightness test will be considered a pass when no wet spots are observed on the exterior surfaces of the containment structure during the water tightness test period and when the measured loss is less than the maximum specified.

3.04 REPAIR METHODS:

A. Methods for repairing concrete not passing the leakage test shall be as described in Section 03 01 30.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 03 10 00

CONCRETE FORMWORK

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide design and furnish materials for fabricating, erecting and removing formwork, falsework and shoring for cast-in-place concrete as indicated and in compliance with Contract Documents.

B. Use formwork to cast all cast-in-place concrete structures with the exception of neat-line dirt excavations and fillets with a dimensional extension to meet 3-inch rebar clearances.

C. Provide and remove all formwork for electrical work as shown on the drawings or specified under electrical work.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 117/117R: Standard Tolerances for Concrete Construction and Materials.

2. 309.2R: Identification and Control of Visible Effects of Consolidation on Formed Concrete Surfaces.

3. 318/318R: Building Code Requirements for Structural Concrete and Commentary.

4. 347: Guide to Formwork for Concrete.

5. 347.3R: Guide to Formed Concrete Surfaces

B. Engineered Wood Association (APA)

C. National Institute of Product Standards and Technology

1. Voluntary Product Standard PS 1 Structural Plywood

D. National Sanitation Foundation (NSF):

1. 61: Drinking Water System Components – Health Effects

1.03 DESIGN REQUIREMENTS:

A. Design formwork in conformance with methodology of ACI 347R for anticipated loads, lateral pressures, depth of concrete placement and rate of concrete placement. Design

shall consider any special requirements due to the use of self-consolidating, plasticized and/or retarded set concrete. All forms and shoring shall be designed at the contractor's expense.

B. See Section 03 35 01 for additional formwork requirements identified in Table 03 35 01-1 which may exceed the requirements of this section.

1.04 QUALIFICATIONS:

A. Formwork Designer: Formwork, falsework, and shoring design shall be stamped by an engineer licensed in the State of Utah.

1.05 SUBMITTALS:

A. Submit product data for form ties, spreaders, chamfer strips, void forms, form coatings, and bond breakers.

B. Submit following shop drawings in accordance with Section 01 33 00.

1. Layout of panel joints and tie hole pattern. Form Ties-Tapered Through-Bolts: Proposed method of sealing form tie holes.

2. Product data for form ties, spreaders, chamfer strips, and bond breakers.

3. Layout and locations of void forms.

1.06 QUALITY ASSURANCE:

A. Comply with requirements in Section 01 45 00 and as specified.

B. Design of Formwork:

1. The Contractor shall assume responsibility for the design, engineering and construction of formwork. Forms shall be designed to produce concrete members identical in shape, lines and dimensions to members shown on the Contract Documents.

2. When high range water reducer (superplasticizer) is used in concrete mix or when self-consolidated concrete is specified, forms shall be designed for full hydrostatic pressure per ACI 347.

3. The formwork shall be designed for the loads and lateral pressures in accordance with ACI 347, ACI 318, and wind loads as specified by the local building code.

4. Construction and contraction joints, openings, offsets, keyways, recesses, moldings, chamfers, blocking, screeds, bulkheads, waterstops, anchorages, inserts, and other features shall be provided.

5. Formwork shall be designed to be readily removable without impact, shock, or damage to 'green' concrete surfaces and adjacent materials.

6. The maximum panel deflection shall be 1/360 of the span between structural members.

C. Unless otherwise specified herein, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits as given in ACI 117.

D. Materials, fabrications and workmanship found defective shall be promptly removed and replaced and new acceptable work shall be provided in accordance with Contract requirements at no additional cost to the Owner.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements in APWA Section 01 66 00.

B. Materials shall be delivered to the site in an undamaged condition and at such intervals as will avoid delay in the work.

C. Material shall be stored and protected in a clean, properly drained location. Material shall be kept off the ground under a weather-tight covering permitting good air circulation. Formwork materials shall be stored on dry wood sleepers, pallets, platforms or other appropriate supports which have slope for positive drainage. Materials shall be protected from distortion, excessive stresses, corrosion and other damage. Materials shall not be stored on the structure in a manner that might cause distortion or damage to the supporting structure.

PART 2 - PRODUCTS

2.01 LUMBER:

A. Lumber used in form construction shall be Douglas fir, No. 2 grade, S4S, Standard Grading and Dressing Rules No. 16, West Coast Lumber Inspection Bureau; or Southern Yellow Pine, No. 2, S4S, Standard Grade Rules Southern Pine Inspection Bureau. Boards shall be 4 inches or more in width.

2.02 PLYWOOD:

A. Only grade-marked plywood conforming to APA shall be provided.

B. Plywood used in form construction shall be Grade B-B, Class 1 plyform, mill-oiled, and sanded on both sides in conformance with U.S. Product Standard PS 1 Structural Plywood.

C. Thickness shall be sized to maintain alignment and surface smoothness, but not less than 5/8-inch thick.

2.03 STEEL FORMS:

A. Commercial grade sheets not less than 16 gage shall be provided.

B. Stock material that is free from warps, bends, kinks, cracks, and rust or other matter that could stain the concrete shall be provided.

C. Galvanized metal stay in place concrete form system may be used at non-exposed concrete joint surfaces only.

1. Manufacturer:

a. AMICO Alabama Metal Industries Corporation, Birmingham, AL Stay-Form

2.04 FORM MATERIAL LOCATIONS:

A. Wall Forms and Underside of Slabs and Beams:

1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particleboard, or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce specified finish.

B. Column Forms:

1. Rectangular Columns: As specified for walls.

2. Circular Columns: Fabricated steel or fiber reinforced plastic with bolted together sections or spirally wound laminated fiber form internally treated with release agent for height of column.

C. Slab-on-grade: Lumber, steel forms or plywood.

D. All Other Forms: Materials as specified for wall forms.

E. Rustication Grooves and Chamfer Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

F. Chamfer Strips: Wood, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

2.05 FORM TIES:

A. Locate form ties on exposed surfaces in a uniform pattern. Place form ties so they remain embedded in the concrete except for a removable portion at each end. Form ties shall have conical or spherical type inserts with a maximum diameter of 1 inch. Construct form ties so that no metal is within 1-1/2 inch of the concrete surface when the

forms, inserts, and tie ends are removed. Do not use wire ties. Ties shall withstand all pressures and maintain forms within acceptable deflection limits.

B. Flat bar ties for panel forms (not permitted for hydraulic structures) shall have plastic or rubber inserts having a minimum depth of 1-1/2 inch and sufficient dimensions to permit patching of the tie hole.

C. Tapered form ties shall be tapered through-bolts or through-bolts that utilize a removable tapered sleeve.

D. Wire ties are not permitted.

E. Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:

1. Integral steel water stop 0.103 inch thick and 0.625 inch in diameter tightly and continuously welded to tie.

2. Neoprene water stop 3/16-inch thick and 15/16 inch diameter whose center hole is one-half diameter of tie, or molded plastic water stop of comparable size.

F. Elastic Vinyl Plug:

1. Design and size of plug shall allow insertion with tool to enable plug to elongate and return to original length and diameter upon removal forming watertight seal.

2. Manufacturer:

a. Dayton Superior, Miamisburg, OH; A58 Sure Plug.

2.06 BOND BREAKER:

A. Bond breaker shall be a V.O.C.-compliant non-staining type that will provide a positive bond prevention.

B. Manufacturers:

1. Dayton Superior, Sure Lift J6LVOC

2. Nox-Crete, Inc.; Silcoseal Select.

2.07 FORM CAULKING:

A. Form caulking shall be a one-component, gun-grade silicone sealant that is capable of producing flush, watertight and non-absorbent surfaces and joints. Sealant shall be compatible with the type of forming material and concrete ingredients used.

B. Products:

1. Series 1200 Construction Caulking; GE Silicones, Waterford, NY.

2. Dow Corning 999-A; Dow Corning Co., Midland, MI.

2.08 CHAMFER STRIPS:

A. Provide 3/4 inch by 3/4-inch chamfer strips milled from clear, straight-grain pine, surfaced each side, or having extruded vinyl type with or without nailing flange unless otherwise shown on the Contract Documents.

2.09 INSERTS:

A. Provide galvanized cast steel or galvanized welded steel inserts, complete with anchors to concrete and fittings such as bolts, wedges and straps.

2.10 DOVETAIL ANCHOR SLOTS:

A. Provide dovetail anchor slots manufactured from 22 gage, galvanized steel with removable felt or polyurethane filler shall be provided where specified or shown on the Contract Documents.

2.11 VOID FORMS:

A. Continuous void forms.

B. Specifically design and manufactured for the purpose of creating a void area directly under concrete members which will allow a space for soil vertical upward movement.

C. Able to support the weight of concrete and construction loads to be placed thereon with no decrease in required void form depth.

D. Constructed from double faced corrugated carboard or fiberboard which is wax impregnated and laminated with moisture-resistant adhesive.

E. Capable of resisting moisture with no loss of load carrying strength or change in depth or configuration.

F. Manufacturer:

1. VoidForm Products, Inc Fort Worth, TX

2. Sonoco, Hartsville, SC

3. Sonovoid, Deslauriers, Inc, LaGrange Park, IL

2.12 FORM RELEASE AGENT:

A. Form release agent shall not bond with, stain, or adversely affect concrete surfaces and shall not impair subsequent treatments of concrete surfaces when applied to forms. A ready-to-use water-based material formulated to reduce or eliminate surface imperfections and containing no mineral oil or organic solvents.

B. Manufacturers and Products:

1. BASF, Shakopee, MN; MasterFinish RL 211.

2. Cresset Chemical Company; Crete-Lease 20-VOC.

3. Dayton Superior; Farm Fresh XL.

PART 3 - EXECUTION

3.01 FORM TOLERANCES:

A. Comply with the requirements of ACI 117 for tolerances for formed surfaces except as specified in Table 03 10 00-1 or 03 35 00.

Table 03 10 00-1	
Vertical alignment (plumbness)	1/4-inch in any 10 feet and 1-inch maximum for entire length
Variation in the lines and surfaces of foundation mats, base slabs and walls	1/4-inch in any 10 feet and 1-inch max. for entire length
Variation from the level or from the grades indicated on the drawings	1/4-inch in any 10 feet
Variation of the linear building lines from established position in plan	1/2-inch in any 20 feet and 1-inch maximum for entire length
Variation of distance between walls	1/4-inch in any 10 feet and 1-inch maximum for entire length and height
Variation in the sizes and locations of sleeves, floor openings and wall openings	+1/4-inch -1/2-inch
Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	-1/4-inch. +1/2-inch.
Offset between adjacent panels of formwork facing material	1/2-inch (ACI 117 Class C finish).
Offset between adjacent panels of formwork facing material for exposed surfaces where appearance is of importance	1/8-inch (ACI 117 Class A finish).

B. Tolerances are not cumulative.

C. Where equipment is to be installed, comply with manufacturer's tolerances if more restrictive than above.

D. Failure of the forms to produce the specified concrete surface and surface tolerance shall be grounds for rejection of the concrete work. Rejected work shall be repaired or replaced at no additional cost to the Owner.

3.02 PREPARATION:

A. Clean form surfaces to be in contact with concrete or foreign material prior to installation. Tape, gasket, plug, and/or caulk joints, gaps, and apertures in forms so that the joint will remain watertight and withstand placing pressures without bulging outward or creating surface irregularities.

B. Coat form surfaces in contact with concrete with a form release agent prior to form installation.

C. Keep form coatings off steel reinforcement, items to be embedded, and previously placed concrete.

D. Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

E. Form liners to be installed for architectural concrete finish shall be in accordance to the manufacturer recommendations. (Not Used in Contract)

F. Void Forms: protect void forms from exposure to moisture and damage prior to installation. See manufacturer recommendations.

3.03 ERECTION AND INSTALLATION:

A. Forms shall be constructed in accordance with ACI 347 to required dimensions, plumb, straight and mortar tight, and all joints and seams shall be made mortar-tight. Forms shall be substantial, properly braced, and tied together to maintain position and shape and to resist all pressures to which they may be subject. Unless otherwise indicated on the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits in ACI 117 and herein specified.

B. Provide means for holding adjacent edges and ends of form panels tight and in accurate alignment to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Forms shall be tight and shall prevent the loss of mortar and fines during placing and vibration of concrete.

C. Provide exterior corners in concrete members with chamfers as specified.

D. Provide means for removing forms without damage to the surface of finished concrete.

E. Do not embed any form-tying device or part thereof other than metal in the concrete.

F. Locate large end of taper tie on the "wet" side of the wall.

G. Use only form or form-tying methods that do not cause spalling of the concrete upon form stripping or tie removal.

H. Form surfaces of concrete members except where placement of the concrete against the ground is shown in the drawings or as indicated below. The dimensions of concrete members shown in the drawings apply to formed surfaces, except where otherwise indicated. Placement of concrete against the ground shall be limited to footings.

I. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide openings with continuous keyways and water stops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with additional reinforcement as shown in the typical structural details. Reinforcing shall be at least 2 inches clear from the opening surfaces and encased items.

J. Set anchor bolts and other embedded items accurately before placing concrete and hold securely in position until the concrete is placed and set. Check special castings, channels, or other metal parts that are to be embedded in the concrete prior to and again after placing concrete. Check nailing blocks, plugs, and strips necessary for the attachment of trim, finish, and similar work prior to placing concrete.

3.04 PROTECTION:

A. During installation, the forms shall not be used as a storage platform nor as a working platform until the forms have been permanently fastened in position.

B. Protect void forms from moisture until concrete placement.

3.05 PIPES AND WALL CASTINGS CAST IN CONCRETE:

A. Install wall spools, wall flanges, and wall anchors before placing concrete. Do not weld, tie, or otherwise connect the wall castings or anchors to the reinforcing steel.

B. Support pipe and fabricated fittings to be encased in concrete on concrete piers or pedestals. Concrete supports shall transfer loads to firm foundations so that no settlement will occur during construction.

C. Pipes or wall castings located below operating water level shall have water stop ring collars and shall be cast in place. Pipes fitted with thrust rings shall be cast in place.

D. All pipe penetrations through the slab shall have cast-in-place HDPE sleeves (minimum SDR 21) one pipe diameter larger than the carrier pipe.

3.06 REMOVAL OF FORMS:

A. Forms shall be removed in accordance with ACI 347 recommendations without damage to concrete and in a manner to ensure complete safety to the structure. Forms, form ties and bracing shall not be removed without specific permission of the Contractor's Registered Professional Engineer.

B. The following table indicates the minimum allowable time after the last cast concrete is placed before forms, shoring, or wall bracing may be removed; during which the air surrounding the concrete is above 50 degrees F.

Table 03 10 00-2	
Sides of footings and encasements	18 hours
Walls, vertical sides of beams, girders, columns, and similar members not supporting loads	48 hours
Slabs, beams, and girders	48 hours (forms only)
Shoring for slabs, beams, and girders	Until concrete strength reaches specified 28-day strength
Wall bracing	Until top or roof slab concrete reaches specified 28-day strength

C. Form removal and reshoring may be allowed with approval of the Engineer of Record. Removal times will be increased if the concrete temperature following placement is permitted to drop below 50 degrees F.

D. Do not remove supports and reshore.

3.07 PATCHING OF TAPERED TIE HOLES:

A. Clear tie hole of all loose debris with a taper tie void brush and flush debris from tie hole with air or water.

B. Install elastic vinyl plug from larger tie hole end in accordance with manufacturer’s instructions using an insertion tool as recommended by the manufacturer.

C. Coat entire annular surface of the hole with epoxy bonding compound prior to filling with non-shrink, non-metallic patching mortar. Apply epoxy in accordance with manufacturer’s instructions.

D. Fill each side of hole with mortar. Apply mortar to the "wet" side of the wall first. Consolidate mortar solidly into the hole.

3.08 ALUMINUM SURFACES IN CONTACT WITH CONCRETE:

A. Coat aluminum surfaces that will be in contact with concrete per Section 09 90 00.

3.09 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 03 15 00

CONCRETE JOINTS AND ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section describes materials, testing, and installation of concrete joints and accessories as specified and as shown on contract drawings.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A276: Standard Specification for Stainless Steel Bars and Shapes.

2. C920: Specification for Elastomeric Joint Sealants

3. C1193: Guide for Use of Joint Sealants

4. D412: Standard Test Methods or Vulcanized Rubber and Thermoplastic Elastomers – Tension.

5. D570: Standard Test Method for Water Absorption of Plastics

6. D624: Standard Test method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.

7. D638: Standard Test Method for Tensile Properties of Plastics

8. D746: Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

9. D747: Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.

10. D792: Standard Test Methods for Density and Specific Gravity of Plastics by Displacement.

11. D994: Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)

12. D1171: Standard Test Method for Rubber Deterioration – Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)

13. D1259: Standard Test Methods for Nonvolatile Content of Resin Solutions.

14. D1752: Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

15. D2240: Standard Test Method for Rubber Property – Durometer Hardness

B. Environmental Protection Agency (EPA):

1. 40 CFR 59: National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

C. Corps of Engineers:

1. CRD-C 572: Specifications for Polyvinylchloride Waterstop.

D. Federal Specifications:

1. TT-S-00230C: Sealing Compound: Elastomeric Type, Single Component

1.03 SUBMITTALS:

A. Submit following shop drawings in accordance with Section 01 33 00.

1. Manufacturer's printed data and application instructions for specified materials and locations where materials are to be used.

2. Submit material one samples of each type of water stops.

3. Submit layouts for joints for approval by Engineer of Record (EOR).

4. Certification that materials used within the joint system are compatible with each other.

1.04 QUALITY ASSURANCE:

A. Comply with requirements in Section 01 45 00 and as specified.

B. See Section 03 35 01 for additional joint requirements identified in Table 03 35 01-1 which may exceed the requirements of this section.

C. Do not add, relocate or omit joints without written permission from the Engineer.

D. Reject material exceeding expiration date for use.

E. Clean concrete surfaces to receive expansion joint compound in accordance with the printed instructions of the joint compound manufacturer.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements in APWA Section 01 66 00.

B. Transport, handle and deliver materials to the job site in the manufacturer's sealed bags, unopened containers or banded pallets.

C. Store materials off the ground on a platform or skids and protect with covers from snow, rain and ground splatter.

D. Store expansion joint compounds in a dry location where they cannot freeze.

E. Store plastic products under cover in a dry location, out of direct sunlight.

1.06 MANUFACTURER'S SERVICES:

A. Prior to joint preparation for joints receiving sealant materials, require joint manufacturer's technical representative to demonstrate, on site, joint preparation, priming, and sealant materials application for the Contractor's personnel performing joint work.

PART 2 - PRODUCTS

2.01 PVC WATERSTOP:

A. Waterstops shall be extruded from a PVC compound and shall be lock-rib, center-bulb, retro-fit or flat-strip type. Water stop shall comply with Corps of Engineers Specification CRD-C-572.

B. PVC waterstops for construction joints: flat ribbed type, 6 inches wide unless otherwise noted on the Contract Drawings, with a minimum thickness of 3/8-inches.

1. Products:

a. Sika Greenstreak; Model 679

b. BoMetals, Inc.; Model FR-638

c. Vinylex; Model R638

C. PVC waterstop for contraction joints shall be ribbed with a center bulb, 6 inches wide with a minimum thickness of 3/8-inches. The center bulb shall have an O.D. not less than 7/8-inches.

1. Products:

a. Sika Greenstreak; Model 732

b. BoMetals, Inc.; Model RCB-638LB

c. Vinylex; Model RB638H

D. PVC waterstop for expansion joints shall be ribbed with a center bulb, 9 inches wide with a minimum thickness of 3/8-inches . The center bulb shall have an O.D. not less than 1-3/8 inches.

1. Products:

a. Sika Greenstreak; Model 738

b. BoMetals, Inc.; Model RCB-938VLB

c. Vinylex; Model RB938H

E. PVC waterstops for sealing existing concrete structures and new concrete placement shall be retro-fit type, 6 inches wide and 3-3/16 inches height with a minimum thickness of 3/8-inches. Attach waterstop to existing concrete using 1/4-inch by 2-1/4 inch stainless steel sleeve expansion bolt with stainless steel batten bars.

1. Products:

a. Sika Greenstreak; Model 609

b. BoMetals, Inc.; Model RF-638

F. Provide waterstops resistant to chemical action with Portland cement, alkalies, acids, and not affected by mildew or fungi. It shall show no effect when immersed for 10 days in a 10 percent solution of sulfuric or hydrochloric acid, saturated lime solution or salt water. Water stops shall be such that any cross section will be dense, homogeneous, and free from porosity and other imperfections. They shall be symmetrical in shape. When tested in accordance with Federal Standard No. 601, the material shall meet the requirements in Table 03 15 10-1.

Table 03 15 10-1

Requirement	ASTM Spec.
Tensile strength, 2,000 psi	D638
Hardness, Shore durometer, 60-70	D2240
Elongation, ultimate, 280	D638
Water absorption, dry weight, maximum (48 hours) 0.32 percent	D570
Specific gravity, 1.3	D792
Stiffness in flexure, 920 psi	D747
Cold brittleness, -35 degrees F	D746
Tear resistance, 290 lbs/inch	D624

2.02 HYDROPHILIC RUBBER WATERSTOP:

A. Provide a bentonite free rubber waterstop. Waterstop shall expand by a minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast. Provide minimum concrete cover as recommended by the waterstop manufacturer.

1. Products:

a. Adeka; Ultraseal MC-2010MN

b. Sika; Hydrotite

2.03 ELASTOMERIC JOINT SEALANT:

A. Federal Specification TT-S-00230C Type 1, Class A, single component, cold applied, pourable, polyurethane.

1. Products:

a. The Euclid Chemical Company; Eucolastic 1

b. Tremco; Vulkem 45SSL

2.04 JOINT SEALANT FOR CONCRETE STRUCTURES:

A. Joint sealant shall be a multipart, gray, non-staining, non-sagging, gun grade polyurethane sealant, which cures at ambient temperature to a firm, flexible, resilient, tear-resistant rubber. Sealant shall comply with ASTM C920, Type M, Grade P, Class 25 for horizontal joints and Grade NS, Class 25 for vertical joints and be recommended by the manufacturer for continuous immersion in water. Troweling of sealants into joints will not be permitted. Sealant shall meet requirements in Table 03 15 10-2.

Table 03 15 10-2

Characteristic or Parameter	Technical Requirements
Pot life	1 to 3 hours
Hardness	35 Shore A, +/- 5
Elongation	650 percent, ASTM D412
Tensile strength	200 psi, ASTM D412
Peel strength on concrete	No adhesion loss at 25 pounds
Temperature service range	40 to 167 degrees F
Immersion in water	Continuous

B. Products:

1. Tremco; Vulkem 227 or Vulkem 245 (for Type M, Grade P, Class 25)

2. Sika Corporation; Sikaflex-2CNS (for Grade NS, Class 25), Sikaflex-2CSL

C. For submerged applications, use multi-component chemical resistant polysulfide sealant conforming to ASTM C920, Type M, Grade NS, Class 25.

1. BASF; Sonolastic Two-part

2. The Euclid Chemical Company; Tammsflex NS

2.05 EPOXY JOINT SEALANT:

A. 100 percent solids per ASTM D1259, two-part epoxy with an instantaneous Shore D hardness of 50 to 65 per ASTM D2240.

1. Metzger-McGuire Co.; MM80 or Edge Pro50

2. The Euclid Chemical Company; Euco700

2.06 BACKING ROD FOR EXPANSION JOINTS:

A. Provide an extruded closed-cell polyethylene foam rod. The rod shall be 1/4-inch larger in diameter than the joint width. Where possible, provide full-length sections for the joint; minimize splices.

1. Industrial Systems Department; Minicel backer rod

2. Hercules, Inc.; Plastic Products Group

2.07 BOND BREAKER TAPE:

A. Provide an adhesive-backed glazed butyl or polyethylene tape that will adhere to the premolded joint material or concrete surface. The tape shall be the same width as the joint. The tape shall be compatible with the sealant.

2.08 PREMOLDED JOINT FILLER FOR PAVEMENTS AND SLABS:

A. Joint filler shall be pre-formed, non-extruded type constructed of closed-cell neoprene conforming to ASTM D1752, Type I.

B. Bituminous-type preformed expansion joint filler conforming to ASTM D994.

2.09 PREMOLDED JOINT FILLER FOR LIQUID CONTAINMENT STRUCTURES:

A. Self-expanding cork per ASTM D1752, Type III.

B. Sponge Rubber per ASTM D1752, Type I. Preformed, non-extruded type constructed of closed-cell neoprene.

2.10 EXPANSION JOINT DOWELS:

A. Stainless steel bar dowels conforming to ASTM A276, Type 316.

B. Alternate to steel bar dowels may be diamond shaped plates.

C. Thoroughly grease expansion joint dowels prior to placing adjoining wall or slab concrete.

2.11 STYROFOAM FILLER BLOCK:

A. Styrofoam filler blocks for future construction and expansion joints.

1. Products:

a. Dow Chemical Company; Styrofoam SM brand

2.12 BOND BREAKER FOR JOINT COMPOUNDS:

A. Provide polyethylene tape.

PART 3 - EXECUTION

3.01 PVC WATERSTOPS:

A. Heat splice at ends and intersections. Provide waterstops that provide a continuous, uninterrupted watertight diaphragm throughout the entire joint system below the high water level and below grade.

B. Construct forms for construction joints to prevent injury to water stops. Hold water stops securely in position in the construction joints by wire ties, continuous bars, and rings as shown on contract drawings. Install water stops in construction, contraction and expansion joints in liquid containment structures and shown on contract drawings.

C. Use factory-made crosses, tees and ells. Make field splices with a thermostatically controlled heating iron in conformance with the manufacturer's current recommendations. Allow at least 10 minutes before pulling or straining the new splice in any way. The finished splices shall provide a cross section that is dense and free of porosity with tensile strength of not less than 80 percent of the unspliced materials.

D. Provide waterstops with an integral fastening system consisting of grommets or pre-punched holes.

3.02 JOINTS:

A. Make joints only at locations shown on the contract drawings or as permitted by the Engineer. Any addition or relocation of construction joints proposed by the Contractor, must be submitted to the Engineer for written permission.

B. Relocate additional joints where they least impair strength of the member. In general, locate joints within the middle third of spans of slabs, beams and girders. If a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams or girders and at tops of footing or floor slabs.

C. Cast structural slabs and beams monolithically without horizontal joints unless specifically indicated on the drawings.

D. Do not use horizontal joints within foundation mats, base slabs, footings, pile caps, slabs on grade or elevated beams and slabs.

E. Provide joints in concrete fills and toppings at the same location as the joints in the supporting concrete.

F. Provide waterstops in all wall and slab joints in liquid containment structures and at locations shown on the contract Drawings. Do not provide metal waterstops unless permitted by Engineer.

G. Construction Joints:

1. Provide flat ribbed waterstops at construction joints where shown on contract drawings and specified herein.

2. Allow 48 hours between pours of adjacent slabs.

3. Where joint key ways are shown on contract drawings form keyways by beveled strips or boards placed at right angles to the formed face. Except where otherwise shown on contract drawings or specified, keyways shall be at least 1-1/2 inches in depth over at least 25 percent of the width of the section.

4. After the pour has been completed to the construction joint and the concrete has hardened, thoroughly clean the entire surface of the joint of surface laitance, loose concrete, foreign material, and expose clean aggregate by sandblasting or waterblasting the surface of construction joints before placing the new concrete. Care shall be taken to protect any exposed joint material, such as PVC waterstops.

5. In case of emergency, place additional construction joints. (An interval of 45 minutes between two consecutive batches of concrete shall constitute cause for an emergency construction joint.)

H. Contraction Joints:

1. Provide center-bulb waterstop at contraction joints where shown on contract drawings and specified herein.

2. Where specifically noted on the Drawings, coat the concrete surface with a bond breaker prior to placing new concrete against it. Avoid coating reinforcement or waterstops with bond breaker at these locations.

3. Full Contraction Joints:

   a. Do not extend reinforcement or other embedded items bonded to the concrete (except dowels bonded on only one side of joint) continuously through any expansion joint.

   b. Where shown on contract drawings provide stainless steel expansion joint dowels. Secure tightly stainless steel expansion joints in forms with rigid ties. Orient dowels to permit joint movement.

4. Partial Contraction Joints:

   a. Extend every other bar of reinforcement steel through partial contraction joints or as indicated on the drawings.

I. Control Joints:

1. Do not use control joints in liquid contain structures unless specifically indicated on the Contract Drawings.

2. Locate control joints as shown on the Contract Drawings.

3. Form control joints with control joint inserts or sawcuts.

4. For sawcutting:

   a. Using early entry saws, saw joints in slabs before the formation of uncontrolled cracking (i.e., cracking that occurs at locations other than construction, control, or contraction joints) and as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing.

   b. Fill saw cut to full depth with elastomeric joint sealant for joints not exposed to vehicular traffic. Fill joints to full depth with epoxy joint sealant for joints exposed to vehicular traffic.

5. Unless noted otherwise on the Contract Drawings, total reduction in concrete member thickness shall be at least 1/4 the member thickness.

J. Expansion Joints:

1. Size and location of expansion joints shall be as shown on the Contract Drawings.

2. Provide center-bulb waterstop at expansion joints where shown on contract drawings and specified herein.

3. Do not extend reinforcement or other embedded items bonded to the concrete except dowels bonded on only one side of joint continuously through any expansion joint.

4. Secure tightly stainless steel expansion joint in forms with rigid ties. Orient dowels to permit joint movement.

3.03 INSTALLATION OF JOINT SEALANTS:

A. Immediately before installing the joint sealant, clean the joint cavity by sandblasting or power wire brushing. Install bond breaker tape per manufacturer's instructions.

B. Apply masking tape along the edges of the exposed surface of the exposed joints.

C. Application criteria for the sealant materials, such as temperature and moisture requirements and primer cure time, shall be in accordance with the recommendations of the sealant manufacturer.

D. After the joints have been prepared as described above, apply the joint sealant. Apply the primer, if required, and joint sealant only with the equipment and methods recommended by the joint sealant manufacturer.

E. Trowel the joints smooth with a tuck pointing tool wiped with a solvent recommended by the sealant manufacturer.

F. After the sealant has been applied, remove the masking tape and any sealant spillage.

G. Sealants used in water retaining structures shall achieve final cure at least seven days before the structure is filled with water.

3.04 LEAKAGE TESTING:

A. Test hydraulic structures in accordance with Section 03 05 10.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 03 15 20

ANCHORAGE IN CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide specified anchor bolts complete with washers and nuts as indicated and in compliance with Contract Documents. Unless otherwise specified, anchor bolts shall be hot-dip galvanized or Type 304 or 316 stainless steel.

1.02 SPECIAL INSPECTION:

A. Special inspection of anchor bolts shall be performed by the Special Inspector and in accordance with the IBC and the Statement of Special Inspections.

1.03 REFERENCES:

A. American Concrete Institute (ACI):

1. 318: Building Code Requirements for Structural Concrete, and Commentary

B. ASTM International (ASTM):

1. A36: Structural Steel

2. A108: Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

3. A123: Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products

4. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

5. A194: Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both

6. A276: Standard Specification for Stainless Steel Bars and Shapes

7. A320: Alloy Steel Bolting Materials for Low-Temperature Service

8. A354: Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

9. A449: Quenched and Tempered Steel Bolts and Studs

10. A490: Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

11. A493: Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging

12. A563: Standard Specification for Carbon and Alloy Steel Nuts

13. A572: Standard Specification for High Strength Low Alloy Columbium Vanadium Structural Steel

14. F593: Stainless Steel Bolts, Hex Cap Screws and Studs

15. F594: Stainless Steel Nuts

16. F844: Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

17. F1554: Anchor Bolts, Steel, 36, 55, 105-ksi Yield Strength

18. F3125: Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength

C. International Building Code (IBC):

1. International Building Code, 2018 Edition

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. A copy of this specification section, with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.

1. Data indicating load capacities

2. Chemical resistance

3. Temperature limitations

4. Installation instructions

5. Manufacturer's data and catalogue numbers

C. All post installed anchors, adhesive and expansion type anchors shall be listed with at least one of the following agencies, ICC & ICC (ES). Submit ICC evaluation reports for

adhesive and expansion type anchors as specified in paragraph 3.02 of this specification section.

D. Design calculation in accordance with paragraph 2.04 of this specification section.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 25 percent, up to a limiting maximum oversizing of 1/4 inch. Minimum anchor bolt diameter shall be 1/2 inch. Anchor bolts shall be furnished with leveling nuts, the faces of which shall be tightened against flat surfaces as shown to not less than 10 percent of the bolt's safe tensile stress.

B. Tapered washers shall be provided where mating surface is not square with the nut.

C. Expansion, wedge or adhesive anchors set in holes drilled in the concrete after the concrete is placed will not be permitted in substitution for anchor bolts except where otherwise specified. Upset threads shall not be acceptable.

2.02 MATERIALS:

A. Anchor bolt materials shall be as specified in Table 03 15 20-1 unless otherwise specified on the contract drawings.

2.03 ANTI-SEIZE COMPOUND:

A. All stainless steel embedded bolts, expansion anchors, and adhesive anchors shall be assembled with a stainless steel anti-seize compound such as molycote.

2.04 DESIGN:

A. Anchor bolts for equipment frames and foundations shall be designed in accordance with the IBC. The contractor designed anchor bolts are differed approval, and the "stamped" calculations and drawing shall be submitted to the engineer of record for review of general compliance with design intent. Calculations and shop drawings shall be submitted with the equipment submittal in accordance with the Section 01 33 00 for all anchorage details. All calculations must be made and signed by a civil or structural engineer currently registered in the State of Utah.

B. All anchor bolts resisting seismic forces shall be design based on cracked concrete requirement in ACI 318.

Table 03 15 20-1
Anchor Bolt Materials

Material	Specification
Stainless Steel Anchor Bolts	ASTM A193, Grade B8M Class 1, AISI 316 or ASTM A320, Grade B8M Class 1, AISI 316
Stainless Steel Threaded Rods at Adhesive Anchors	ASTM F593 CW1 (1/4 inches to 5/8 inches Rod) ASTM F593 CW2 (3/4 inches to 1 1/2 inches Rod)
Stainless Steel Nuts and Washers	ASTM A194 Grade 8M, SS316 Nuts with Type 316 SS Washers (ASTM F594 Group 2 Type 316 SS Nuts at Adhesive Anchors)
Carbon Steel Anchor Bolts	ASTM F1554 (Grade 36) – Hot Dip Galvanized unless noted otherwise
High-Strength Carbon Steel Anchor Bolts	ASTM F1554 (Grade 55 Weldable per Supplementary Requirement S1) – Hot Dip Galvanized unless noted otherwise
Carbon Steel Nuts and Washers	ASTM A563 and ASTM F844
Concrete Expansion Anchors	Stainless Steel HILTI "KWIK BOLT TZ"; SIMPSON STRONG-TIE STRONG BOLT 2
Concrete Adhesive Anchoring System	HILTI HIT-HY 200; SIMPSON STRONG-TIE SET-XP
Stainless Steel Headed Anchor Studs	ASTM A276 or A493; Nelson Stud Welding, Inc.

Table 03 15 20-1 Anchor Bolt Materials	
Material	**Specification**
Carbon Steel Headed Anchor Studs	ASTM A108; Nelson Stud Welding, Inc.

PART 3 - EXECUTION

3.01 GENERAL:

A. Fieldwork, including cutting and threading, shall not be permitted on galvanized items. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators. Grouting of anchor bolts with nonshrink or epoxy grouts, where specified, shall be in accordance with Section 03 60 00. All stainless steel anchor bolts and fasteners shall be assembled with stainless steel anti-seize compound.

3.02 INSTALLATION:

A. Cast-In-Place Anchor Bolts:

1. Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed. Only where specifically shown on the contract plans recesses or blockouts shall be formed in the concrete and the metalwork shall be grouted in place in accordance with Section 03 60 00 after strength is attained. The surfaces of metalwork in contact with concrete shall be thoroughly cleaned.

2. After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

3. For grouting of anchor bolts, use non-shrink, non-metallic grout as specified in Section 03 60 00.

B. Adhesive Anchors:

1. Use of adhesive or capsule anchors shall be as shown on the contract drawings and shall be subject to the following conditions:

a. Use shall be limited to locations where exposure, on an intermittent or continuous basis, to acid concentrations higher than 10 percent, to chlorine gas, or to machine or diesel oils, is extremely unlikely.

b. Use shall be limited to applications where exposure to fire or exposure to concrete or rod temperature above 120 degrees F is extremely unlikely. Overhead applications (such as pipe supports), because of the above concerns, shall be disallowed.

c. Anchor diameter and grade of steel shall be per contract documents or per equipment supplier specifications. Anchor shall be threaded or deformed full length of embedment and shall be free of rust, scale, grease, and oils.

d. Embedment depth shall be as specified on the drawings. Adhesive capsules of different diameters may be used to obtain proper volume for the embedment, but no more than two capsules per anchor may be used. When installing different diameter capsules in the same hole, the larger diameter capsule shall be installed first. Any extension or protrusion of the capsule from the hole is prohibited.

e. All installation recommendations by the anchor system manufacturer shall be followed carefully, including, but not limited to, maximum hole diameter, minimum embedment, and minimum edge distance.

f. Holes shall have rough surfaces, such as can be achieved using a rotary percussion drill.

g. Holes shall be blown clean with compressed air and be free of dust or standing water prior to installation.

h. Anchor shall be left undisturbed and unloaded for full adhesive curing period.

i. Concrete temperature (not air temperature) shall be compatible with curing requirements of adhesives per adhesive manufacturer. Anchors shall not be placed in concrete below 25 degrees F.

2. The Contractor shall supply the Engineer with the current ICC evaluation report from the ICC Evaluation Services for the particular brand of adhesive anchors to be used.

3.03 EXPANSION ANCHORS:

A. Use of expansion anchors shall be as shown on the contract drawings and shall be subject to Conditions c, e, f, g, and h specified in paragraph 3.02-B.1 of this specification section.

3.04 FIELD QUALITY CONTROL:

A. Testing: 10 percent of each type and size of drilled-in anchor shall be proof loaded by the independent testing laboratory. Adhesive anchors and capsule anchors shall not be torque tested unless otherwise directed by the Engineer. If more than 10 percent of the tested anchors fail to achieve the specified torque or proof load within the limits as defined on the Drawings, all anchors of the same diameter and type as the failed anchor shall be tested, unless otherwise instructed by the Engineer.

1. Tension testing should be performed in accordance with ASTM E488.

2. Torque shall be applied with a calibrated torque wrench.

3. Proof loads shall be applied with a calibrated hydraulic ram. Displacement of adhesive and capsule anchors at proof load shall not exceed D/10, where D is the nominal anchor diameter.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 03 21 00

REINFORCEMENT BARS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide concrete reinforcement as indicated and in compliance with Contract Documents:

1. Section Includes:

a. Reinforcement bars

b. Welded wire reinforcement

c. Reinforcement accessories

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A82: Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

2. A184: Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.

3. A185: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

4. A496: Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.

5. A497: Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete Reinforcement.

6. A555: Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods.

7. A615: Standard Specification for Deformed and Plain Billet-Steel Bars for Concretes Reinforcement.

8. A616: Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement.

9. A617: Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement.

10. A706: Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

11. A767: Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

12. A775: Standard Specification for Epoxy-Coated Reinforcement Steel Bars.

13. A884: Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.

14. A955: Standard Specification for Deformed and Plain Stainless Steel Bars for Concrete Reinforcement.

15. A1064: Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plan and Deformed, for Concrete.

B. American Concrete Institute (ACI):

1. 301: Standard Specification for Structural Concrete.

2. 315: Details and Detailing of Concrete Reinforcement.

3. 318: Building Code Requirements for Structural Concrete.

4. 350: Building Code Requirements for Environmental Engineering Concrete Structures

5. SP-66: ACI Detailing Manual.

C. Concrete Reinforcing Steel Institute (CRSI):

1. Manual of Standard Practice.

2. Placing Reinforcing Bars.

D. American Welding Society (AWS):

1. D1.4: Structural Welding Code, Reinforcement Steel.

E. Where reference is made to one of the above standards, the version in effect at the time of bid opening shall apply.

1.03 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.04 SUBMITTALS:

A. Unless otherwise acceptable to the Engineer, each submittal shall include reinforcement only for the individual structure to which it pertains.

B. Shop Drawings:

1. Submit bar lists and placing drawings for all reinforced concrete and masonry structures in accordance with Section 01 33 00.

2. Detail reinforcement in conformance with ACI SP-66.

3. Clearly indicate bar sizes, spacings, locations and quantities of reinforcement steel and wire reinforcement, bending schedules, and supporting and spacing devices. Show joints, with applicable joint reinforcement.

4. Coordinate bar splicing and placement with Contractor’s concrete placing schedule and joint locations. Do not add or delete joints without permission from the Engineer.

5. Show wall reinforcement in elevation.

6. Show slab reinforcement in plan view.

7. Show location and size of all penetrations greater than 12-inches in diameter or least dimension of the opening with the corresponding added reinforcement around the penetrations.

8. Clearly show marking for each reinforcement item.

9. Indicate locations of reinforcement bar cut-offs, splices and development lengths.

C. Submit Certificates: Submit AWS qualification certificates for welders employed on the Work for the appropriate electrode and class of material. Submit certified copies of mill test reports of reinforcement analysis for each shipment of reinforcement with specific lots in shipments identified.

D. Chemical composition of reinforcement steel: Ladle analysis indicating percentage of carbon, phosphorous, manganese and sulfur present in steel.

E. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, submit Manufacturer's literature that contains instructions and recommendations for installation for each type of coupler used; certified test reports that verify the load

capacity of each type and size of coupler used; and Shop Drawings that show the location of each coupler with details of how they are to be installed in the formwork.

1.05 QUALITY ASSURANCE:

A. Comply with requirements in Section 01 45 00 and as specified.

B. Do not fabricate reinforcement until shop and placement drawings have been reviewed and accepted by the Engineer.

C. Perform concrete reinforcement work in accordance with CRSI Manual of Practice, ACI 301, ACI SP-66 and ACI 318.

D. An independent testing agency shall be retained by the Owner to visually inspect and test reinforcing steel welds in accordance with AWS D1.4.

E. An independent testing agency shall be retained by the Owner to inspect each mechanical coupler and verify each component is installed in accordance with Manufacturer's instructions and ICC Evaluation Services Report or equivalent code agency report.

1.06 QUALIFICATIONS:

A. Welders: AWS qualified within previous 12 months.

1.07 INSPECTION AND TESTING:

A. In no case shall any reinforcement steel be covered with concrete until the installation of the reinforcement has been observed by the Engineer and the Engineer's authorization to proceed with the concreting has been obtained. The Engineer shall be given 24 hours minimum prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has finished observations of the reinforcement steel.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements in APWA Section 01 66 00.

B. Ship and store reinforcement steel with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted placing drawings.

C. Store reinforcement steel off the ground, protected from standing water and kept free from free from mill scale, rust, dirt, grease or other foreign matter.

PART 2 - PRODUCTS

2.01 REINFORCEMENT STEEL:

A. Reinforcement Steel: ASTM A615, 60 ksi yield grade; deformed billet steel bars, unfinished.

B. Reinforcement Steel: ASTM A706, 60 ksi yield strength; deformed low-alloy steel bars, unfinished.

C. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A82.

D. Welded Wire Reinforcement:

1. Provide welded wire reinforcement conforming to ASTM A185 in flat sheets.

2. Provide deformed welded wire reinforcement conforming to ASTM A497 in flat sheets.

3. Provide support bars and reinforcement bar supports as specified herein to obtain the concrete cover indicated.

4. Provide welded wire reinforcement heavier than W2.9 in flat sheets.

2.02 ACCESSORY MATERIALS:

A. Tie Wire: Minimum 16 gage annealed type.

B. Chairs, Bolsters, Bar Supports, and Spacers: Sized and shaped for strength and support of reinforcement during concrete placement.

C. Special Chairs, Bolsters, Bar Supports, and Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic type; size and shape.

D. Provide 3-inch by 3-inch plain precast concrete blocks, precast concrete doweled blocks or concrete brick for support of bottom reinforcement in foundation mats, base slabs, footings, pile caps, grade beams and slabs on grade. Provide block thickness to produce concrete cover of reinforcement as indicated.

E. Mechanical Couplers:

1. Reinforcement Tension Bar Splicers:

a. Manufacturers: Cadweld or Lenton rebar splicers by Erico Products, Inc. and Dayton Barsplice, Inc.

b. Manufacturers: DB-SAE splicer system by Richmond Screw Anchor Company, Inc., C2D rebar flange coupler by Williams Form Engineering Corporation and Lenton Form Saver by Erico Products, Inc.

c. Develop minimum 125 percent of yield capacity of bars spliced in tension when tested as assembly in accordance with ASTM A370 and A615.

F. Reinforcement Compression Bar Splicers:

1. Manufacturers:

a. G-Loc splicers by Gateway Building Products Division

b. Speed-Sleeve by Erico Products, Inc.

G. Provide epoxy for grouting reinforcement bars specifically formulated for such application for the moisture condition, application temperature, and orientation of the hole to be filled.

H. Epoxy grout shall meet the requirements in Section 03 60 00.

2.03 FABRICATION:

A. Fabricate concrete reinforcement in accordance with CRSI Manual of Standard Practice.

B. Weld reinforcement in accordance with AWS D1.4 only when permitted by the Engineer.

C. Locate reinforcement splices not indicated on Drawings, at point of minimum stress. Review location of splices with Engineer.

D. Cold bend bars. Do not straighten or rebend bars.

E. Do not heat reinforcement steel to bend or straighten.

F. Bend bars around a revolving collar having a diameter of not less than that recommended by the ACI 318.

G. Cut bar ends that are to be butt spliced or threaded by saw cutting. Terminate such ends in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Place, support and secure reinforcement against displacement. Do not deviate from required position. Place reinforcement a minimum of 2 inches clear of any metal pipe or fittings.

B. Position dowels accurately. Rigidly support, align and securely tie dowels normal to the concrete surface before concrete placement. Setting dowels into wet concrete is prohibited.

C. Position wall dowels projecting from base slabs on grade with templates or guides held in place above the concrete placement line. Position the templates to obtain the required clearance between the dowels and the face of the walls.

D. Bars additional to those indicated that may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at no additional cost to the Owner.

E. Do not extend continuous reinforcement or other fixed metal items through expansion joints. Provide 2 inches clearance from each face of expansion joint.

F. Provide additional reinforcement bars to support top reinforcement in slabs. Do not shift reinforcement bars from positions in upper layers to positions in lower layers as a substitute for additional support bars.

G. Support reinforcement steel in accordance with CRSI “Placing Reinforcement Bars” with maximum spacing of 4 feet-0 inches.

H. Tie reinforcement steel at intersections in accordance with CRSI “Placing Reinforcement Bars”:

1. Maximum tie spacing for footings, walls and columns: every third intersection or 3 feet-0 inches.

2. Maximum spacing for slabs and other work: every fourth intersection or 3 feet-0 inches.

3. Tie a minimum of 25 percent of all intersecting bars in foundation mats, base slabs, footings, pile caps, slabs on grade and elevated slabs.

4. Secure all dowels in place before placing concrete.

5. Tie wires shall be bent away from the forms and from finished concrete surfaces in order to provide the required concrete coverage.

I. Locate reinforcement to avoid interference with items drilled in later, such as concrete anchors as identified on the Contract Drawings.

J. Extend welded wire reinforcement to within 2 inches of edges of slab or section. Lap sheets at least 12 inches or two wire spaces, whichever is greater, at ends and edges and wire tightly together. Stagger end laps.

K. Unless shown otherwise on Drawings, place welded wire reinforcement in slabs on grade between the upper third point and mid-point of slab. Placing welded wire reinforcement on the subgrade and pulling it up during concrete placement is not permitted.

L. Support welded wire reinforcement placed over the ground on wired concrete blocks (dobies) spaced not more than 3 feet on centers in any direction.

M. Support welded wire reinforcement placed over horizontal forms on slab bolsters spaced not more than 30 inches on center.

N. Mechanical coupler systems may be substituted for dowels at Contractor's option when permitted by Engineer.

O. Provide additional reinforcement bars to support ties and stirrups in beams where top reinforcement is not continuous.

P. Securely support and tie reinforcement steel to prevent movement during concrete placement.

Q. Ship, handle and place stainless steel reinforcement bars such that they do not come into direct contact with carbon steel. Use stainless steel or non-metallic tie wires and bar chairs. Use nylon, PVC, or polyethylene spacers where stainless steel bar must be attached to carbon steel, to maintain a minimum 1-inch clearance.

R. Unless otherwise shown on the Drawings or permitted by the Engineer, do not bend reinforcement bars that project from in-place concrete.

S. Do not weld reinforcement steel bars (including tack welded) either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written permission has been obtained from the Engineer. Immediately remove bars that have been welded, including tack welds, without such permission from the work. Comply with AWS D1.4 when welding of reinforcement is or called for.

T. Reinforcement steel interfering with the location of other reinforcement steel, conduits or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Make greater displacement of bars to avoid interference only with the permission of the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior permission from the Engineer.

U. Reinforcement shall be clean and free from loose mill scale, dirt, grease, oil, form release agent, dried concrete or any material reducing bond with concrete.

V. Setting bars and welded wire reinforcement on layers of fresh concrete as the work progresses or adjusting reinforcement during the placement of concrete is prohibited.

W. Provide and place safety caps on all exposed ends of vertical reinforcement that pose a danger to injury or life safety.

3.02 CONCRETE COVER OVER REINFORCEMENT BARS:

A. Conform to ACI 318 for concrete cover over reinforcement.

3.03 REINFORCEMENT AROUND OPENINGS AND PENETRATIONS:

A. Accommodate placement of formed openings and penetrations.

B. Unless specific additional reinforcement around openings and penetrations is shown on the Drawings, provide additional reinforcement steel on each side of opening or penetration equivalent to one half of the cross-sectional area of the reinforcement steel interrupted by an opening or penetration. The bars shall have sufficient length to be fully developed at each end beyond the opening or penetration.

C. Refer to details on Drawings for additional diagonal bars around openings or penetrations and bar extension length on each side of openings or penetrations.

D. Where welded wire fabric is used provide extra reinforcement using fabric or deformed bars around opening or penetration.

3.04 SPLICING OF REINFORCEMENT:

A. Splices may be used to provide continuity due to bar length limitations. Minimum length of bars spliced for this reason is 30 feet. Do not splice reinforcement that is detailed to be continuous in the Drawings.

B. Stagger bar splices.

C. Provide tension lap splices at all laps in compliance with ACI 318. Use Class B splices at all locations, unless otherwise noted.

D. Except as otherwise indicated on the Drawings, stagger splices in circumferential reinforcement in circular walls using Class B tension splices. Do not splice adjacent bars within the required lap length.

E. Make reinforcement continuous through construction joints.

F. Reinforcement may be spliced at construction joints provided that entire lap is placed within only one concrete placement.

3.05 ACCESSORIES:

A. Provide accessories such as chairs, chair bars and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.

B. Use precast concrete blocks where the reinforcement steel is to be supported over soil.

C. Provide stainless steel bar supports or steel chairs with plastic tips where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity or liquid (including bottom of slabs over liquid containing areas) unless otherwise noted on contract documents.

D. Do not use metal chairs, ferrous clips, nails, etc. that extend to the surfaces of the concrete. Do not use stones, brick or wood block supports.

E. Do not use alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcement steel fastened to the bottom and top mats unless permitted by the Engineer.

F. Mechanical Couplers:

1. Couplers that are located at a joint face can be a type that can be set either flush or recessed from the face as indicated.

2. Seal couplers during concrete placement to completely eliminate concrete or cement paste from entering.

3. Recess couplers intended for future connections a minimum of 1/2 inch from the concrete surface. After the concrete is placed, plug the coupler with plastic plugs that have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials.

4. Unless indicated otherwise, provide mechanical coupler spacing and size to match the spacing and size of the reinforcement indicated for the adjacent section.

3.06 FIELD QUALITY CONTROL:

A. Remove reinforcement with kinks or bends not shown on shop or placement drawings. Remove such reinforcement from job site and replace with new fabricated steel. Do not field bend reinforcement unless reinforcement is indicated or specified to be field bent.

B. Protect reinforcement from rusting, deforming, bending, kinking and other injury. Clean in-place reinforcement that has rusted or been splattered with concrete using sand or water blasting prior to incorporation into the Work.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide cast-in-place concrete as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

2. 214R: Recommended Practice for Evaluation of Strength Test Results of Concrete

3. 301: Standard Specifications for Structural Concrete

4. 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete

5. 304.2R: Placing Concrete by Pumping Methods

6. 305R: Hot Weather Concreting

7. 306R: Cold Weather Concreting

8. 308: Standard Practice for Curing Concrete

9. 309R: Guide for Consolidation of Concrete

10. 311.4R: Guide for Concrete Inspection

11. 318: Building Code Requirements for Structural Concrete

12. 347.3R: Guide to Formed Concrete Surfaces

13. 350: Code Requirements For Environmental Engineering Concrete Structures

B. ASTM International (ASTM):

1. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3. C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field

4. C33: Standard Specification for Concrete Aggregates

5. C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

6. C40: Standard Test Method for Organic Impurities in Fine Aggregates for Concrete

7. C42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

8. C87: Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar

9. C88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

10. C94: Standard Specification for Ready-Mixed Concrete

11. C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in Cube Specimens)

12. C123: Standard Test Method for Lightweight Particles in Aggregate

13. C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

14. C138: Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete

15. C143: Standard Test Method for Slump of Hydraulic Cement Concrete

16. C150: Standard Specification for Portland Cement

17. C157: Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete

18. C171: Standard Specification for Sheet Materials for Curing Concrete

19. C172: Standard Practice for Sampling Freshly Mixed Concrete

20. C192: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

21. C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

22. C260: Standard Specification for Air-Entraining Admixtures for Concrete

23. C277: Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar Bar Method)

24. C289: Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)

25. C295: Standard Guide for Petrographic Examination of Aggregates for Concrete

26. C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

27. C311: Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete

28. C494: Standard Specification for Chemical Admixtures for Concrete

29. C595: Standard Specification for Blended Hydraulic Cements

30. C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

31. C881: Standard Test Method for Epoxy Resin Base Bonding Systems for Concrete

32. C882: Standard Test Method for Bond Strength of Epoxy Resin Systems Used with Concrete by Slant Shear

33. C1017: Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

34. C1064: Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete

35. C1077: Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

36. C1107: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

37. C1116: Standard Specification for Fiber Reinforced Concrete

38. D75: Standard Practice for Sampling Aggregates

39. E154: Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

40. E1745: Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

41. E329: Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction

C. American Association of State Highway and Transportation Officials (AASHTO):

1. M182: Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data:

1. Manufacturer's specifications and instructions including Material Safety Data Sheets (MSDS) for admixtures and curing materials. Manufacturer’s certification of compatibility of all admixtures.

C. Shop Drawings:

1. Prior to placing concrete provide all submittal requirements of Section 03 35 01.

2. Provide certificate that cement used complies with ASTM C150 and these specifications.

3. Provide certificates that aggregates comply with ASTM C33 and contain less than 1 percent asbestos by weight or volume. Submit gradation analysis with concrete mix designs.

4. Provide certificate of compliance with these specifications from the manufacturer of the concrete admixtures.

5. For each formulation of concrete proposed, prepare mix designs in accordance with ACI 318, Chapters 4 and 5, except as modified herein. Submit mix design for review by the Engineer at least 15 days before placing of any concrete.

6. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.

7. Proposed special procedures for protection of concrete under wet weather placement conditions.

8. ACI 301, Section 8 applies for all concrete elements thicker than 48 inches.

9. Provide in mix designs gradation of aggregate. Gradation shall be performed within 4 months prior to submittal.

    a. Gradation:

        (1) List gradings and percent passing through each sieve for coarse, fine, and combined aggregates.

        (2) Testing shall be performed within 4 months prior to submittal.

    b. Provide evidence not more than 120 days old showing compliance with the requirements of Article Materials, Paragraph B, including the following:

        (1) Deleterious substances in fine aggregate per ASTM C33, Table 2.

        (2) Deleterious substances in coarse aggregate per ASTM C33, Table 4.

    c. Alkali Aggregate Reactivity: Aggregate shall be classified as non-potentially reactive in accordance with ASTM C33, Table 3 as tested using methods from ASTM C227. Include documentation of test results per applicable standards.

10. Admixtures: Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.

D. Informational Submittals:

1. Preinstallation Conference minutes.

2. Statement of Qualification:

    a. Batch Plant: Certification under National Ready Mix Concrete Association (NRMCA) Program for Certification of Ready-Mixed Concrete Production Facilities or approved equal.

    b. Mix designer. NRMCA Concrete Technologist Level 2 or licensed professional engineer.

    c. Testing agency credentials according to ASTM C1077 and ASTM E329

(1) Field tester(s): ACI Concrete Field Testing Technician, Grade 1

(2) Laboratory staff: ACI Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I with supervisor being Grade II.

3. Field test reports.

4. Recorded temperature data from concrete placement where specified.

5. Concrete Delivery Tickets:

a. For each batch of concrete before unloading at Site.

b. In accordance with ASTM C94, including requirements 14.2.1. through 14.2.10.

c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

E. Test and Evaluation Reports:

1. Provide results of drying shrinkage tests from trial concrete mixes by the Contractor's testing laboratory firm.

F. Manufacturer’s Instructions:

1. Provide epoxy bonding compound manufacturer's specific instructions for use. Provide manufacturer's data sheets as to suitability of product to meet job requirements with regard to surface, pot life, set time, vertical or horizontal application, and forming restrictions.

G. Shrink Test Results:

1. Provide shrink test results for Class A concrete mixes in accordance with ASTM C157 as modified herein

H. Field Quality Control Submittals:

1. Provide delivery tickets for ready-mix concrete or weighmasters certificate per ASTM C94, including weights of cement and each size aggregate and amount of water added at the plant and record of pours. Record the amount of water added on the job on the delivery ticket. Water added at the plant shall account for moisture in both coarse and fine aggregate.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SHRINKAGE TESTS:

A. The testing laboratory shall perform drying shrinkage tests for the trial batches as specified herein.

B. Fabricate, cure, dry, and measure specimens in accordance with ASTM C157 modified as follows:

1. Remove specimens from molds at an age of 23 hours plus or minus 1 hour after trial batching, place immediately in water at 70 degrees F, plus or minus 3 degrees F for at least 30 minutes, measure within 30 minutes thereafter to determine original length, and then submerge in saturated lime water at 73 degrees F plus or minus 3 degrees F. At age seven days, make measurement to determine expansion, expressed as a percentage of original length. This length at age seven days shall be the base length for drying shrinkage calculations (zero days' drying age).

2. Then, store specimens immediately in a humidity-controlled room maintained at 73 degrees F, plus or minus 3 degrees F and 50 percent, plus or minus 4 percent relative humidity for the remainder of the test. Make and report measurements to determine shrinkage expressed as percentage of base length separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.

C. Compute the drying shrinkage deformation of each specimen as the difference between the base length (at zero days' drying age) and the length after drying at each test age. Compute the average drying shrinkage deformation of the specimens to the nearest 0.0001 inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004 inch**,** disregard the results obtained from that specimen. Report results of the shrinkage test to the nearest 0.001 percent of shrinkage. Take compression test specimens in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project.

D. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age, shall be 0.036 or 0.042 percent, respectively. Use a mix design for construction that has first met the trial batch shrinkage requirements.

E. If the trial batch specimens do not meet the shrinkage requirements, revise the mix design and/or materials and retest.

1.06 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00.

B. Unless otherwise indicated, materials, workmanship, and practices shall conform to the following standards:

1. Local building codes.

2. ACI 301, “Structural Concrete for Buildings”.

3. ACI 318, “Building Code Requirements for Reinforced Concrete”.

4. ACI 350, “Code Requirements For Environmental Engineering Concrete Structures”.

C. Where provisions of pertinent codes and standards conflict with this specification, the more stringent provisions govern.

D. Concrete not meeting the minimum specified 28-day design strength shall be cause for rejection and removal from the work.

E. Perform concrete work in conformance with ACI 301 unless otherwise specified.

F. Do not use admixtures, including calcium chloride, which will cause accelerated setting of cement in concrete.

G. Do not place concrete until design mix, material tests and trial concrete batch mix compression test results are accepted by the Engineer.

H. The Owner shall employ a testing laboratory to test conformity of materials to specifications. Concrete testing shall be performed by an ACI Concrete Field Technician, Grade I or equivalent. Allow free access to obtain test samples.

I. Methods of Sampling and Testing:

1. Fresh Concrete Sampling: ASTM C172

2. Specimen Preparation: ASTM C31

3. Compressive Strength: ASTM C39

4. Air Content: ASTM C231

5. Slump: ASTM C143

6. Temperature: ASTM C1064

7. Unit Weight: ASTM C138

8. Obtaining Drilled Cores: ASTM C42

9. Drying Shrinkage: ASTM C157

J. Acceptance of Structure: Acceptance of completed concrete work requires conformance with dimensional tolerances, appearance and strength as indicated or specified.

K. Hot weather concrete to conform to ACI 305R and as specified herein.

L. Cold weather concrete to conform to ACI 306R and as specified herein.

M. Reject concrete delivered to job site that exceeds the time limit or temperature limitations specified. Refer to paragraph 3.02.A for limits.

N. Do not place concrete in water or on frozen or uncompacted ground.

O. Workability:

1. Concrete shall be of such consistency and composition that it can be worked readily into the forms and around the reinforcement without excessive vibrating and without permitting the materials to segregate or free water to collect on the surface.

2. Adjust the proportions to secure a plastic, cohesive mixture, and one that is within the specified slump range.

3. To avoid unnecessary changes in consistency, obtain the aggregate from a source with uniform quality, moisture content, and grading. Handle materials to minimize variations in moisture content that would interfere with production of concrete of the established degree of uniformity and slump.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Provide in conformance with APWA Section 01 66 00 and as specified herein.

B. Deliver concrete to discharge locations in watertight agitator or mixer trucks without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.

C. Reject concrete not conforming to specification, unsuitable for placement, exceeding the time or temperature limitations or not having a complete delivery batch ticket.

1.08 SITE CONDITIONS:

A. Do not place concrete until conditions and facilities for making and curing control test specimens are in compliance with ASTM C31 and as specified herein.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Cement:

1. Portland Cement, ASTM C595, Type IL.

2. Use only one brand of cement in any individual structure. Use no cement that has become damaged, partially set, lumpy, or caked. Reject the entire contents of the sack or container that contains such cement. Use no salvaged or reclaimed cement.

3. Maximum tricalcium aluminate shall not exceed 8 percent. The maximum percent alkalies shall not exceed 0.6 percent.

B. Fly Ash:

1. Provide fly ash conforming to the following requirements:

a. Class F fly ash conforming to ASTM C618 for chemical and physical properties.

b. Supplemental requirements in percent:

(1) Maximum carbon content: 3 percent

(2) Maximum sulfur trioxide (SO3) content: 4 percent

(3) Maximum loss on ignition: 3 percent

(4) Maximum water requirement (as a percent of control): 100 percent

(5) Fineness, maximum retained on No. 325 sieve: 25 percent

C. Ground Granulated Blast Furnace Slag (GGBF):

1. GGBF, when used, shall meet the requirements of ASTM C989, Grade 100 or better.

D. Silica Fume:

1. The use of silica fume and other natural pozzolans is not permitted.

E. Fine Aggregates:

1. Clean, sharp, natural sand conforming to requirements of ASTM C33 with a fineness modulus between 2.50 and 3.0.

F. Coarse Aggregate:

1. Well graded crushed stone, natural rock conforming to requirements of ASTM C33, and shall contain less than 1 percent asbestos by weight or volume.

2. Limit deleterious substances in accordance with ASTM C33, Table 3, Severe Weathering Regions, limit clay lumps not to exceed 1.0 percent by weight, and limit loss when tested for soundness using magnesium sulfate to 12 percent.

G. Water and Ice:

1. Use water and ice free from injurious amounts of oil, acid, alkali, salt, organic matter or other deleterious substances and conforms to requirements of ASTM C94.

2. Water shall not contain more than 500 mg/L of chlorides nor more than 500 mg/L of sulfate.

3. Heat or cool water to obtain concrete temperatures specified, and in conformance with ACI 305R and ACI 306R.

H. Color Additive for Exterior Electrical Duct Encasement:

1. For exterior electrical duct concrete encasements, use a red color additive for identification purposes.

I. Concrete Admixtures:

1. Maintain compressive strength and maximum water-cement ratios specified in Table 03 30 00-1 when using admixtures. Include admixtures in solution form in the water-cement ratio calculations.

2. Do not use any admixture that contains chlorides or other corrosive elements in any concrete. Admixtures shall be nontoxic after 30 days.

3. Use admixtures in compliance with the manufacturer's printed instructions. The manufacturer shall certify the compatibility of multiple admixtures used in the same mix.

4. Do not use admixtures in greater dosages than recommended by manufacturer.

5. Air Entrainment:

a. Class A concrete; an air-entraining admixture conforming to ASTM C260.

b. Class A-2 concrete; an air-entraining admixture conforming to ASTM C260.

c. Products:

(1) BASF Corporation; MasterAir AE 90.

(2) Sika Corporation; AER-C.

d. Adjust the admixture content to accommodate fly ash or pozzolan requirements, and other admixtures when used, in order to obtain the specified air content.

6. Water Reducing:

a. Class A or Class A-2 concrete; a water-reducing admixture conforming to ASTM C494, Type A and compatible with the air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations.

b. Products:

(1) BASF Corporation; Polyheed Series

(2) Sika Corporation, Plastocrete 161

(3) WR Grace & Co.; Darex II-AEA

(4) Euclid Chemical Company; Eucon NW

7. Water Reducing and Retarding:

a. Class A or A-2 concrete; a water-reducing and retarding admixture conforming to ASTM C494, Type D and compatible with the air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations.

b. Products:

(1) BASF Corporation; Pozzolith Series

(2) Sika Corporation; Plastiment

(3) Euclid Chemical company; Eucon WR-91

8. Mid-Range Water-Reducing Admixture (Superplasticizer):

a. Class A or A-2 concrete; a water-reducing and retarding admixture conforming to ASTM C494, Type A and F and compatible with the air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations.

b. Products:

(1) BASF Corporation; MasterPolyheed 900

(2) Sika Corporation; SikaPlast 200

(3) Euclid Chemical company; Eucon MR

9. High-Range Water-Reducing Admixture (Superplasticizer):

a. High-Range water-reducing admixture conforming to ASTM C494, Type F or ASTM C1017, Type I.

b. Products:

(1) BASF Corporation; Glenium Series

(2) WR Grace & Co.; Daracem 19

(3) Euclid Chemical Company; Eucon SP

10. Shrinkage Reducing Admixture:

a. Class A concrete; shrinkage-reducing admixture is permitted to be used in the mix to meet shrinkage limitations provided that specified strength are met and there is no reduction in sulfate resistance and no increase in permeability. Quantity of shrinkage-reducing admixture used in the mix shall be added to the quantity of water for purposes of determining the water/cementitious materials ratio.

b. Products:

(1) BASF Corporation; MasterLife SRA 20

(2) GCP Applied Technologies; Eclipse

(3) The Euclid Chemical Company; Eucon SRA

J. Epoxy Bonding Agent:

1. Epoxy bonding agent shall conform to ASTM C881 Type I, II, IV or V; Grade 2 for epoxy resin adhesives. The class of epoxy bonding agent shall be suitable for ambient and substrate temperatures.

2. Products:

a. Sika Corporation; Sikadur 32, Hi-Mod

b. Sika Corporation; Sikadur 32, Hi-Mod LPL

c. BASF Corporation, MasterEmaco ADH 326

K. Curing Compound:

1. Liquid form, which will form impervious membrane over, exposed surface of concrete when applied to fresh concrete by means of spray gun. Compound shall not inhibit future bond of floor covering or concrete floor treatment. Use Type I-D compound with red fugitive dye, Class B, having 18 percent minimum solids conforming to ASTM C309.

2. Products:

a. BASF Building Systems; MasterKure 1315WB.

b. The Euclid Chemical Company; Super Diamond Clear VOX.

c. W. R. Meadows, Inc.; VOCOMP-30.

d. Dayton Superior Corp; Cure and Seal 30 percent.

L. Burlap Mats:

1. Conform to AASHTO M182.

M. Sisal-Kraft Paper and Polyethylene Sheets for Curing:

1. Conform to ASTM C171.

N. Crystalline Waterproofing:

1. Provide crystalline waterproofing in all foundation, slabs and all concrete for water retaining structures, gallery roof slabs, wells, well roof slabs, and below grade structures.

2. Cementitious crystalline waterproofing admixture shall be added to concrete at time of batching.

3. Chloride Environment Field Review: An independent review shall have been completed on a marine structure of at least 19 years of age, subject to ongoing salt water exposure and containing crystalline waterproofing admix to protect the reinforcing steel from chloride attack. Based on concrete sampling and analysis the derived chloride diffusion coefficients of the in place concrete shall show an expected time to corrosion of over 150 years based on an average of a minimum of 3 test locations.

4. Products:

   a. Xypex; Admix C-1000NF, Admix C-2000NF, or Admix C-500

2.02 MIXES:

A. Conform to ASTM C94, except as modified by these specifications.

B. Air content, for Class A and B concrete only, shall be as determined by ASTM C231:

1. 5 +/- 1-1/2 percent for concrete using 1-1/2 inch maximum aggregate size.

2. 6 +/- 1-1/2 percent for concrete using 3/4-inch maximum aggregate size.

3. 7 +/- 1-1/2 percent for concrete using 1/2 -inch maximum aggregate size.

C. Provide concrete with the following compressive strengths at 28 days and proportion it for strength and quality requirements in accordance with ACI 318. The resulting mix shall not conflict with limiting values specified in Table 03 30 00-1.

Table 03 30 00-1

Class	Type of Work	28-Day Minimum Compressive Strength (psi)	Minimum Cementitious Content (lbs per C.Y.)	Maximum Water/ Cement Ratio
A	Concrete for all process and liquid containing structures, foundations, piles, and concrete not otherwise specified.	5,000	560	0.42
A-2	Concrete for non-process interior building construction and concrete not otherwise specified.	5,000	560	0.42
A-3	Cement grout	5,000	560	0.42
B	Site Pavement, Sidewalks and Curbs	3,000	420	0.45

Table 03 30 00-1				
Class	**Type of Work**	**28-Day Minimum Compressive Strength (psi)**	**Minimum Cementitious Content (lbs per C.Y.)**	**Maximum Water/ Cement Ratio**
C	Concrete fill below structure foundations, pipe encasement, miscellaneous unreinforced concrete.	2,000	188	0.60

D. Measure slump in accordance with ASTM C143:

1. Proportion and produce the concrete to have a maximum slump of 4 inches. Proportion and produce the concrete for filling driven pipe piles to have a slump of 6 inches. A tolerance of up to 1 inch above the indicated maximum is allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

2. Mixes containing water reducers shall have a maximum slump of 6 inches after the addition of a mid-range water reducer and maximum slump of 8 inches after the addition of a high range water reducer.

E. Pozzolan Content:

1. Fly ash shall not exceed 20 percent of the total cementitious content.

2. Ground Granulated Blast Furnace Slag (GGBF) will be permitted as a substitute for fly ash at no additional cost to the Owner, in the event that Class F Fly Ash is not available. The slag substitution shall be in the same proportions and percentages of the total cementitious material as shown for fly ash. A higher percentage of GGBF will be allowed if permitted by the Engineer to suit project needs.

F. Aggregate Size:

1. Aggregate size shall be 3/4-inch maximum for slabs and sections 8 inches thick and less. Aggregate size shall be 1 inch maximum for sections greater than 8 inches and less than 17 inches. Aggregate size shall be 1-1/2 inches maximum for all larger slabs and sections. For Class A-3 Concrete: Aggregate shall be:

   a. 3/8-inch maximum

b. Sand aggregate

2. Combined aggregate grading shall be as shown in the following table:

Table 03 30 00-2					
Maximum Aggregate Size	1-1/2 inch	1 inch	3/4-inch	1/2-inch	3/8-inch
Aggregate Grade per ASTM C33	467	57	67	7	8

2.03 CONCRETE TEMPERATURE MONITORING EQUIPMENT:

A. Equipment used to monitor concrete temperature during the curing period shall consist of electronic equipment capable of continuously monitoring and logging the temperature of the concrete, embedded in the concrete at the locations indicated in the Thermal Control Plan.

B. As a minimum the equipment shall consist of an enclosed, battery operated logger embedded in the concrete, attached wires extending to and from the surface of the concrete, and a handheld reader that can be attached to the wires and logger data downloaded.

C. Manufacturers:

1. IntelliRock System, by Engius.

2. The Command Center Maturity System, by the Transtec Group, Inc.

PART 3 - EXECUTION

3.01 INSPECTION:

A. Examine the subgrade and the conditions under which work is to be performed and notify the Engineer in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions are corrected to comply with specified subgrade conditions in a manner acceptable to the Engineer.

3.02 MIXING AND TRANSPORTING CONCRETE:

A. General: Conform to concreting procedures set forth in ASTM C94, ACI 304R and as specified herein.

1. Transport concrete to discharge locations without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.

2. Discharge concrete into forms in accordance with Table 03 30 00-3 after cement has entered mixing drum or before the drum has revolved 300 revolutions after the addition of water, whichever occurs first. Do not add water at the jobsite unless permitted by the Engineer. If it is necessary to add water to obtain the specified slump, add water per ASTM C94, but do not exceed the maximum water content in the reviewed concrete design mix. Added water shall be incorporated by additional mixing of at least 35 revolutions.

3. Do not add water to concrete containing high range water reducing admixture. Do not add water to concrete in delivery equipment not acceptable for mixing.

4. Keep a record showing time and place of each placement of concrete, together with transit-mix delivery slips certifying the contents of the pour.

5. Discharge of concrete shall be completed within the limits set out in Table 03 30 00-3.

Table 03 30 00-3

Maximum Time to Concrete Discharge

Concrete Temperature	Limit
Over 90 Degree F	Remove concrete from jobsite and discard concrete
86 to 90 Degree F	45 minutes
81 to 85 Degree F	60 minutes
70 to 80 Degree F	75 minutes
Below 70 Degree F	90 minutes

B. Conveying: Convey concrete from agitator or mixer truck to place of final deposit in forms by one of the following methods:

1. Buckets or hoppers with discharge gates having a clear opening equal to not less than one-third the maximum interior horizontal area or five times the maximum aggregate size being used, whichever is greater, and side slopes of not less than 60 degrees to horizontal.

2. Buggies or wheelbarrows equipped with pneumatic tires.

3. Round bottom, metal or metal-lined chutes with inclined slope of between 2 to 3 feet horizontally to 1 foot vertically and of sufficient capacity to avoid overflow.

4. Circular drop pipes with a top diameter of at least eight times the maximum aggregate size, but not less than 6 inch, or tapered to not less than six times maximum aggregate size.

3.03 CONCRETE ACCEPTANCE:

A. Accept or reject each batch of concrete delivered to the point of agitator or mixer truck discharge. Sign delivery batch tickets to indicate concrete acceptance.

B. Reject concrete delivered without a complete concrete delivery batch ticket as specified herein. The concrete supplier will furnish copies of the signed batch ticket to the Contractor and Engineer.

C. The testing agency shall perform field tests at the point of agitator or mixer truck discharge. Accept or reject concrete on the basis of conformity with slump, air content and temperature specified.

D. The testing agency shall inspect concrete transit truck's barrel revolution counter and gauge for measuring water added to the concrete. Reject concrete that exceeds the maximum barrel revolution of 300, the limits in Table 03 30 00-3 or concrete that has water content exceeding the specified water-cement ratio.

E. Reject concrete not conforming to specification before discharging into the forms.

3.04 PREPARATION AND COORDINATION:

A. Contractor shall notify the Engineer of readiness to place concrete in any portion of the work a minimum of 48 hours prior to concrete placement. Failure to provide this notification will be cause for delay in placing until observations can be completed. For small concrete placement less than 10 cubic yards, the time may be coordinated with the Engineer and revised to 24 hours.

B. Reinforcement, installation of waterstop, positioning of embedded items, and condition of formwork will be observed by the Engineer prior to concrete placement.

C. Coordinate the sequence of placement such that construction joints will occur only as designed.

D. Schedule sufficient equipment for continuous concrete placing. Provide for backup equipment and procedures to be taken in case of an interruption in placing. Provide backup concrete vibrators at the project site. Test concrete vibrators the day before placing concrete.

E. Compact the subgrade and/or bedding. Saturate the subgrade approximately eight hours before placement and sprinkle ahead of the placement of concrete in areas where vapor barrier is not used. Remove standing water, mud, and foreign matter before concrete is deposited.

F. Where shown on contract drawings, intentionally roughen surfaces of set concrete in a manner to expose bonded aggregate uniformly at joints.

G. Where concrete is required to be placed and bonded to existing concrete, coat the contact surfaces with epoxy bonding agent. The method of preparation and application of the bonding agent shall conform to the manufacturer's recommendations.

3.05 CONCRETE PLACEMENT:

A. Placement shall conform to ACI 304R as modified by these specifications.

B. Alternate sections of concrete walls and slabs may be cast simultaneously. Do not place adjacent sections of walls and slabs until three days after placement of first placed concrete.

C. Do not place concrete until free water has been removed or has been diverted by pipes or other means and carried out of the forms, clear of the work. Do not deposit concrete underwater, and do not allow free water to rise on any concrete until the concrete has attained its initial set. Do not permit free or storm water to flow over surfaces of concrete so as to injure the quality or surface finish.

D. Do not place concrete during inclement weather. Protect concrete placed from inclement weather. Keep sufficient protective covering ready at all times for this purpose.

E. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing. Do not deposit concrete in large quantities in one place to be worked along the forms with a vibrator.

F. Deposit concrete in walls and columns continuously and in level layers 4 feet thick. Avoid inclined layers and cold joints. Place concrete at lower portion of slope first on sloping surfaces.

G. Deposit concrete slab on grade in forms continuously and in level layers 1 to 2 feet thick. Avoid inclined layers and cold joints. Place concrete at lower portion of slope first on sloping surfaces.

H. Do not deposit partially hardened concrete in forms. Retempering of partially hardened concrete is not permitted. Remove partially hardened concrete from site at no additional compensation.

I. Do not allow concrete to fall freely in forms to cause segregation (separation of coarse aggregate from mortar). Limit maximum free fall of concrete to 4 feet. Do not move concrete horizontally more than four feet from point of discharge. Space points of deposit not more than eight feet apart.

J. At least two hours shall elapse after depositing concrete in the columns or walls before depositing in beams, girders, or slabs supported thereon. Place beams, girders, brackets, column capitals, and haunches monolithically as part of the floor or roof system, unless otherwise shown on contract drawings.

K. Consolidate concrete using mechanical vibrators operated within the mass of concrete and/or on the forms conforming to procedures set forth in ACI 309R and as specified herein.

L. Conduct vibration to produce concrete of uniform texture and appearance, free of honeycombing, streaking, cold joints or visible lift lines.

M. Conduct vibration in a systematic manner with regularly maintained vibrators. Furnish sufficient backup units at job site. Use vibrators having minimum frequency of 8,000 vibrations per minute and of sufficient amplitude to consolidate concrete. Use not less than one vibrator with crew for each 35 to 40 cubic yards of concrete placed per hour.

N. Insert and withdraw vibrator vertically at a uniform spacing over the entire area of placement. Space distances between insertions such that spheres of influence of each insertion overlap.

O. Use additional vibration with pencil vibrators on vertical surfaces and on exposed concrete to bring full surface of mortar against the forms to eliminate air voids, bug holes and other surface defects. Employ the following additional procedures for vibrating concrete as necessary to maintain proper consolidation of concrete:

1. Reduce distance between internal vibration insertions and increase time for each insertion.

2. Insert vibrator as close to face of form as possible without contacting form or reinforcement.

3. Thoroughly vibrate area immediately adjacent to waterstops without damaging the waterstop.

4. Use spading as a supplement to vibration where particularly difficult conditions exist.

P. Pumping Concrete:

1. Conform to the recommendations of ACI 304.2R except as modified herein.

2. Base pump size on rate of concrete placement, length of delivery pipe or hose, aggregate size, mix proportions, vertical lift, and slump of concrete.

3. Use pipe with inside diameter of at least three times the maximum coarse aggregate size, but not less than 2 inches.

4. Do not use aluminum pipes for delivery of concrete to the forms.

Q. Waterstops:

1. Prevent displacement of waterstops during concrete placement.

3.06 CURING AND PROTECTION:

A. General:

1. Protect concrete from premature drying, hot or cold temperatures, and mechanical injury, beginning immediately after placement and maintain concrete with minimal moisture loss at relatively constant temperature.

2. Comply with curing procedures set forth in ACI 301, ACI 308 and as specified herein.

3. Perform hot weather concreting in conformance with ACI 305R and as specified herein when the ambient atmospheric temperature is 80 degrees F or above.

4. Perform cold weather concreting in conformance with ACI 306R.

5. Concrete required to be moist cured shall remain moist for the entire duration of the cure. Repeated wetting and drying cycles of the curing process will not be allowed.

B. Curing Duration:

1. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared from unformed concrete surfaces. Initial curing starts as soon as concrete achieves final set. Forms left tightly in place are considered as part of the curing system, provided that wooden forms are kept moist by wetting three times a day. Keep continuously moist for not less than 72 hours.

2. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least 10 days.

3. Avoid rapid drying at the end of the final curing period.

C. Curing Requirements:

1. Unformed Surfaces: Protect finished slabs from direct rays of the sun to prevent checking, crazing and plastic shrinkage. Cover and cure entire surface of newly placed concrete immediately after completing finishing operations and water film has evaporated from surface or as soon as marring of concrete will not occur.

2. Formed Surfaces: Minimize moisture loss for formed surfaces exposed to heating by the sun by keeping forms wet until safely removed. Keep surface continuously

wet by warm water spray or warm water saturated fabric immediately following form removal unless otherwise permitted by the Engineer.

3. Water Containment Structures: Moist cure by the application of water to maintain the surface in a continually wet condition unless otherwise permitted by the Engineer. Use water that is free of impurities that could etch or discolor exposed concrete surfaces. Other concrete: Moist cure by moisture-retaining cover curing, or the use of curing compound.

D. Curing Methods:

1. Water Curing: Water curing is required for all water retention structures for foundations, floors, and walls. Use water curing for unformed surfaces. Continuously water cure all exposed concrete for the entire curing period. Provide moisture curing by any of the following methods:

   a. Keeping the surface of the concrete continuously wet by ponding or immersion.

   b. Continuous water-fog spray or sprinkling.

   c. Covering the concrete surface with curing mats, thoroughly saturating the mats with water, and keeping the mats continuously wet with sprinklers or porous hoses. Place curing mats to provide coverage of the concrete surfaces and edges, with a 4 inch lap over adjacent mats. Weight down the curing cover to maintain contact with the concrete surface.

2. Sealing Materials:

   a. Use common sealing materials such as plastic film or waterproofing (Kraft) paper.

   b. Lap adjacent sheets a minimum of 12 inch. Seal edges with waterproof tape or adhesive. Use sheets of sufficient length to cover sides of concrete member.

   c. Place sheet materials only on moist concrete surfaces. Wet concrete surface with fine water spray if the surface appears dry before placing sheet material.

   d. The presence of moisture on concrete surfaces at all times during the prescribed curing period is proof of acceptable curing using sheet material.

3. Membrane Curing Compound:

   a. Apply membrane-curing compound uniformly over concrete surface by means of roller or spray at a rate recommended by the curing compound

manufacturer, but not less than 1 gallon per 150 square foot of surface area. Agitate curing material in supply container immediately before transfer to distributor and thoroughly agitate it during application for uniform consistency and dispersion of pigment.

b. Do not use curing compounds on construction and expansion joints or on surfaces to receive liquid hardener, dustproofer/sealer, concrete paint, tile, concrete fills and toppings or other applications requiring positive bond unless removed by pressure washing or sand blasting.

c. Reapply membrane-curing compound to concrete surfaces that have been subjected to wetting within 3 hours after curing compound has been applied by method for initial application.

E. Protection from environmental conditions: Maintain the concrete temperature above 50 degrees F continuously throughout the curing period. Make arrangements before concrete placing for heating, covering, insulation or housing to maintain the specified temperature and moisture conditions continuously for the curing period.

1. When the atmospheric temperature is 80 degrees F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering.

2. Protect the concrete continuously for the entire curing period.

3. Maintain concrete temperature as uniformly as possible and protect from rapid atmospheric temperature changes.

4. Avoid temperature changes in concrete that exceed 5 degrees F in any one hour and 50 degrees F in any 24-hour period.

F. Protection from physical injury: Protect concrete from physical disturbances such as shock and vibration during curing period. Protect finished concrete surfaces from damage by construction equipment, materials, curing procedures and rain or running water. Do not load concrete in such a manner as to overstress concrete.

G. Protection from Deicing Agents: Do not apply deicing chemicals to concrete.

3.07 FIELD QUALITY CONTROL:

A. Hot Weather Requirements

1. During hot weather, give proper attention to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete

temperatures or water evaporation in accordance with ACI 305R and the following.

2. When the weather is such that the temperature of the concrete as placed would exceed 90 degrees F, use ice or other means of cooling the concrete during mixing and transportation so that the temperature of the concrete as placed will not exceed 90 degrees F.

3. Take precautions when placing concrete during hot, dry weather to eliminate early setting of concrete. This includes protection of reinforcing from direct sunlight to prevent heating of reinforcing, placing concrete during cooler hours of the day, and the proper and timely application of specified curing methods.

B. Cold Weather Requirements:

1. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather in accordance with ACI 306R and the following.

2. When the temperature of the surrounding atmosphere is 40 degrees F or is likely to fall below this temperature, use heated mixing water not to exceed 140 degrees F. Do not allow the heated water to come in contact with the cement before the cement is added to the batch.

3. When placed in the forms during cold weather, maintain concrete temperature at not less than 55 degrees F. Materials shall be free from ice, snow, and frozen lumps before entering the mixer.

4. Maintain the air and the forms in contact with the concrete at temperatures above 40 degrees F for the first five days after placing, and above 35 degrees F for the remainder of the curing period. Provide thermometers to indicate the ambient temperature and the temperature 2 inches inside the concrete surface.

C. Backfill Against Walls:

1. Do not place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28-day compressive strength. Where backfill is to be placed on both sides of the wall, place the backfill uniformly on both sides.

2. Do not backfill the walls of structures that will be laterally restrained or supported by suspended slabs or slabs on grade until the slab is placed and the concrete has reached the specified compressive strength unless noted otherwise on drawings.

D. Concrete Testing:

1. Concrete quality testing will be performed on the concrete by independent testing agency retained by the Owner.

2. The testing agency will use concrete samples provided by the Contractor at the point of agitator or mixer truck discharge to perform slump (per ASTM C143), air content (per ASTM C231), and temperature tests (per ASTM C1064) and for field control test specimens.

3. The testing agency will submit test reports of concrete field measurements specified above to the Contractor and to the Engineer.

4. Provide and maintain facilities for safe storage and proper curing of concrete test specimens on the project site, as required by ASTM C31.

5. Concrete Quality Test Specimen:

    a. Perform sampling and curing of test specimen in accordance with ASTM C31.

    b. Testing agency personnel will record truck and load number from the delivery batch ticket, the concrete placement location of each specimen, the date, concrete strength, slump, air content and temperature.

    c. The testing agency will cast a minimum of one set of 6 test specimens, each 4-inch diameter by 8-inch long cylinders according the to the following volumes:

        (1) when concrete placement in a single day is less than 200 CY: for each 50 cubic yards of each mix design of concrete per structure,

        (2) when concrete placement in a single day is greater than 200 CY: for each 100 cubic yards of each mix design of concrete per structure,

        (3) but not less than once a day nor less than once for each 5,000 square feet of surface area of foundation mats, base slabs, columns, walls or elevated slabs and floor beams.

    d. Test cylinders in accordance with ASTM C39. Test one cylinder at 7 days for information; test three cylinders at 28 days for acceptance; and hold two reserve cylinders for verification. Strength acceptance will be based on the average of the strengths of the three cylinders tested at 28 days. If one cylinder of a 28-day test manifests evidence of improper sampling, molding, or testing, other than low strength, discard it and use a reserve cylinder for the test result.

6. The Contractor may take field control test specimens for small quantities of concrete.

7. Concrete acceptance shall be based on the requirements of ACI 318 and ACI 350.

8. Field cured cylinders conforming to ASTM C31 will be required to determine field compressive strength of concrete. Laboratory cured cylinders for concrete quality testing shall not be used for determining field compressive strength.

9. Concrete Coring:

   a. When the concrete quality test specimen compression tests fail to be in compliance with the Contract Documents or when the Engineer detects deficiencies in the concrete, the Contractor will take concrete cores at least 2 inches in diameter from the structure in conformance with ASTM C42 at locations determined by the Engineer.

   b. Obtain at least three representative cores from each member or area of concrete that is considered potentially deficient.

   c. Obtain additional cores to replace cores that show evidence of having been damaged subsequent to or during removal from the structure.

   d. The testing agency shall compression test the cores taken from the structure in conformance with ASTM C39 and submit test strength test results of cores specified above to the Contractor and to the Engineer.

   e. All costs associated with coring and testing of cores will be borne by the Contractor at no additional cost to the Owner.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 03 34 00

CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and install Controlled Low Strength Material (CLSM) as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 229R: Controlled Low-Strength Materials
2. 301: Specifications for Structural Concrete
3. 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete
4. 305R: Hot Water Concreting
5. 306R: Cold Water Concreting
6. 308: Standard Practice for Curing Concrete
7. 318: Building Code Requirements for Structural Concrete and Commentary

B. ASTM International (ASTM):

1. C31: Practice for Making and Curing Concrete Test Specimens in the Field
2. C33: Specification for Concrete Aggregates
3. C39: Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. C94: Standard Specification for Ready-Mixed Concrete
5. C138: Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
6. C143: Standard Test Method for Slump of Hydraulic-Cement Concrete
7. C150: Standard Specification for Portland Cement
8. C172: Practice for Sampling Freshly Mixed Concrete

9. C231: Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

10. C494: Standard Specification for Chemical Admixtures for Concrete

11. C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

12. C940: Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory

13. C1064: Test Method for Temperature of Freshly Mixed Portland Cement Concrete

14. D75: Practice for Sampling Aggregates

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. CLSM mix design and results of strength tests from trial mixes by the Contractor's testing laboratory firm.

2. Submit manufacturer's Stable-Air Generator Admixture product data, installation instructions and recommendations for material use.

3. Test and Performance - Submit the following data:

a. Any required deviations from prescribed tests and special handling instructions for test specimens.

b. For locations intended to be excavatable, Controlled Low Strength Material shall have a maximum strength of 100 psi according to ASTM C39 at 56 days after placement.

c. Pipe pile backfill Controlled Low Strength Material shall have a minimum strength of 800 psi according to ASTM C39 at 56 days after placement.

d. Influent Sewer: Controlled Low Strength Material shall have a maximum strength of 200 psi according to ASTM C39 at 56 days after placement.

e. Controlled Low Strength Material shall have minimal subsidence and bleed water which is measured as a final bleeding of less than 2.0 percent (retains 98.0 percent of original height after placement, approximately 1/4-inch per foot of depth) as measured in Section 10 of ASTM C940.

f. Controlled Low Strength Material shall have a unit weight of 90 - 110 lbs./ft^3 measured at the point of placement.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Do not place CLSM until design mix, material tests and trial batch mix compression test results are approved by the Engineer. Approvals are required at least 30 days before placing any production CLSM.

C. Employ an independent testing laboratory, acceptable to the Engineer to test conformity of materials to specifications and to design CLSM mixes.

D. Furnish, pay for and deliver representative samples of sufficient quantity of cement, aggregates and admixtures required for trial batch mixes to the testing laboratory. Obtain materials from the batching plant that will be supplying production CLSM in conformance with ASTM D75.

E. Measure all materials for CLSM, including water, with equipment and facilities suitable for accurate measurement and capable of being adjusted in conformance with ASTM C94. Use scales certified by local Sealer of Weights and Measures within one year of use and accurate when static load tested to plus or minus 0.4 percent of total capacity of scale. Batch all materials by weight except admixtures that may be batched by volume.

F. The testing laboratory will take control test specimens; conduct slump tests and measure air content and temperature in the field.

G. Methods of Sampling and Testing:

1. Fresh Concrete Sampling: ASTM C172

2. Specimen Preparation: ASTM C31

3. Compressive Strength: ASTM C39

4. Air Content: ASTM C231

5. Slump: ASTM C143

6. Temperature: ASTM C1064

7. Unit Weight: ASTM C138

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Order CLSM from batching plant so that trucks arrive at discharge locations when material is required.

C. Deliver CLSM to discharge locations in watertight agitator or mixer trucks without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.

D. Reject CLSM not conforming to specification, unsuitable for placement, exceeding the time or temperature limitations or not having a complete delivery batch ticket.

1.07 PROJECT/SITE CONDITIONS:

A. Do not place CLSM until conditions and facilities for making and curing control test specimens are in compliance with ASTM C31 and as specified herein.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Furnish Type IL cement for all work, unless otherwise specified. Use one approved brand from one mill throughout the contract term unless otherwise approved by the Engineer.

B. Water:

1. Use water that is potable and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances, and conforms to the requirements for water in ASTM C94, and as specified herein.

2. The maximum water-soluble chloride ion in the water shall not exceed 0.060 percent by weight of cement.

C. Aggregates:

1. Use aggregates for CLSM conforming to ASTM C33 and to the following requirements.

D. Admixtures:

1. General Requirements: ASTM C494.

E. Fly Ash: Provide fly ash conforming to the following requirements:

1. Class F fly ash conforming to ASTM C618 for chemical and physical properties.

2. Supplemental requirements in percent:

a.	Maximum carbon content	3 percent
b.	Maximum sulfur trioxide (SO_3) content	4 percent
c.	Maximum loss on ignition	3 percent
d.	Maximum water requirement (as a percent of control)	100 percent
e.	Fineness, maximum retained on No. 325 sieve	25 percent

2.02 MIXES:

A. Mix design shall produce a consistency that will result in a flowable product at the time of placement that does not require manual means to move it into place.

B. Provide excavatable mix with compressive strength of maximum 100 psi when measured 56 days after placement.

C. Influent Sewer: Provide mix with compressive strength of maximum 200 psi when measured 56 days after placement.

D. Controlled Low Strength Material shall have minimal subsidence and bleed water which is measured as a Final Bleeding of less than 2.0 percent (retains 98.0 percent of original height after placement, approximately 1/4-inch per foot of depth) as measured in Section 10 of ASTM C940 "Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory".

E. The fresh unit weight shall be 90 - 110 lbs./ft^3, except where specified, and in the absence of strength data the cementitious content shall be a maximum of 150 lbs./cy.

F. Influent Sewer: Unless shown as otherwise on the Drawings, CLSM shall have a unit weight between 90 and 125 pcf.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Batch, mix and deliver CLSM in conformance with ASTM C94. Batch all constituents at a central batching or mixing plant.

B. Seasonal Conditions:

1. Conform to ACI 305R and as specified herein for hot weather concreting. Do not add retarder admixture to any concrete.

2. Conform to ACI 306R and as specified herein for cold weather concreting. Do not add accelerator admixture to any concrete.

3.02 TRANSPORTING AND MIXING:

A. Conform to concreting procedures set forth in ACI 304R and as specified herein.

B. Transport CLSM to discharge locations without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.

3.03 FIELD TESTING:

A. General:

1. The testing laboratory will use concrete samples taken at the point of agitator or mixer truck discharge to perform slump, air content, and temperature tests and for field control test specimens.

B. Notification of Delivery:

1. Notify the Engineer of concrete deliveries a minimum of 48 hours in advance of the scheduled placement. Include within this notification, the mix design and quantity of concrete, method and location of placement, frequency of trucks, ordered slump and time of initial delivery.

2. Furnish delivery batch ticket to the representative from the owner's testing laboratory or to the Engineer representative in the field with each batch delivered to the discharge locations in conformance with ASTM C94.

C. Test Measurements at Discharge:

1. The testing laboratory firm will take measurement of concrete slump, air content and temperature for each 50 cubic yards of each mix design but not less than once a day. The laboratory will conduct the slump, air content and temperature test measurements in conformance with ASTM C143, ASTM C231, and ASTM C1064, respectively.

2. The testing laboratory will submit test reports of field measurements specified above to the Contractor and to the Engineer.

D. Control Test Specimens:

1. The testing laboratory will cast a minimum of one set of three field control test specimens in conformance with ASTM C31 for each 150 cubic yards of each mix design of concrete but not less than once a day.

2. Laboratory personnel will record truck and load number from the delivery batch ticket, the concrete placement location of each specimen, the date, concrete strength, slump, air content, temperature and truck driver's name.

3. Furnish tightly constructed nonabsorbent test cylinder molds. Use molds of same type and manufacture for all test specimens. Leave molds on cylinders until received in testing laboratory.

4. Furnish boxes for initial curing of test cylinders in conformance with ASTM C31 from time of fabrication until they are transported to the testing laboratory.

5. The testing laboratory will compression test one of each set of three specimens at seven days. Immediately notify the Contractor and the Engineer if the seven-day strength is deficient. Test the two remaining cylinders at 65 days for concrete strength acceptance. The acceptance test result is the average of the strengths of the two specimens tested at 56 days. The laboratory firm will submit compression test results of the control test specimens to both the Contractor and the Engineer. Evaluation and acceptance of concrete shall conform to ACI 301 and ACI 318.

3.04 CURING AND PROTECTION:

A. Protect CLSM from premature drying, hot or cold temperatures, and mechanical injury, beginning immediately after placement and maintain concrete with minimal moisture loss at relatively constant temperature.

B. Comply with curing procedures set forth in ACI 301, applicable portions of ACI 308 and as specified herein.

C. Perform hot weather concreting in conformance with ACI 305R and as specified herein when the ambient atmospheric temperature is 80 degrees F or above.

D. Perform cold weather concreting in conformance with ACI 306R and as specified herein when the ambient atmospheric temperature is 40 degrees F or below.

E. Protect Controlled Low Strength Material from traffic until sufficient strength has been achieved for further construction operations.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 03 35 01

CONCRETE FINISHES AND FLOOR TREATMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section describes materials and methods of concrete finishes for cast in place concrete and floor treatment for all concrete.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 117: Specification for Tolerances for Concrete Construction and Materials (ACI 117-10) and Commentary

2. 301: Specifications for Structural Concrete

3. 302.1R: Construction of Concrete Floors

4. 303R: Architectural Cast-in-Place Concrete

5. 303.1: Architectural Cast-in-Place Concrete

6. 311.4R: Guide for Concrete Inspection

7. 347.3R: Guide to Formed Concrete Surfaces

B. ASTM International (ASTM):

1. D4263: Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

1.03 SUBMITTALS:

A. Submit following shop drawings in accordance with Section 01 33 00.

B. Submit manufacturer’s product data and surface preparation and application instructions.

C. Submit manufacturer’s color chart for colored floor treatment.

D. Submit VOC content information for floor treatment products.

E. Contractor should establish in-place mockups for the formed face concrete finish CSC2. Multiple in-place mockups are required for the same form face concrete finish if the finish

is applied to both horizontal and vertical surfaces such as a column and an elevated slab. In-place mockups to be established and approved within the first 5% of contracted volume of concrete. Contractor and Licensed Professional should agree on location of mockups. Locations of mockups should be clearly identified and established in permanently visible and accessible locations. In-place mock ups will be maintained and protected in-place by the Contractor until all structures have been completed and all the concrete surfaces have been accepted by the Licensed Professional. In-place mock-ups to be representative of the size and extent of work and be a minimum size of 8-foot square for each finish unless otherwise agreed upon with the Licensed Professional. Before work extends beyond 5% of the contracted volume, the in-place mockups for each formed face finish should be reviewed by and approved by the Licensed Professional in writing. Should different concrete suppliers or contractors be used, an additional mockup is required for each mix, source supplier, or contractor for each formed faced finish noted.

F. Qualifications:

1. Submit statement of qualifications, experience, and training of concrete finishing personnel.

1.04 QUALITY ASSURANCE:

A. Prior to concrete construction, develop an outlined quality control program for concrete finishing.

B. Prior to concrete placement Engineer or Engineers Field Representative will participate in the pre-pour walk-through with the contractor performing the work to verify concrete finishes required.

C. For concrete that will receive additional applied floor finishes, ensure that concrete surface finish and preparation is compatible with the accepted floor finish manufacturer's products. Provide documentation from the floor product manufacturer that specifies the concrete finish and preparation required for proper installation of the floor products.

D. Make changes in concrete finishes and preparation necessary to accommodate flooring products different from those specified at no additional cost to the Owner. Submit the proposed new finishes and their construction methods to the Engineer.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 FLOOR SEALERS AND DENSIFIERS:

A. Shall contain silicate and siliconate and be VOC compliant.

B. Products:

1. Dayton Superior; Sure Hard Densifier J17

2. The Euclid Chemical Company; Euco Diamond Hard

3. BASF Construction Chemicals; Kure-and-Harden

2.02 CLEAR FLOOR HARDENER:

A. Provide a colorless, aqueous solution of zinc and magnesium fluorosilicate.

B. Products:

1. The Euclid Chemical Company; Eucosil.

2. BASF Construction Chemicals; Sonosil

3. L&M Construction Chemicals, Inc; Chem Hard

2.03 NONSLIP AGGREGATE FLOOR FINISH:

A. Minimum 50 percent aluminum oxide content.

B. Products:

1. Dayton Superior; Emery Non-slip

2. BASF Construction Chemicals; Frictex-NS

3. L&M Construction Chemicals, Inc; Grip It

2.04 DRY SHAKE METALLIC FLOOR HARDENER:

A. Products:

1. The Euclid Chemical Company; Surflex

2. Dayton Superior; Ferro Tuff

3. BASF Construction Chemicals; Master Plate 200

2.05 EPOXY BONDING AGENT:

A. Shall be in accordance with Section 03 30 00.

2.06 CONCRETE REPAIR MATERIAL:

A. Shall be in accordance with Section 03 01 30.

PART 3 - EXECUTION

3.01 CONCRETE FINISHES:

A. Do not use curing compound where epoxy, urethane, mortar bed, grout, additional concrete or other toppings or adhesive will be applied unless removed by pressure washing or sand blasting.

B. Do not sprinkle with dry cement or add water when finishing concrete surfaces.

C. Finish concrete surfaces in accordance with the following schedule:

Table 03 35 01-1	
Formed Concrete Surface Finishes	**Area Applied**
CSC2	All formed faced concrete , no exception*
*	If surfaces to be coated provide surface preparation to comply with coating manufacturer requirements.
Unformed Concrete Surface Finishes	**Area Applied**
S-1	Slabs to be covered with roofing assemblies, concrete or grout.*
S-2	Exterior slabs.
S-3	Interior slabs. Slab surfaces to receive sealer or hardener.*
S-4	Slabs in contact with liquid.*
S-5	Slabs at slopes greater than 10 percent and stairs.
E-1	Exposed top of walls, beams, and similar unformed surfaces*
E-2	Unexposed top of walls, beams, and similar unformed surfaces.
*	If surfaces to be coated provide surface preparation to comply with coating manufacturer requirements.

D. Formed Finishes:

1. Finish CSC2: Concrete surfaces where visual appearance is of moderate importance. Description of surface requirements are defined in Table 03 35 01-2 and subsequent Table 03 35 01-3 through Table 03 35 01-7.

Table 03 35 01-2									
Formed Concrete Surface Category (CSC)*	**CSC Requirements**					**Additional Requirements**			
	Texture, Panel Joint	**Void Patching***		**Color Uniformity**		**Surface Irregularities**	**Construction and Facing-Joint**	**Mockup**	**Form-facing category**
		Tie Holes	**Other Voids***	**a**	**na**				
CSC2	T2	Fill	fill ¼" and larger	CU I	CU1	S13	CJ2	Required	FC2

*Guidance for CSC2 deviates from ACI 347-13R guidance in several cases, guidance in table 03 35 01-2 and subsequent table governs over criteria in ACI 347-13Rfor Surface Void Criteria. For matching requirements of formed concrete surface categories refer to the following notes and tables; a= absorbent form facing; na=nonabsorbent form facing.

Table 03 35 01-3	
Texture Classification	**Texture**
T2	Acceptable gaps in adjacent formwork components ≤ 1/2 in. - Acceptable depth of mortar loss ≤ 3/8 in. - Acceptable surface offsets of panel joints up to 1/2 in.(ACI 117-10, Section 4.8.3, Class C). - Allowable projections 1/2 in. from adjacent surface. - Form-facing material examples: Class BBOES plywood, MDO plywood. - Imprints of modular panel frames are acceptable. - Fins to be ground down to ¼" or less (deviation from ACI 347-13R)

Table 03 35 01-4	
Color Uniformity Classification	**Characteristics**
CU1	- Light and dark color variations are acceptable, - Color variations between adjacent placements and layer lines are acceptable, - Rust and dirt stains are acceptable.

Table 03 35 01-5	
Surface Irregularities Classification	**Characteristics**
SI3	- ACI 117-10, Section 4.8.3, Class B-Surface, - Maximum gradual deviation over a distance 5 feet, or abrupt deviation is 1/4 inch, - Limit deflection of formwork structure to L/360, - ACI 117-10, Section 4.8.2 does not apply

Table 03 35 01-6	
Construction and Facing Joints Classification	**Characteristics**
CJ2	- Acceptable offset of surfaces between two adjacent placements is less than or equal to 1/2 inch, - The use of chamfer strips of similar reveals are recommended at construction joints.

Table 03 35 01-7			
Criterion	**Form-Facing Categories**		
		FC2	
Holes, greater than 1/4 in.		Acceptable if patched sanded and sealed or ground to match adjacent form surface	
Holes, 1/4 in. or less		Acceptable without patching, provided form surface is not damaged or torn aroundhole(s)	
Vibrator burns		Unacceptable	
Scratches/dents		Acceptable if patched, sanded, and scaled or grounded to match adjacent form surface	
Concrete remnants		Unacceptable	
Cement residue		Acceptable	
Swelling of facing at fastener or tie holes		Unacceptable	
Patching		Acceptable	

E. Unformed Finishes:

1. Finish S-1: Screed to grade without special finish unless otherwise shown on contract documents. Roughen and/or apply bonding agent where shown on contract drawings.

2. Finish S-2: Trowel finish.

3. Finish S-3: Trowel finish free from trowel marks and all irregularities. Do not hard trowel.

4. Finish S-4: Trowel finish without local depressions or high points. For liquid containment slabs apply a stiff bristle broom finish. Leave broom lines parallel to the direction of slab drainage. Do not hard trowel.

5. Finish S-5: Trowel finish without local depressions or high points. Apply a stiff bristle broom finish. Leave broom lines parallel to the direction of slope drainage. Do not hard trowel.

6. Finish E-1: Provide 3/4-inch chamfer on external corners of exposed concrete walls, beams columns, equipment pads and exposed edges of construction joints. Do not chamfer columns flush with concrete block walls. Repair defective concrete, remove fins, fill depressions 1/4-inch or deeper, and fill tie holes. Strike smooth and float.

7. Finish E-2: Repair defective concrete, remove fins, fill depressions 1/4-inch or deeper, and fill tie holes. Strike smooth and float.

F. Protect finished concrete surfaces from damage by construction equipment, materials, curing procedures and rain or running water.

3.02 FINISHING OF FORMED SURFACES:

A. Cure, finish and repair surfaces in accordance with ACI requirements.

B. Perform finish work in accordance with the schedule in Table 03 35 01-1 and Table 03 35 01-2 as soon as possible after forms are removed.

C. Conform to the requirements specified in Section 03 10 00 for tolerances for formed surfaces.

3.03 TOLERANCE:

A. Within the footprint of the steel package treatment plant tankage, the allowable tolerance of finish elevations (S-2) shall not exceed 1/4 inch per 20 feet in all directions to provide a flat surface for tankage floors to be supported.

B. The tolerance for finish surface under secondary clarifiers, gravity thickeners, chemical storage pad and electrical room is 1/4 inch per 10 feet.

3.04 FINISHING OF UNFORMED SURFACES:

A. Perform finish work in accordance with the schedule in Table 03 35 01-1.

B. Provide S-3 trowel finish to all top, horizontal and inclined surfaces not otherwise specified or indicated. This includes concrete fills and toppings and floors. Provide hand trowel finish to all surfaces such as weirs or walls over which liquids will flow. Do not hard trowel.

C. Provide S-5 broom finish to exterior walkways, exterior stairs, entrance platforms and loading docks.

3.05 FLOOR TREATMENT APPLICATION:

A. Prepare concrete surface in accordance with manufacturer's printed instructions.

B. Perform concrete moisture testing in accordance with product manufacturer's requirements.

C. Apply floor treatment in accordance with product manufacturer's written instructions.

D. Provide mock ups for Nonslip aggregate floor finish and Dry Shake Hardener floor finish. Minimum size of mock up sample shall be 2 feet x 2 feet.

E. Colors for colored floor treatment shall be as selected by Engineer.

3.06 CONCRETE REPAIR:

A. Surface Defects:

1. Do not repair defects until concrete has been inspected by the Engineer. Repair of concrete surfaces shall be in accordance with Section 03 01 30.

2. Repair defects including, air voids and bug holes with a nominal diameter or depth greater than 1/4-inch, honeycombed areas, visible construction joints, fins, burrs, color and texture variations and other defects as determined by the Engineer. Make concrete repairs with a polymer modified cementitious repair mortar in accordance with Section 03 01 30 to produce a concrete surface uniform in color and texture and free of all irregularities.

B. Crack Repair:

1. Shall be in accordance with Section 03 01 30.

C. Tie-Hole Repair:

1. Shall be in accordance with Section 03 10 00.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 03 48 18

PRECAST REINFORCED CONCRETE VAULTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes materials, design, and installation of factory-built precast reinforced concrete underground vaults and chambers.

1.02 REFERENCES:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. HB: Standard Specifications for Highway Bridges.

2. M198: Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

B. American Concrete Institute (ACI):

1. 318: Building Code Requirements for Structural Concrete and Commentary

C. ASTM International (ASTM):

1. A48: Standard Specification for Gray Iron Castings.

2. A615: Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods.

3. C31: Practice for Making and Curing Concrete Test Specimens in the Field

4. C33: Specification for Concrete Aggregates

5. C39: Test Method for Compressive Strength of Cylindrical Concrete Specimens

6. C143: Test method for Slump of Hydraulic Cement Concrete

7. C150: Specification for Portland Cement

8. C172: Practice for Sampling Freshly Mixed Concrete

9. C192: Practice for Making and Curing Concrete Test Specimens in the Laboratory

10. C231: Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

11. C260: Specification for Air-Entraining Admixtures for Concrete

12. C494: Specification for Chemical Admixtures for Concrete

13. C857: Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.

14. C858: Specification for Underground Precast Utility Chambers

15. C1064: Test Method for Temperature of Freshly Mixed Portland Cement Concrete

16. D75: Practice for Sampling Aggregates

17. D4101: Standard Specification for Polypropylene Injection and Extrusion Materials

1.03 SUBMITTALS:

A. Shop Drawings: Submit the following in accordance with Section 01 33 00.

1. Completely detailed shop drawings for precast concrete vaults. Indicate all dimensions, details, reinforcing steel, inserts, connections, openings and lifting devices. Mark each component for identification. Show mark on erection plan and place legibly on unit at time of manufacture.

B. Drawings of modifications or changes in features or details, which are necessitated by design requirements. Make such modifications without additional compensation.

C. Do not fabricate precast concrete vaults before shop drawings are accepted by the Engineer.

D. Design calculations and certification, signed and sealed by a Professional Engineer registered in the State where the vaults will be installed and employed by the vault manufacturer and stating:

1. Elements and connections are designed to withstand required loads and forces as referenced herein.

2. Codes and specifications to which structural design conforms.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Vault design and construction comply with the specified design load conditions, ASTM C858 and as specified herein.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Store vaults on clean blocking, off the ground and protected from rain and ground splatter.

PART 2 - PRODUCTS

2.01 PRECAST REINFORCED CONCRETE VAULTS:

A. Manufacturers:

1. Oldcastle Precast, Inc.

2. Shea Concrete Products Inc.

B. Materials:

1. Minimum concrete compressive strength of 5,000 psi at 28 days conforming to Section 03 30 00.

2. Portland Cement: ASTM C150, Type II.

3. Coarse Aggregate and sand conforming to Section 03 30 00.

4. Steel reinforcement conforming to ASTM A615, Grade 60.

5. Water: Potable.

6. Provide air entraining and water reducing concrete admixtures as specified in Section 03 30 00.

7. Butyl rubber-based sealants conforming to AASHTO M198, Type B but with no bitumen content.

8. Non-Shrink Grout:

a. BASF Chemical Company; Masterflow 713 Plus

b. The Euclid Chemical Co.; Euco NS Grout

c. Sika Corporation; SikaGrout 212

C. Design Criteria. Use design loads according to ASTM C857, ASTM C890, ASTM C891, and ASTM C913 or as indicated below, whichever produces the more severe conditions:

1. Design precast reinforced concrete vault to withstand earth and groundwater loads. Assume groundwater elevation to be at grade. Provide design based on an equivalent fluid pressure equal to a minimum of 95 pounds per cubic foot corresponding to saturated soil.

2. Design precast reinforced concrete vault to withstand internal hydrostatic and seismic loading. Assume internal fluid level to be at the top of the vault. Provide design based upon an equivalent fluid pressure of 65 pounds per cubic foot.

3. Design precast reinforced concrete vault to withstand vehicle loading with an impact factor as prescribed in referenced ASTM standards or a minimum of 250 psf surcharge. Account for vehicle positions both above and alongside vault including directly on each maintenance hole cover. HS-20 vehicle loading shall be considered.

4. Design precast reinforced concrete vault ceiling to withstand additional concentrated loads from lifting hooks located directly above each valve, meter or other equipment. Provide lifting hook capable of supporting the load, but not less than 2,500 pounds each hook.

5. Design vaults for the condition where the structure is completely backfilled to the top of the vault and the roof is removed.

6. Design and install vaults to withstand hydrostatic uplift caused by a groundwater elevation at grade level or equal to the top of the vault, whichever produces the most severe condition. Consider a safety factor of 1.50 when considering the self weight of the vault plus the weight of an angled wedge of soil emanating from the edge of the base slab extension based on the soil's friction angle where applicable. Where a base slab extension does not occur, consider a safety factor of 1.15 considering only the weight of the structure.

7. Walls and floor slab: minimum of 8 inches in thickness. Cast lower wall section and floor slab together in one placement.

8. Precast reinforced concrete vault roof: minimum of 8 inches in thickness.

9. Design vault to withstand the load condition where the vault roof is removed while the structure is backfilled to grade and subject to live and dead loads.

10. Provide precast reinforced concrete vault as indicated on the drawings. Provide a watertight vault enclosure including sumps and entrance tubes as indicated.

11. Fabricate precast reinforced concrete vault in sections for as required for installation.

12. Provide pipe sleeves with water stops, rubber pipe boots or other devices at pipe penetrations as indicated.

13. Provide reinforced concrete vertical entrance tube with inside dimensions as indicated.

2.02 MAINTENANCE HOLE FRAMES AND COVERS:

A. Conform to requirements of ASTM A48.

B. Manufacturers:

1. Neenah Foundry

2. Campbell Foundry

C. Castings to be free from scale, lumps, blisters and sandholes.

D. Machine contact surfaces to prevent rocking.

E. Thoroughly clean and hammer inspect.

F. Capable of withstanding AASHTO H-20 loading unless otherwise indicated or specified.

2.03 BITUMINOUS WATERPROOFING MATERIAL:

A. Manufacturers:

1. Tnemec Company, Inc.; Series 46-465 H.B. Tnemecol

2. PPG Industries; Amercoat 78HB

3. Carboline; Bitumastic 300M

B. Apply waterproofing to outside of walls, floor, and ceiling.

2.04 ENTRANCE HATCHES:

A. Provide access hatches per Section 05 53 00.

B. Manufacturers:

1. Bilco Co.

2. Halliday

3. Babcock-Davis Associates, Inc.

C. Provide aluminum hatches of the type and size indicated and as follows:

1. Fabricate hatch and frame with 1/4-inch extruded aluminum frame and 1/4-inch diamond checkered aluminum plate covers.

2. Reinforce cover, with aluminum bars and angles welded to underside of covers, to withstand AASHTO H-20 wheel loading.

3. Provide hatch with hinges, hold-open safety-lock bars and flush lift handles, factory assembled, and shipped complete for installation.

4. Provide stainless steel hardware throughout. Hinge covers to frames with heavy duty stainless steel concealed hinges and stainless steel pins. Attach hinges to covers and frames with countersunk/flathead stainless steel machine screws. Fit covers flush to frame.

5. Provide slam latch, flush mounted grip handle, and removable plug and key wrench.

6. Fabricate gutter type hatches with 1-1/2-inch drainage coupling in one corner of the channel frame.

7. Provide frost proof inner hatch.

8. Provide ladder-up safety post.

9. Provide drain PVC drain piping to location required by the Contract Drawings or as recommended by the Engineer.

2.05 LIFTING HOOKS:

A. Provide lifting hooks in the ceiling above pumps, valves and meters.

PART 3 - EXECUTION

3.01 PROTECTION:

A. Protect aluminum from contact with dissimilar metals, concrete, masonry or mortar.

B. Before coating application, clean contact surfaces, remove dirt, grease, oil, foreign substances.

3.02 FINISHES:

A. Finishes: Aluminum ladders to receive finish as specified or directed by the Engineer. Hatches to receive manufacturers' standard finish for aluminum.

3.03 INSTALLATION:

A. Install precast reinforced concrete vault, and related appurtenances in accordance with manufacturer's instructions.

B. Place precast reinforced concrete vault onto level prepared bedding as indicated. Provide uniform bearing over entire base of vault.

C. Seal all joints inside and out with specified sealant to ensure joints are waterproof.

D. Repair or replace damaged waterproofing.

E. Backfill vault excavation uniformily and in such a manner so as not to damage the waterproofing.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 03 60 00

GROUT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Furnish all labor, materials, equipment, and incidentals required, and install grout complete as shown on the Drawings and as indicated and in compliance with Contract Documents.

1.02 SUMMARY:

A. Section Includes:

1. Material for grouting reinforcing bars, anchor bolts into existing or newly placed concrete.

2. Material for grouting under bearing plates for columns or beams.

3. Materials for grouting under equipment.

4. Materials for miscellaneous grouting including but not limited to railing posts, equipment guides, bollards, precast concrete joints and supports etc.

1.03 REFERENCE STANDARDS:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. M182: Burlap Cloth made from Jute or Kenaf

B. American Petroleum Institute (API):

1. RP 686: Recommended Practice for Machinery Installation and Installation Design

C. ASTM International (ASTM):

1. C33: Standard Specification for Concrete Aggregates

2. C150: Standard Specification for Portland Cement

3. C531: Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts, and Monolithic Surfacings

4. C595: Standard Specification for Blended Hydraulic Cement

5. C827: Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixes

6. C1107: Standard Specification for Packaged Dry, Hydraulic, Cement Grout (Non-shrink)

7. D695: Standard Test Method for Compressive Properties of Rigid Plastics

D. U.S. Army Corps of Engineers Standard (CRD):

1. C621: Corps of Engineers Specification for Non-shrink Grout

1.04 DESIGN REQUIREMENTS:

A. Design grout and related anchorage systems in accordance with the design loads specified on the contract drawings or as required by the equipment manufacturer.

B. The design and selection of the grout and grouting system shall be based on the duration and magnitude of the load and the frequency of application. The use of a grout for a specific application shall be verified by the manufacturer of the grout.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data:

1. Commercially manufactured non-shrink, non-metallic cementitious grout:

a. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to referenced ASTM standards, and Material Safety Data Sheet (MSDS).

2. Commercially manufactured non-shrink epoxy grout:

a. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to referenced ASTM Standards and Material Safety Data Sheet (MSDS).

3. Cement Grout:

a. Include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures, and the proposed mix of the grout.

4. Concrete Grout:

a. Include data for concrete as delineated in Section 03 30 00. This includes the mix design, constituent quantities per cubic yard, and the water/cement ratio.

5. Bonding Agent:

a. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to referenced ASTM standards, and Material Safety Data Sheet (MSDS).

C. Laboratory Test Reports.

1. Submit laboratory test data as required under Section 03 30 00 for concrete to be used as concrete grout.

D. Mill test reports for each shipment of cement, regardless of quantity, prior to incorporation into the work.

E. Manufacturer's specifications and instructions for all admixtures, curing materials, adjustable inserts and non-shrink non-metallic grout. Manufacturer’s certification of compatibility of all admixtures.

1.07 QUALITY ASSURANCE:

A. Qualifications

1. Grout manufacturer to have a minimum of 5 years’ experience in the production and use of the type of grout proposed for the Work.

B. Field Testing

1. Field testing and inspection services required will be provided by the Owner. Provide assistance in the sampling of materials and provide any ladders, platforms, etc. for access to the Work. Comply with the applicable ASTM Standards for testing.

2. The field testing of concrete grout will be as specified for concrete in Section 03 30 00.

3. Take compression test specimens from the first placement of each type of grout to ensure compliance with these Specifications.

a. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at one, seven and 28 days.

b. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C579, Method B. A set of three specimens will be made for testing at seven days.

1.08 RESPONSIBILITIES:

A. Assist the Owner in obtaining specimens for testing and furnish all materials necessary for fabricating the test specimens.

B. The cost of laboratory tests on grout will be paid by the Owner except where test results show the grout to be defective. In such case, the Contractor shall pay for the tests, removal and replacement of defective work, and re-testing all at no cost to the Owner.

1.09 WARRANTY:

A. Warrant the materials and products specified in this Section against defective materials and workmanship with the manufacturer’s standard warranty, but for no less than one year from the date of substantial completion.

B. Warrant the work against defects for one year from the date of substantial completion.

1.10 DELIVERY, STORAGE, AND HANDLING:

A. Comply with the requirements in APWA Section 01 66 00.

B. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers, and printed instructions.

C. Store materials in accordance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to six months or the manufacturer's recommended storage time, whichever is less.

D. Reject material that becomes damp, lumpy or otherwise unacceptable and immediately remove from the site and replace with acceptable material at no cost to the Owner.

E. Deliver non-shrink cement based grouts as pre-blended, prepackaged mixes requiring only the addition of water.

F. Deliver non-shrink epoxy grouts as premeasured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

1.11 SERVICES OF MANUFACTURER'S REPRESENTATIVE:

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall instruct the Contractor's personnel in the mixing, proper use and application of the non-shrink grout and epoxy grout.

B. The manufacturer's representative shall provide written certification that materials have been mixed and applied properly and surfaces to receive these products have been prepared properly, all in conformance with manufacturer's requirements.

C. The on-site time required for the manufacturer's representative to achieve a successful installation shall be at the expense of the Contractor.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Provide materials produced by one manufacturer or supplier in order to provide standardization of appearance.

2.02 APPLICATION:

A. Unless indicated otherwise, provide grouts as listed below:

Table 03 60 00-1

Type of Grout	Application
Cement Grout	Surface repairs
Non-Shrink – Class I	Storage tanks and other non-motorized equipment.
	Filling block-out spaces for embedded items such as railing posts, gate guide frames, etc. (Where placement time is less than 20 minutes.)
	Repair of holes and defects in concrete members that are not water bearing and not in contact with soil or other fill material.
Non-Shrink – Class II	Column base plates.
	Filling block-out spaces for embedded items such as railing posts, gate guide frames, etc. (Where placement time exceeds 20 minutes.)
	Under precast concrete elements.
Non-Shrink Epoxy	Machinery subject to severe shock loads and high vibration.
Concrete Grout	Toppings and concrete/grout fill, bottom of liquid containing concrete walls.

2.03 MATERIALS:

A. Non-shrink Class I Grout:

1. Non-shrink Class I Grout shall have a minimum 28-day compressive strength of 5000 psi, when mixed at a fluid consistency.

2. Non-shrink Class I grout shall meet the requirements of ASTM C1107, Grade B or C, when mixed to fluid, flowable and plastic consistencies.

3. Products:

   a. Sika Corporation; SikaGrout 212

   b. Master Builders, Inc.; Set Grout

   c. The Euclid Chemical Company; Euco NS

B. Non-shrink Class II Grout:

1. Non-shrink grout shall be a high precision, fluid, extended working time grout. The minimum 28-day compressive strength shall be 7,500 psi, when mixed at a fluid consistency.

2. Grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C1107.

3. Non-shrink grouts shall meet the requirements of ASTM C1107; Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C939.

4. The grout when tested shall not bleed or segregate at maximum allowed water.

5. Products:

   a. Master Builders, Inc.; Masterflow 928

   b. The Euclid Chemical Company; Hi-Flow Grout

   c. Sika Corporation; SikaGrout 212

C. Cement Grout:

1. Cement grouts shall be a mixture of one part portland cement conforming to ASTM C595 types IL and one to two parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout, but not to the degree that it will allow the grout to flow.

2. Cement grout materials shall be as indicated in Section 03 30 00.

D. Concrete Grout:

1. Concrete grout shall conform to the requirements of Section 03 30 00 except as specified herein. Proportion with cement, coarse and fine aggregates, water, water reducer, and air entraining agent to produce a mix having an average strength of 5,000 psi at 28 days. Coarse aggregate size shall be 3/8-inch maximum. Keep the W/C ratio as low as practical while still retaining sufficient workability.

E. Non-shrink Epoxy-Based Grout:

1. Provide a pre-proportioned, three component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 14,000 psi in seven days when tested in conformity with ASTM D695 and have a maximum thermal expansion of 30 x 10-6 when tested in conformity with ASTM C531.

2. Products:

a. Master Builders, Inc.; Ceilcote 648 CP

b. U.S. Grout Corporation; Five Star Epoxy Grout

c. Sika Corporation; Sikadur 42 Grout-Pak

d. The Euclid Chemical Company; High Strength Epoxy Grout

F. Dry Pack Grout:

1. Make dry pack (to be packed or tamped in place) at no slump consistency.

2. When mixing the batch, add only enough water to the dry materials to produce a rather stiff mixture. Additions of water may be made in small increments until the desired consistency is obtained.

G. Non-epoxy Bonding Compound:

1. Provide non-epoxy bonding compound that is re-wetable for up to two weeks.

2. Products:

a. Larsen Products Corporation; Weldcrete

b. Sta-Dry Manufacturing Corporation; Link

c. The Euclid Chemical Company; Euco Weld

2.04 CURING MATERIALS:

A. Curing materials for cement grout shall be as specified in Specification 03 30 00 and as recommended by the manufacturer for prepackaged grouts.

PART 3 - EXECUTION

3.01 GENERAL:

A. Grout shall not be placed until base concrete has attained its design strength, unless authorized otherwise by the Engineer.

B. Prepare surfaces for curing, and protection of cement grout in accordance with Section 03 30 00.

C. Shade the work sites from sunlight for at least 24 hours before and 48 hours after grouting.

D. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.02 PREPARATION:

A. Clean concrete surfaces to receive grout free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints, and free of all loose or unsound material or foreign matter that may affect the bond or performance of the grout.

B. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

C. Remove all loose rust, oil or other deleterious substances from metal embedments prior to the installation of the grout.

D. Wash concrete surfaces clean and keep them moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturate by covering the concrete with a plastic sheet or using either a soaker hose, flooding the surface or other method acceptable to the Engineer. Remove visible water from the surface upon completion of the 24-hour period prior to grouting. Use an accepted adhesive bonding agent in lieu of surface saturation when accepted by the Engineer for each specific location of grout installation.

E. Epoxy based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.

F. Construct grout forms or other leak proof containment. Forms shall be lined or coated with release agents recommended by the grout manufacturer.

G. Support equipment during alignment and installation of grout by shims, wedges, blocks, or other accepted means. Prevent the shims, wedges, and blocking devices from bonding to the grout by appropriate bond breaking coatings and remove them after grouting unless otherwise accepted by the Engineer.

H. The embedment depth for epoxy grouted anchor bolts and threaded rod anchors shall be at least 15 bolt or rod diameters, unless otherwise indicated on the drawings.Holes shall be prepared for grouting as recommended by the grout manufacturer.

3.03 INSTALLATION:

A. Anchor bolts and threaded rod anchors:

1. Anchor bolts and threaded rod anchors shall be clean, dry and free of grease and other foreign matter when installed. The bolts, rods and bars shall be set and positioned and the epoxy grout shall be placed and finished in accordance with the recommendations of the grout manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with epoxy grout, without voids. During assembly of all threaded stainless steel components, anti-seize thread lubricant shall be liberally applied to the threaded portion not embedded in concrete grouting machinery foundations

2. Block out the original concrete or finish off a sufficient distance below the bottom of the machinery base to provide for the thickness of grout shown on the Contract Drawings. After the machinery has been set in position and placed at the proper elevation by steel wedges, the space between the bottom of the machinery base and the original placement of concrete shall be filled with a pourable non-shrink grout. Grout and grouting procedure shall be in accordance with API 686.

B. Cement Grouts and Non-shrink Cementitious Grouts:

1. Mix in accordance with manufacturer’s recommendations. Do not add cement, sand, pea gravel, or admixtures without prior approval by the grout manufacturer and the Engineer.

2. Avoid mixing by hand. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the additional water required to obtain workability. However, do not exceed the manufacturer's maximum recommended water content.

3. Place grout into the designated areas in a manner that will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material.

Placement should proceed in a manner that will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (re-temper) after initial stiffening.

4. Just before the grout reaches its final set, cut back the grout to the substrate at a 45-degree angle from the lower edge of bearing plate unless otherwise accepted by the Engineer.

5. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer.

C. Non-Shrink Epoxy Grouts:

1. Apply bonding agent, if required, in accordance with the requirements of the grout manufacturer. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not over mix. Mix full batches only to maintain proper proportions of resin, hardener, and aggregate. Partial mixes will be rejected and will require the suspect grout to be removed and be replaced.

2. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 degrees F or above 90 degrees F.

3. Place grout into the designated areas in a manner that will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

4. The extension of grout horizontally beyond base plate shall be less than or equal to the grout thickness.

5. Epoxy grouts are self-curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

D. Concrete Grout:

1. Provide the underlying concrete surface with a broomed finish. Protect and keep the surface clean until placement of concrete grout.

2. Remove the debris and clean the surface of all dirt and other foreign materials.

3. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Remove excess water just prior to placement of the concrete grout.

Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16- to 1/8-inch thick cement paste.

E. Dry Pack:

1. Dry pack consistency shall be such that the grout is plastic and moldable but will not flow.

2. The use of pneumatic pressure for dry-packed grouting requires acceptance of the Engineer.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 03 64 23

CRACK REPAIR EPOXY INJECTION GROUTING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide crack repair epoxy injection grout as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. T237: Standard Method of Test for Testing Epoxy Resin Adhesive.

B. American National Standards Institute (ANSI).

C. ASTM International (ASTM):

1. C882: Standard Specification for Test Method for Bond Strength of Epoxy-Resin System Used with Concrete by Slant Shear.

2. D570: Standard Test Method for Water Absorption of Plastics.

3. D638: Standard Test Method for Tensile Properties of Plastics.

4. D648: Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.

5. D695: Standard Test Method for Compressive Properties of Rigid Plastics.

6. D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.03 DEFINITIONS:

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Crack Injection: method of sealing or repairing cracks by injecting a polymer.

C. Large Cracks: wider than 0.008 inch, inject all.

D. Moderate Cracks: width greater than or equal to 0.005 inch and less than 0.008 inch, inject leaking cracks.

E. Small Cracks: width equal to 0.005 inch or less. Repair leaking cracks per method approved by Engineer if unable to inject.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Physical and chemical properties for epoxy adhesives.

2. Technical data for metering, mixing, and injection equipment.

3. Drawings and photos of proposed injection locations. Do not proceed with injection until review by Engineer is complete.

4. Manufacturer's recommended surface preparation procedures and application instructions for epoxy adhesives.

5. Installation instructions for repairing core holes with epoxy grout.

6. Manufacturer's Certificate of Compliance: certified test results for each batch of epoxy adhesive.

7. Statements of Qualification for Epoxy Adhesive:

a. Manufacturer's site representative.

b. Injection applicator.

c. Injection pump operating technician.

8. Epoxy adhesive two component ratio and injection pressure test records for concrete crack repair work.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Qualifications for Epoxy Injection Staff:

1. Manufacturer's site representative:

a. Capable of instructing successful methods for restoring concrete structures utilizing epoxy injection process.

b. Understands and is capable of explaining technical aspects of correct material selection and use.

c. Experienced in the operation, maintenance, and troubleshooting of application equipment.

2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:

a. Licensed and certified by epoxy manufacturer.

b. Minimum 3 years' experience in successful epoxy injection for at least 10,000 linear feet of successful crack injection including 2,000 linear feet of wet crack injection to stop water leakage.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Packing and Shipping: package adhesive material in new sealed containers and label with following information:

1. Manufacturer's name.

2. Product name and lot number.

3. ANSI Hazard Classification.

4. ANSI recommended precautions for handling.

5. Mix ratio by volume.

C. Storage and Protection: Store adhesive containers at ambient temperatures below 110 degrees F and above 45 degrees F.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Materials, equipment, and accessories specified in this Section shall be products of:

1. BASF Building Systems, Shakopee, MN; SCB Concresive Series

2. Sika Corporation, Lyndhurst, NJ; Sikadur Series

3. The Euclid Chemical Company, Cleveland, OH; Euco Series

2.02 EPOXY ADHESIVE:

A. Two-component A and B structural epoxy adhesive for injection into cracks or other voids in concrete structures for bonding or grouting.

B. Adhesive Properties:

	Test Method	
7-day, Tensile Strength, psi	ASTM D638	5,000 min.
Tensile Elongation @ Break, percent	ASTM D638	1.0% min.
Compressive Yield Strength, 7 days @ 73 degrees F, psi	ASTM D695[a]	8,000 min.
Compressive Modulus, psi	ASTM D695[a]	$1.5x10^5$ min.
Heat Deflection Temperature, °F	ASTM D648[a]	120 min.[a]
Water absorption @ 24 hours, maximum %	ASTM D570	1.0
Bond Strength @ 2 days psi	ASTM C882	1,000 min.
Bond Strength @ 14 days psi	ASTM C882	1,500 min.
Slant Shear Strength: (5,000 psi Compressive Strength Conc.) (Where test results are available psi.)	AASHTO T237[b]	
Cured 3 days @ 40 degrees F—Wet Concrete		3,500 min.
Cured 1 day @ 77 degrees F—Dry Concrete		5,000 min.
Cured 3 days @ 77 degrees plus or minus 3 degrees F		5,000 min.
[a] Cure test specimens so that peak exothermic temperature of adhesive does not exceed 100 degrees F. [b] See referenced specifications for preparation method of test specimens.		

2.03 SURFACE SEAL:

A. Sufficient strength and adhesion for holding injection fittings firmly in place, and to resist pressures preventing leakage during injection.

B. Capable of removal after injection adhesive has cured.

2.04 SOURCE QUALITY CONTROL:

A. Test Requirements: perform tests for each batch of adhesive.

B. Pot Life Test:

1. Condition Components A and B to required temperature.

2. Measure components in ratio of Component B as stated on manufacturer's label into an 8-fluid ounce paper cup.

3. Start stopwatch immediately and mix components for 60 seconds using wooden tongue depressor, take care to scrape sides and bottom of cup periodically.

4. Probe mixture once with tongue depressor every 30 seconds, starting 2 minutes prior to minimum specified pot life.

5. Pot Life Definition: time at which a soft stringy mass forms in center of cup.

C. Fabrication of Slant Shear Specimens for Testing Bond of Injectable Adhesives to Wet Concrete at 40 degrees F:

1. Scope: Test method for preparation of diagonal concrete mortar blocks used in determining slant shear strength of low viscosity injectable adhesives in accordance with AASHTO T237 when concrete is wet.

2. Materials:

a. Diagonal concrete mortar blocks prepared in accordance with AASHTO Test Method T237 and cured to produce a mortar with compressive strength of 5,000 psi or greater.

b. Paraffin wax.

c. Masking Tape: 3/4 inch wide.

d. Suitable 20-mil-thick shim stock.

3. Preparation:

a. Place a 20-mil shim between diagonal faces of two blocks and align so ends and sides are square.

b. Bind block with masking tape covering gap between blocks.

c. Leave a gap between blocks on one face uncovered for removal of shim and application of adhesive.

d. Paint melted paraffin wax over masking tape.

e. Shallow dam may be built up around opening using paraffin wax or modeling clay to help retain adhesive.

f. Apply suitable capping compound to each end of specimen producing smooth surfaces perpendicular to longitudinal axis of block.

g. Remove shim stock from gap opening.

h. Soak specimen in water at 40 degrees F, plus or minus 3 degrees F for at least 24 hours.

i. After soaking, remove specimen, shake free water from surface and gap opening.

j. Prepare liquid adhesive.

k. Within 5 minutes after removing specimen from water, start flowing adhesive into crack without entrap air bubbles.

l. Place specimen in 40 degrees F, plus or minus 3 degrees F ambient for curing within 15 minutes after removing specimen from water for bonding. Do not expose specimen to temperatures beyond 77 degrees F during the 15-minute period.

m. Cure specimen for 72 hours, plus or minus 4 hours at 40 degrees F, plus or minus 3 degrees F.

PART 3 - EXECUTION

3.01 GENERAL:

A. Structurally repair cracks in structures as specified in Section 03 30 00.

B. Cracks: repair by injection of epoxy adhesive.

3.02 PREPARATION:

A. Free cracks from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks in accordance with epoxy adhesive manufacturer’s instructions.

C. Clean surfaces adjacent to cracks from dirt, dust, grease, oil, efflorescence, and other foreign matter detrimental to bond of surface seal system.

D. Do not use acids and corrosives for cleaning, unless neutralized prior to injecting epoxy.

3.03 APPLICATION:

A. Sealing: apply surface seal in accordance with manufacturer’s instructions to designated crack face prior to injection; seal surface of crack to prevent escape of injection epoxy.

B. Entry Ports:

1. Establish openings for epoxy entry in surface seal along crack.

2. Determine space between entry ports equal to thickness of concrete member to allow epoxy to penetrate to the full thickness of the wall.

3. Provide a means to prevent concrete dusts and fines from contaminating the crack or ports when drilling.

4. Space entry ports closer together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:

   a. Cracks extend entirely through wall.

   b. Backfill of walls on one side.

   c. Difficult to excavate behind wall to seal both crack surfaces.

5. Core drill to verify epoxy depth where only one side of wall is exposed.

C. Epoxy Injection:

1. Store epoxy at minimum of 70 degrees F.

2. Start injection into each crack at lowest elevation entry port.

3. Continue injection at first port until adhesive begins to flow out of port at next highest elevation.

4. Plug first port and start injection at second port until adhesive flows from next port.

5. Inject entire crack with same sequence.

D. Finishing:

1. Cure epoxy adhesive after cracks have been completely filled to allow surface seal removal without draining or runback of epoxy material from cracks.

2. Remove surface seal from cured injection adhesive.

3. Finish crack face flush with adjacent concrete.

4. Indentations or protrusions caused by placement of entry ports are not acceptable.

5. Remove surface seal material and injection adhesive runs and spills from concrete surfaces.

3.04 EQUIPMENT:

A. Portable, positive displacement-type pumps with in-line metering to meter and mix two adhesive components, and inject mixture into crack.

B. Pumps:

1. Electric or air powered with interlocks providing positive ratio control of proportions for the two components at nozzle.

2. Primary injection pumps for each material of different mix ratio, including a standby backup pump of similar ratio.

3. Capable of immediate compensation for changes in resins.

4. Do not use batch mix pumps.

C. Discharge Pressure: automatic pressure controls capable of discharging mixed adhesive at pressures up to 200 psi, plus or minus 5 percent, and able to maintain pressure.

D. Automatic Shutoff Control: provide sensors on both Component A and B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.

E. Proportioning Ratio Tolerance: maintain epoxy adhesive manufacturer's prescribed mix ratio within a tolerance of plus or minus 5 percent by volume at discharge pressure up to 160 psi.

F. Ratio/Pressure Check Device:

1. Two independent, valved nozzles, capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.

2. Pressure gauge, capable of sensing pressure behind each valve.

3.05 FIELD QUALITY CONTROL:

A. Epoxy Adhesive Two Component Ratio Tests:

1. Disconnect mixing head and pump two adhesive components simultaneously through ratio check device.

2. Adjust discharge pressure to 160 psi for both adhesive components.

3. Simultaneously discharge both adhesive components into separate calibrated containers.

4. Compare amounts simultaneously discharged into calibrated containers during same time period to determine mix ratio.

5. Complete test at 160 psi discharge pressure and repeat procedure for 0 psi discharge pressure.

6. Run ratio test for each injection unit at beginning and end of each injection work day, and when injection work has stopped for more than 1 hour.

7. Document and maintain complete accurate records of, ratios and pressure checks.

B. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect two adhesive component delivery lines to pressure check device.

2. Pressure Check Device:

a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.

b. Pressure gauge capable of sensing pressure buildup behind each valve.

3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.

4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.

5. Run pressure test for each injection equipment unit:

a. Beginning and end of each injection work day.

b. When injection work as stop for more than 45 minutes.

6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

C. Crack Injection Tests:

1. Initial Cores:

a. 4-inch-diameter for full crack depth taken from Engineer's selected locations.

b. Take three cores in first 100 linear feet of crack repaired and one core sample for each 500 linear feet thereafter.

2. Provide suitable containers for storage, curing, and transportation of test specimens.

3. Methods of Testing Cores:

   a. Penetration: Visual examination.

   b. Bond Strength/Compression Test: concrete failure prior to adhesive failure.

4. Test Requirements:

   a. Penetration: minimum of 90 percent of crack shall be full of epoxy adhesive.

   b. Bond Strength/Compression Test: concrete failure before adhesive failure, or 6,500 psi with no failure of either concrete or adhesive.

5. Evaluation and Acceptance of Tests:

   a. If initial cores pass tests as specified, epoxy adhesive injection at area represented by cores will be accepted.

   b. If initial cores fail either by lack of penetration or bond strength, crack repair shall not proceed further until areas represented by cores are re-injected or repaired and retested for acceptance.

   c. Obtain verifying core samples, number and location as selected by Engineer, after rework of areas represented by failed initial cores is complete.

6. Core Hole Repair:

   a. Correct as result of testing on notification from Engineer.

   b. Refill initial and verifying core holes with an epoxy grout tamped and rodded in-place to form a dense fill.

   c. Finish surface to blend with adjacent concrete.

3.06 TESTS AND INSPECTIONS:

A. Special inspection, testing, and professional observation shall be provided by the Contractor as indicated in the Statement of Special Inspection in the Drawings and in Section 01 45 33.

B. Special Inspector shall verify that manufacturer and installer's procedures and instructions for surface preparation and installation are followed.

3.07 ALTERNATIVE CRACK REPAIRS:

A. Where specifically approved in writing by the Engineer, alternative crack repair products and procedures may be used, as Specified in Section 03 01 30.

B. Each individual location where alternative crack repair products or procedures are used, shall be approved in writing by the Engineer, prior to beginning work or installing the alternative products.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

DIVISION 04

MASONRY

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SECTION 04 20 00

UNIT MASONRY AND ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide unit masonry and accessories as indicated and in compliance with Contract Documents.

1. The work under this Section includes the following:

a. Masonry units

b. Mortar and grout

c. Integral water repellent for block and mortar

d. Block sealer

e. Steel reinforcing bars

f. Ties and anchors

g. Miscellaneous masonry accessories

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. TMS 602: Building Code Requirements for Masonry Structures & Commentary.

2. SP-66: ACI Detailing Manual.

B. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A82: Standard Specification for Steel Wire, Plain for Concrete Reinforcement.

3. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

4. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

5. A307: Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

6. A563: Standard Specification for Carbons and Alloy Steel Nuts.

7. A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

8. C90: Standard Specification for Loadbearing Concrete Masonry Units.

9. C91: Standard Specification for Masonry Cement.

10. C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).

11. C140: Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units.

12. C144: Standard Specification for Aggregate for Masonry Mortar.

13. C150: Standard Specification for Portland Cement.

14. C199: Standard Test Method for Pier Test for Refractory Mortars.

15. C207: Standard Specification for Hydrated Lime for Masonry Purposes.

16. C270: Standard Specification for Mortar for Unit Masonry.

17. C395: Standard Specification for Chemical-Resistant Resin Mortars.

18. C404: Standard Specification for Aggregates for Masonry Grout.

19. C476: Standard Specification for Grout for Masonry.

20. C494: Standard Specification for Chemical Admixtures for Concrete.

21. C780: Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.

22. C920: Standard Specification for Elastomeric Joint Sealants.

23. C979: Standard Specification for Pigments for Integrally Colored Concrete.

24. C1019: Standard Method of Sampling and Testing Grout.

25. C1093: Standard Practice for Accreditation of Testing Agencies for Masonry.

26. C1314: Standard Test Method for Compressive Strength of Masonry Prisms.

27. C1329: Standard Specification for Mortar Cement.

28. C1623: Standard Specification for Manufactured Concrete Masonry Lintels.

29. D1056: Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

30. D2287: Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.

31. E119: Standard Test Methods for Fire Tests of Building Construction and Materials.

32. E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.

33. E514: Standard Test Method for Water Penetration and Leakage Through Masonry.

34. F1941: Standard Specification for Electrodeposited Coatings on Threaded Fasteners [Metric].

35. F3125: Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

C. National Concrete Masonry Association (NCMA):

1. TEK8-2A: Removal of Stains from Concrete Masonry

2. Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering

1.03 DEFINITIONS:

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.04 PERFORMANCE REQUIREMENTS:

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in TMS 602.

2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C1314.

1.05 PRECONSTRUCTION TESTING:

A. Preconstruction Testing Service: Owner qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C140 for compressive strength.

2. Mortar Test (Property Specification): For each mix required, according to ASTM C109 for compressive strength.

3. Grout Test (Compressive Strength): For each mix required, according to ASTM C1019.

1.06 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.

2. Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.

3. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI SP-66, "Details and Detailing of Concrete Reinforcement."

D. Samples for Verification: For each type and color of the following:

1. Exposed CMUs.

2. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.

3. Concrete Masonry Units: Verification Samples: For each product specified, two samples, representing types, colors, textures, and finishes to be installed

4. Accessories embedded in masonry.

E. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch

numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Engineer and accepted in writing.

F. Qualification Data: For testing agency.

G. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include data on material properties.

b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.

3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.

4. Grout mixes. Include description of type and proportions of ingredients.

5. Reinforcing bars.

6. Joint reinforcement.

7. Anchors and metal accessories.

H. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109 for compressive strength, ASTM C1506 for water retention, and ASTM C91 for air content.

2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

I. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in TMS 602.

J. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated. Testing agency shall be retained by Owner/Engineer.

C. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

D. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

E. Masonry Standard: Comply with TMS 602 unless modified by requirements in the Contract Documents.

F. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 01 45 00 for mockups.

1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches long by 36 inches high by full thickness.

2. Clean exposed faces of panels with masonry cleaner indicated.

3. Protect accepted sample panels from the elements with weather-resistant membrane.

4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar, sealer, and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically accepted by Engineer in writing.

a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically accepted by Engineer in writing.

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical wall area as shown on Drawings.

2. Build mockups for each type of exposed unit masonry construction in sizes approximately 48 inches long by 48 inches high by full thickness, including face and backup wythes and accessories.

   a. Include a sealant-filled joint at least 16 inches long in each mockup.

   b. Include lower corner of window opening at upper right had corner of interior wall mockup and door jamb on the left edge. Make opening approximately 12 inches wide by 16 inches high.

   c. Include door jamb on the left edge of interior wall mockup.

   d. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).

3. Clean exposed faces of mockups with masonry cleaner as indicated.

4. Protect accepted mockups from the elements with weather-resistant membrane.

5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar, block sealer, and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

6. Accepted mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

E. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

F. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.09 PROJECT/SITE CONDITIONS:

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

2. Protect sills, ledges, and projections from mortar droppings.

3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

4. Prevent mortar and dirt contamination onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 degrees F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.01 MASONRY UNITS, GENERAL:

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.02 CONCRETE MASONRY UNITS:

A. Basis of Design:

1. Premier Ultra Burnished Masonry Units as manufactured by County Materials

2. Trendstone Plus as manufactured by Trendstone Corporation

B. Product Description

1. Integrally pigmented loadbearing hollow units with a net area compressive strength of greater than or equal to 1900 psi.

2. Coloring: Integral, through-body coloring; synthetic or natural iron oxide pigments

3. Water Repellent: Integral Water Repellent.

4. Finish: Ground Face filled and polished

C. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

2. Provide square-edged units for outside corners and bullnose units at opening jambs unless otherwise indicated.

D. Integral Water Repellent: Provide units made with integral water repellent.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.

a. Products:

(1) ACM Chemistries; RainBloc.

(2) BASF Aktiengesellschaft; Rheopel Plus.

(3) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.

E. CMUs: ASTM C90.

1. Density Classification: Normal weight.

2. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

3. Exposed Faces: Provide color and texture matching the range represented by approved sample.

2.03 MASONRY LINTELS:

A. General: Provide one of the following:

B. Masonry Lintels: Built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Temporarily support built-in-place lintels until cured.

2.04 MORTAR AND GROUT MATERIALS:

A. Cement: ASTM C595, Type IF. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C207, Type S.

C. Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C91.

1. Products:

a. Capital Materials Corporation; Flamingo Color Masonry Cement

b. Cemex S.A.B. de C.V.; Citadel Type S

c. Holcim (US) Inc.; Mortamix Masonry Cement

d. Lafarge North America Inc.; Lafarge Masonry Cement

e. Lehigh Cement Company; Lehigh Masonry Cement

f. National Cement Company, Inc.; Coosa Masonry Cement

E. Mortar Cement: ASTM C1329.

1. Products:

a. Lafarge North America, Inc.; Lafarge Mortar Cement

F. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

3. Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Aggregate for Grout: ASTM C404.

H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products:

a. The Euclid Chemical Company; Accelguard 80

b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset

c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA

I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.

1. Products:

a. ACM Chemistries; RainBloc for Mortar

b. BASF Aktiengesellschaft; Rheopel Mortar Admixture

c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture

J. Water: Potable.

K. Block Sealer: Provide sealer recommended by selected CMU manufacture to bottom four feet of wall for all exposed CMU surfaces in areas indicating an exposure on drawings as highly corrosive.

2.05 REINFORCEMENT:

A. Uncoated Steel Reinforcing Bars: ASTM A615 Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A951.

1. Interior Walls: Hot-dip galvanized, carbon steel.

2. Exterior Walls: Hot-dip galvanized, carbon steel.

3. Wire Size for Side Rods: 0.187-inch diameter.

4. Wire Size for Cross Rods: 0.187-inch diameter.

5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.

6. Provide in lengths of not less than 10 feet**,** with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Truss type with single pair of side rods.

2.06 ANCHORS:

A. Materials: Provide anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82; with ASTM A153, Class B-2 coating.

B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

C. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

2.07 MISCELLANEOUS ANCHORS:

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.

C. Anchor Bolts: Headed steel bolts complying with ASTM A307, Grade A; with ASTM A563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A153, Class C; of dimensions indicated.

2.08 MISCELLANEOUS MASONRY ACCESSORIES:

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or PVC.

B. Preformed Control-Joint Gaskets: Made from PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D226, Type I (No. 15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Products:

a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817

b. Heckmann Building Products Inc.; No. 376 Rebar Positioner

c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner

d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner

2.09 MASONRY CLEANERS:

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers:

a. Diedrich Technologies, Inc.

b. EaCo Chem, Inc.

c. ProSoCo, Inc.

2.10 MORTAR AND GROUT MIXES:

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

2. Use Portland cement-lime masonry cement mortar unless otherwise indicated.

3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For reinforced masonry, use Type M or S.

D. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in TMS 602 for dimensions of grout spaces and pour height.

2. Proportion grout in accordance with ASTM C476, Table 1.

3. Compressive strength of grout shall be equal to or exceed 1900psi.

4. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143/C143M.

PART 3 - EXECUTION

3.02 EXAMINATION:

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

2. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION, GENERAL:

A. Thickness: Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

3.04 TOLERANCES:

A. Dimensions and Locations of Elements:

1. For dimensions in cross-section or elevation do not vary by more than plus 1/2-inch or minus 1/4-inch.

2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2-inch.

3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4-inch in a story height or 1/2-inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8-inch, with a maximum thickness limited to 1/2 inch.

2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.

4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.05 LAYING MASONRY WALLS:

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.

2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.

3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

4. At fire-rated partitions, treat joint between top of partition, penetrations, and underside of structure above to comply with Section 07 84 00.

3.06 MORTAR BEDDING AND JOINTING:

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.

2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.

3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.

4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

3.07 MASONRY JOINT REINFORCEMENT:

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.

2. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.08 CONTROL AND EXPANSION JOINTS:

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

2. Install preformed control-joint gaskets designed to fit standard sash block.

3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.

4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.09 LINTELS:

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 REINFORCED UNIT MASONRY INSTALLATION:

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

2. Limit height of vertical grout pours to not more than 60 inches.

3.11 FIELD QUALITY CONTROL:

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.

3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.

G. Prism Test: For each type of construction provided, according to ASTM C1314 at 7 days and at 28 days.

3.12 REPAIRING, POINTING, AND CLEANING:

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.13 MASONRY WASTE DISPOSAL:

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.

2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 31 23 00.

3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

3.14 PROTECTION:

A. Protect the walls, including window sills, with non-staining waterproof coverings when work not in process.

B. Provide minimum 24-inch overhang of protective covering on each side of wall and anchor securely.

C. Protect facing materials from staining.

3.15 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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DIVISION 05

METALS

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SECTION 05 50 00

MISCELLANEOUS METAL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes metal fabrications not specifically included in other Sections and required for completion of work as shown on Contract Drawings and in accordance with Contract Documents.

B. Furnish labor, materials, equipment and incidentals necessary to install the products specified.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B18.5: Round Head Bolts

B. ASTM International (ASTM):

1. A6: General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling.

2. A36: Standard Specification for Carbon Structural Steel.

3. A48: Standard Specification for Gray Iron Castings.

4. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

5. A108: Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.

6. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

7. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

8. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.

9. A240: Standard Specification for heat-resisting chromium and chromium-nickel stainless steel plate, sheet, and strip for pressure vessels.

10. A276: Standard Specification for Stainless Steel Bars and Shapes.

11. A307: Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

12. A325: Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.

13. A366: Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality.

14. A489: Standard Specification for Carbon Steel Lifting Eyes.

15. A500: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

16. A501: Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

17. A536: Standard Specification for Ductile Iron Castings.

18. A569: Steel, Carbon (0.15 Maximum, Percent) Hot-Rolled Sheet and Strip Commercial Quality.

19. A570: Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

20. A572: Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

21. A576: Steel Bars, Carbon, Hot-Wrought, Special Quality.

22. A675: Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.

23. A786: Rolled Steel Floor Plates.

24. A929: Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe

25. A992: Standard Specification for Structural Shapes.

26. B26: Specification for Aluminum-Alloy Sand Castings.

27. B211: Specification for Aluminum-Alloy Bars, Rods, Profiles and Tubes.

28. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

29. B221: Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.

30. B247: Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings and Rolled Ring Forgings.

31. B308: Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

32. B429: Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

33. D1056: Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.

34. F436: Standard Specification for Hardened Steel Washers.

35. F541: Standard Specification for Alloy Steel Eyebolts.

36. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

37. F594: Standard Specification for Stainless Steel Nuts.

38. F844: Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

39. F1554: Standard Specification of Anchor Bolts, steel, 36, 55 and 105-ksi Yield Strength.

40. F2329: Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

41. F3125: Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

C. American Institute of Steel Construction (AISC):

1. ANSI/AISC 360-5: Specification for Structural Steel Buildings

2. AISC Manual of Steel Construction, Thirteenth Edition

D. American Welding Society (AWS):

1. A2.4: Standard Symbols for Welding, Brazing, and Nondestructive Examination

2. D1.1: Structural Welding Code

3. D1.2: Structural Welding Code - Aluminum

E. National Association of Architectural Metal Manufacturers (NAAMM):

1. MBG 531: Metal Bar Grating Manual

2. MBG 532: Heavy Duty Metal Bar Grating Manual

3. MBG 533: Welding Specifications for Fabrication of Steel, Aluminum and Stainless Bar Grating

F. Aluminum Association:

1. Aluminum Design Manual–Specifications and Guidelines for Aluminum Structures.

a. AA M31C22A41

(1) M31: Mechanical Finish, Fine Satin

(2) C22: Finish, Medium Matte

(3) A41: Clear Anodic Coating, Class I

G. Submit the following shop drawings in accordance with Section 01 33 00.

1. Submit shop drawings and product data showing materials of construction and details of installation for all items furnished under this Section. Shop drawings shall show sizes of members, method of assembly, anchorage and connection to other members.

2. Test Reports:

a. Submit certified copies of mill test reports on each steel, stainless steel, or aluminum proposed for use showing the physical properties and chemical analysis.

3. Product Data:

a. Manufacturer's catalog sheets on pre-manufactured items.

4. Miscellaneous Submittals:

a. Provide International Conference of Building Officials (ICBO) or other similar building code organization recommendations regarding safe allowable design loads for concrete anchors.

5. Stamped by Professional Structural Engineer registered in State where the project is located.

1.03 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.04 DESIGN CRITERIA:

A. Structural Connections: AISC Specification for Structural Steel Buildings. Design connections not fully detailed on the Drawings to resist the loads shown on the Contract Drawings or specified.

B. Where beam end reactions are not shown, design the connection for one-half the total allowable uniform load in kips for beams laterally supported at the given span, as determined by the tables for allowable loads on beams in the AISC Manual of Steel Construction, in addition to any axial loads identified on the Contract Drawings.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Test and inspect structural assemblies in accordance with Section 01 45 33.

C. Design connections not detailed on the Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State where the Project is located.

D. Steel:

1. Conform to codes for arc and gas welding in building construction of AWS and to AISC Specifications. Surfaces to be welded shall be free from loose scale, rust, grease, paint, and other foreign material, except mill scale that will withstand vigorous wire brushing may remain. Perform no welding when base metal is lower than 0 degrees F.

2. Qualify welding operators in accordance with AWS D1.1. Qualification tests shall be run by a recognized testing laboratory acceptable to the Engineer at Contractor's expense.

E. Aluminum:

1. Weld with gas metal arc (GMA) or gas tungsten arc (GTA) processes in accordance with AWS.

F. Adhesive Anchors:

1. Adhesive Anchor Installers shall be trained and certified by manufacturer.

G. Galvanized Coating:

1. Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Insofar as practical, factory assemble items specified herein. Package, ship and tag unassembled materials in a manner that will protect materials from damage and will facilitate identification and field assembly.

C. Package stainless steel items in a manner to provide protection from carbon impregnation.

D. Protect painted coatings and hot-dip galvanized finishes from damage due to metal banding and rough handling. Use padded slings and straps.

E. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.

F. Store fabricated items in a dry area, not in direct contact with ground.

1.07 FIELD MEASUREMENTS:

A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of the work.

B. The Contractor shall review the Contract Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

PART 2 - PRODUCTS

2.01 MISCELLANEOUS METAL SHAPES, CASTINGS, BOLTS AND ACCESSORIES:

A. Structural Steel Shapes:

1.	W Shapes:	ASTM A992, 50 ksi
2.	S, C and MC Shapes:	ASTM A36
3.	L Shapes:	ASTM A36
4.	HSS Square and Rectangular Shapes:	ASTM A500, Grade C, 50 ksi
5.	HSS Round Shapes:	ASTM A500, Grade C, 46 ksi
6.	Pipe Shapes:	ASTM A53, Grade B, 35 ksi

	7.	Plates and Bars:	ASTM A36
	8.	Steel Sheets:	ASTM A366
B.	Stainless Steel Shapes:		
	1.	Exterior and Submerged Uses:	AISI, Type 316
	2.	Industrial Uses:	AISI, Type 316
	3.	Interior and Architectural Uses:	AISI, Type 304
	4.	For Welding:	AISI, Type 304L, Type 316L
	5.	Shapes and Bars	ASTM A276
	6.	Plate, Sheet and Strip	ASTM A240
C.	Aluminum Shapes:		
	1.	Structural Shapes	ASTM B308, Alloy 6061-T6
	2.	Extruded Pipe	ASTM B429, Alloy 6063-T6
	3.	Aluminum Sheet and Plate	ASTM B209, Alloy 6061-T6
D.	High Strength Bolts for Steel Members		ASTM A325/F3125
C.	Steel Washers		ASTM F436
D.	Plain Unhardened Steel Washers:		ASTM F844

E. Anchor Bolts: ASTM F1554, Grade 36 standard headed bolts with heavy hex nuts, Grade A washers, hot-dip galvanized, unless otherwise specified.

F. Stainless Steel Bolts and Nuts: F593 and F594, AISI Type 316

G. Connection Bolts for Wood Members: ASTM A307, galvanized where specified

H. Iron Castings: ASTM A48, Class 35

I. Galvanizing: ASTM A123, Zn w/0.5 percent minimum Ni.

J. Galvanizing, hardware: ASTM A153, Zn w/0.5 percent minimum Ni.

2.02 POST INSTALLED ANCHORS:

A. Mechanical Expansion Type Anchors: Anchors shall be qualified per ICC-ES AC193.

1. Products:

a. Hilti Corporation, Kwik-Bolt TZ

b. Dewalt, Power Stud SD1+ Stud Anchor

c. Simpson Strong Tie, Strong Bolt

2. General:

a. Use Zinc or chromate-plated carbon steel where totally embedded, in interior locations with controlled humidity and other protected locations, unless otherwise specified on Contract Drawings.

b. Use stainless steel in other locations or when attaching aluminum and stainless steel.

c. Do not use expansion anchors in submerged and dynamic load applications.

B. Drop-In Anchors: Anchors shall be qualified per ICC-ES AC01.

1. Products:

a. Hilti Corporation, HDI Drop-In Anchor

b. Dewalt Fasteners, Steel Drop-In

c. Simpson Strong-Tie, Drop-In

2. General:

a. Use Zinc or chromate-plated carbon steel in interior locations with controlled humidity and other protected locations, unless otherwise specified on Contract Drawings.

b. Use stainless steel in other locations or when attaching aluminum and stainless steel.

c. Do not use drop-in anchors in corrosive or humid areas or when subjected to dynamic loads.

C. Sleeve Anchors: Anchors shall be qualified per ICC-ES AC01.

1. Products:

a. Hilti Corporation, HLC Sleeve Anchor

b. Dewalt Fasteners, Lok-Bolt

c. Simpson Strong-Tie, Sleeve-All

2. General:

a. Use Zinc or chromate-plated carbon steel in interior locations with controlled humidity and other protected locations, unless otherwise specified on Contract Drawings.

b. Use stainless steel in other locations or when attaching aluminum and stainless steel. Anchors in submerged locations shall be stainless steel Type 316.

D. Undercut Anchors:

1. Products:

a. Hilti Corporation, HDA Undercut Anchor

b. Dewalt Fasteners, Atomic+ Undercut

c. Simpson Strong-Tie, Type Torq-Cut

2. General:

a. Use Zinc or chromate-plated carbon steel in interior locations with controlled humidity and other protected locations, unless otherwise specified on Contract Drawings.

b. Use stainless steel in other locations or when attaching aluminum and stainless steel.

c. Under cut anchors are not acceptable for use in submerged applications.

E. Adhesive Anchors:

1. Products:

a. Hilti Corporation, HIT-HY 200

b. Dewalt Fasteners, PE1000+ Epoxy Adhesive Anchoring System

c. Simpson Strong Tie, SET-XP Epoxy-Tie or Acrylic-Tie

2. General:

a. Adhesive anchors shall be hot-dipped galvanized.

b. Use stainless steel in other locations or when attaching aluminum and stainless steel. Anchors in submerged locations shall be stainless steel Type 316.

2.03 ANCHOR CHANNEL INSERTS:

A. Make anchor channels from channel profiles with "I" anchors shop welded to back of channels. Furnish anchor channels with head bolts, channels, nuts for a complete installation. Material shall be Stainless Steel Type 304.

2.04 WEDGE INSERTS:

A. Manufacturers:

1. Gateway Building Products

2. Richmond Screw Anchor Company

B. General:

1. Malleable iron casting, 3/4-inch minimum size with minimum combined working load capacity of 1,300 pounds in shear and 1,000 pounds in tension.

2. Stainless Steel bolts and hardware.

2.05 EYE BOLTS:

A. Provide eyebolts of the welded-eye or forged type, carbon steel hot-dipped galvanized steel per ASTM F2329.

B. Provide threaded carbon steel lifting eyes that comply with ASTM A489, Type 1, Style B.

C. Provide threaded alloy steel eyebolts that comply with ASTM F541 and ASME B18.5, Type 1, long length.

2.06 GRATING SUPPORT ANGLES AND FRAMING:

A. Provide stainless steel support angles embedded in concrete. Angles shall be 1/4-inch thick, inside depth of support angle shall equal depth of bearing bar, inside length of support angle leg shall equal depth of grating. Provide 1 inch by 1/4-inch by 8 inches long bent anchor bars or 3/8-inch diameter by 6 inch headed anchor studs welded to backs of angles at 18 inches on center.

B. Provide stainless steel support angles embedded in concrete. Angles shall be equal depth of bearing bar, inside length of support angle leg shall equal depth of grating, but not less

than 1-3/4 inch. Provide long bent anchor bars or headed anchor studs welded to backs of angles as indicated on the Contract Drawings.

C. For fiberglass reinforced plastic grating provide supports and framing in accordance with Section 06 60 10.

2.07 METAL FRAMES:

A. Provide door, hatch, and grille frames, and other frames fabricated from structural shapes, as indicated on the Contract Drawings.

B. Fabricate frames from rolled steel sections or rolled steel sections and steel plates. Select sections for trueness of web and flange. Straighten members so finished frames are uniform, square, and true throughout length and depth of assembled units.

C. Connect built-up members of frames by plug welding. Miter or cope and join members with continuous welding beads. Provide temporary spreader bars to prevent springing frames out of shape prior to and during erection.

2.08 STRAP ANCHORS AND STUD ANCHORS:

A. Provide anchors for frames, curbs, sills, and other metal fabrications anchored into concrete or masonry. Fabricate anchors from strap iron, bent to shape, or of weldable studs, welded to backs of members. Where size and spacing not noted, provide 1 inch by 1/4-inch strap anchors or 3/4-inch diameter studs for concrete and 1-1/2 inch by 1/8-inch strap anchors for masonry. Space masonry anchors to fit jointing of adjacent masonry work at 4 feet on center. Space concrete anchors at 3 feet on center.

B. Where anchors and plates or clips are to be built in for attachment of later Work, provide bolts in plates or clips, welded to back, with threaded ends extended.

C. For attaching Work to concrete where anchors or inserts cannot be built in, provide concrete anchors or machine bolts and screws.

2.09 NEOPRENE GASKET:

A. Provide soft, closed-cell neoprene gasket material suitable for exposure to sewage and sewage gases conforming to ASTM D1056, Type 2, Class C, and Grade 1.

B. Unless otherwise shown on Contract Drawings, provide neoprene gaskets with a minimum thickness of 1/4-inch.

C. Furnish neoprene gaskets without skin coat.

2.10 MAINTENANCE HOLE COVERS AND FRAMES:

A. Manufacturers:

1. Neenah Foundry Inc.

2. Campbell

B. General:

1. Assemblies shall be of dimension and type as shown on Contract Drawings.

2.11 STEEL BOLLARDS:

A. Galvanized steel pipe bollards shall be fabricated to dimensions and details shown in Contract Drawings. Fabricated bollards from 6 inch nominal outside diameter pipe.

2.12 PRESSURE RELIEF VALVES:

A. Wall Type Pressure Relief Valves:

1. Manufacturers:

a. Trumbull Industries, Inc..; QuadroSeal Hydrostatic Tank Pressure Relief Valves

b. Clow Valve Co.; Type F-1494

c. Neenah Foundry, Inc.; Type R-5002

2. General:

a. Valves shall have a removable strainer retained in the valve.

b. Valves shall be furnished with rubber or neoprene seats and stainless steel or brass pins.

c. Valves shall be flanged and gasketed for connection to ductile iron wall pipe or fittings.

B. Floor Type Pressure Relief Valves: (Not Used in Contract)

1. Manufacturers:

a. Clow Valve Co.; Type F-1493

b. Neenah Foundry, Inc.; Type R-5000

2. General:

a. Shall be furnished with lead, rubber or neoprene seats.

C. Provide 4 inch cast-iron or stainless steel or ductile iron pressure relief valves as shown on Contract Drawings.

2.13 STOP PLANK GROOVES:

A. Manufacturers:

1. Neenah Foundry Inc., Type R-7500 Type A

B. Cast iron or ductile iron stop plank grooves.

2.14 MANUAL BAR SCREEN:

A. General:

1. Manual bar screen shall be 316 stainless steel firmly fastened to the manual bar screen channel using 316 stainless steel hardware as indicated on the contract drawings.

2.15 FABRICATION:

A. Connections and Workmanship:

1. Fabricate details and connection assemblies in accordance with Contract Drawings and Specifications, with projecting corners clipped and filler pieces welded flush.

2. Fit work together in fabrication shop and deliver complete or in parts, ready to be set in-place or assembled in field.

3. Provide work true to detail; with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture free from defects impairing strength or durability.

4. Provide clips, lugs, brackets, straps, plates, bolts, nuts, washers, and similar items, as required for fabrication and erection.

5. Provide castings of uniform quality, free from blowholes, porosity, hard spots, shrinkage distortion; smooth and well cleaned by shot blasting.

6. Welding:

a. Provide rigid and continuous welds or spot welded as specified and as shown on Contract Drawing. Dress the face of welds flush and smooth. Close fit exposed joints and locate where least conspicuous.

b. Weld aluminum work on the unexposed side when possible in order to prevent pitting or discoloration.

c. Weld aluminum in compliance with the latest edition of AWS D1.2. Support and clamp component parts of built-up members in proper position for welding.

d. Weld shop connections and bolt or field weld connections, unless otherwise specified.

e. Grind exposed edges of welds to 1/8-inch minimum radius. Grind burrs, jagged edges, and surface defects smooth.

f. Prepare welds and adjacent areas so there is:

(1) No undercutting or reverse ridges on weld bead.

(2) No weld spatter on or adjacent to weld or other area to be painted or coated.

(3) No sharp peaks or ridges along weld bead.

7. Bolting:

a. Use bolts of lengths required so bolts do not project more than 1/4-inch beyond face of nut. Do not use washers unless specified. Provide hexagonal head bolts with hexagonal nuts.

b. Provide holes required for connection of adjacent or adjoining work wherever noted on Drawings. Locate holes for bolting equipment to supports to tolerance of +/- 1/16-inch of dimensions indicated.

B. Galvanizing:

1. Galvanize after fabrication by hot-dipped process conforming with ASTM A123.

2. Ship and handle in manner to avoid damage to zinc coating.

C. Painting of aluminum in contact with concrete:

1. Coat areas of aluminum fabrications in contact with concrete with high solids epoxy or phenolic epoxy having a minimum volume solids of 80 percent (ASTM D2697). Maximum thickness of an individual coating shall not exceed the manufacturer's recommendation.

2. Manufacturers:

a. PPG, Amerlock 400 or 400VOC

b. PPG, PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating 97-145 series

c. Tnemec, Chembuild Series 135

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Upon receipt of material at job site, inspect all materials for shipping damage. Replace damaged items at no cost to Owner.

B. Examine supports for size, layout and alignment.

C. Correct defects considered detrimental to proper installation.

3.02 INSTALLATION:

A. Provide items such as bolts, shims, blocks, nuts, washers, and wedging pieces to complete installation.

B. Erect to lines and levels, plumb and true, and in correct relation to adjoining Work. Secure parts using concealed connections when practicable.

C. Plumb and true vertical members to tolerance of +/- 1/8 inch in 10 feet. Level horizontal members to tolerance of +/- 1/8 inch in 10 feet.

D. Use steel bolts to connect structural steel members. Use stainless steel bolts to connect structural aluminum members.

E. Anchor Bolts and Concrete Anchors:

1. Preset anchor bolts using templates. Do not use concrete anchors in place of anchor bolts.

2. After anchor bolts are embedded, protect projecting threads by applying grease and having the nuts installed until the time of installation of equipment or metalwork.

3. Do not install concrete anchors until concrete has reached specified minimum compressive strength.

4. Install concrete anchors in accordance with anchor manufacturer recommendation. Embedment depth of anchor shall be as recommended by the anchor manufacturer, but not less than as shown on Contract Drawings.

5. Locate concrete anchors to clear reinforcing bars in concrete.

F. Weld headed anchor studs in accordance with manufacturer's recommendations.

G. Do not place new holes or enlarge unfair holes by use of cutting torch.

3.03 PAINTING, REPAIR, AND PROTECTION:

A. Prepare surface of aluminum in contact with concrete.

1. Prepare aluminum surface by solvent or steam cleaning per SSPC SP-1; do not use alkali cleaning. Then dust blast.

2. Paint aluminum in contact with concrete with three or more coats of high solids epoxy or phenolic epoxy. Under no circumstances shall aluminum contact dissimilar metal.

B. Under no circumstances shall aluminum contact dissimilar metal.

C. Between aluminum grating, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4-inch thick neoprene isolator pads, 85 +/- 5 Shore A durometer, sized for full width and length of bracket or support.

D. Apply an anti-seize compound on all stainless steel fasteners to prevent galling.

E. Field Repair of Damaged Galvanized Coatings:

1. Clean and repair Zinc coating that has been burned by welding, abraded, or otherwise damaged after installation. Clean damage area by wire brushing and removing all traces of welding flux and loose or cracked zinc coating.

2. Coat surfaces using zinc-rich paint.

F. Field repair of damaged primer.

1. Touch up abrasions in the shop primer immediately after erection. Paint areas left unprimed for welding with primer after welding.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 05 53 00

METAL GRATING, COVER PLATES, AND ACCESS HATCHES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide metal grating, cover plates and access hatches as indicated and in compliance with Contract Documents.

B. This section includes:

1. Aluminum Bar Grating

2. Steel Grating

3. Aluminum Cover Plates

4. Stainless Steel Cover Plates

5. Stainless Steel Floor Access Hatches

C. Furnish all labor, materials, equipment and incidentals necessary to install the products specified.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A6: General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling.

2. A36: Standard Specification for Carbon Structural Steel.

3. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

4. A240: Standard Specification for heat-resisting chromium and chromium-nickel stainless steel plate, sheet, and strip for pressure vessels.

5. A307: Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

6. A325: Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.

7. A569: Steel, Carbon (0.15 Maximum, Percent) Hot-Rolled Sheet and Strip Commercial Quality.

8. A570: Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

9. A575: Steel Bars, Carbon, Merchant Quality, M-Grades

10. A576: Steel Bars, Carbon, Hot-Wrought, Special Quality.

11. A675: Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.

12. A786: Rolled Steel Floor Plates.

13. A1554: Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength

14. B26: Specification for Aluminum-Alloy Sand Castings.

15. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

16. B221: Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.

17. B247: Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings and Rolled Ring Forgings.

18. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

19. F594: Standard Specification for Stainless Steel Nuts.

B. American Welding Society (AWS):

1. D1.1: Structural Welding Code.

2. D1.2: Structural Welding Code - Aluminum.

C. National Association of Architectural Metal Manufacturers (NAAMM):

1. MBG 533: Welding Specifications for Fabrication of Steel, Aluminum and Stainless Bar Grating.

D. Aluminum Association:

1. Aluminum Association Designation System for Aluminum Finishes

2. AAMA 607.1: Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum

1.03 DESIGN CRITERIA:

A. Grating and Cover Plates:

1. Provide grating and cover plates of minimum depth shown on contract drawings, not exceeding manufacturer's maximum recommended span, and meeting the following load and deflection criteria.

a. 100 psf uniform live load or 300 pounds concentrated live load, whichever produces maximum stress

b. L/360 maximum deflection under uniform live load of 100 psf

B. 12,000 psi maximum flexural stress

C. Heavy Duty Grating

1. Provide grating meeting AASHTO HS 20 loads.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Detail shop drawings indicating:

a. Dimensions.

b. Sectional assembly.

c. Location and identification mark.

d. Connections and fastening methods.

e. Size and location of supporting frames required.

f. Materials of construction.

g. Installation instructions.

2. Catalog data and design tables showing limits for span length and deflection under load.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Obtain field measurements prior to preparation of shop drawings and fabrication.

C. Steel:

1. Conform to codes for arc and gas welding in building construction of AWS and to AISC Specifications. Prepare surfaces to be welded according to requirements of AWS D1.1. No welding shall be done when base metal lower than 0 degrees F.

2. Qualify welding operators in accordance with AWS D1.1.

D. Aluminum:

1. Weld with gas metal arc (GMA) or gas tungsten arc (GTA) processes in accordance with manufacturer's recommendations as accepted and in accordance with recommendations of AWS D1.2.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Store to avoid damage.

C. Remove material that has become damaged as to be unfit for use.

D. Identify and match-mark all materials, items, and fabrications for installation and field assembly.

1.08 FIELD MEASUREMENTS:

A. Verify dimensions and make any field measurements necessary and be fully responsible for accuracy and layout of the work.

B. Review the Contract Drawings and report any discrepancies to the Engineer for clarification prior to starting fabrication.

PART 2 - PRODUCTS

2.01 STEEL GRATING:

A. Manufacturers:

1. IKG Borden Metal Products Co.; Type B or W/B.

2. Ohio Gratings, Inc.; Type DT or SGCS Series.

B. Provide steel grating material conforming to ASTM A36.

C. Provide grating size as indicated on the Contract Drawings.

D. Fabricate in standard size sections where possible with a maximum panel weight of no more than 80 pounds.

E. Apply bearing bar banding at ends of grating sections and at fixture or pipe openings where two or more bearing bars are cut.

F. Anchor grating to support members using stainless steel saddle clips.

G. Exterior grating shall be serrated. Provide interior surface with mill finish.

H. Hot dip galvanize steel grating after fabrication in accordance with ASTM A123.

2.02 ALUMINUM BAR GRATING:

A. Manufacturers:

1. IKG Borden Metal Products Co.; Type S/B or B/F.

2. Ohio Gratings, Inc.; Type SG or ADT Series.

3. McNichols Co.; GAL or GAA and GBB Series.

B. Provide aluminum alloy 6063-T6 grating material.

C. Provide grating as indicated on the Contract Drawings.

D. Fabricate in standard size sections where possible with a maximum panel weight of no more than 80 pounds.

E. Apply bearing bar banding at ends of grating sections and at fixture or pipe openings where two or more bearing bars are cut.

F. Anchor grating to support members using stainless steel saddle clips.

G. Exterior grating shall be serrated. Provide interior surface with mill finish.

2.03 ALUMINUM COVER PLATE:

A. Provide floor checkered plates conforming to the following aluminum alloys and tempers with a mill finish:

1. Angles

a. Extruded: AA 6063-T5

b. Structural: AA 6061-T6

2. Checkered Plate: AA 6061-T6

3. Anchors Bolts, Washers, and Nuts: Stainless Steel Type 316

B. General:

1. Fabricate with a maximum panel weight of no more than 80 pounds.

2. Provide flush type lifting handles for all section of checkered plates.

3. Provide a raised pattern, non-skid surface.

4. See drawings for stiffener spacing.

5. Thickness as shown on contract drawings.

C. Furnish fixed cover checkered plates complete with frames, anchors, lifting handles and stainless steel flush head screw fastenings.

D. Furnish hinged checkered plate covers complete with frames, anchors, lifting handles and heavy duty hinges. Provide a minimum of two hinges of Type 316L stainless steel, with stainless steel pins and fastenings for each checkered plate section.

2.04 STAINLESS STEEL COVER PLATE:

A. Provide floor checkered plates conforming to the following material properties:

1. Angles: AISI, Type 304 or 316, per Contract Drawings

2. Plate: ASTM A240 Type 316L

3. Anchors Bolts, Washers, and Nuts: Stainless Steel Type 316

B. General:

1. Fabricate with a maximum panel weight of no more than 80 pounds.

2. Provide flush type lifting handles for all section of checkered plates.

3. Provide a raised pattern, non-skid surface.

4. See drawings for stiffener spacing.

5. Thickness as shown on contract drawings.

C. Furnish fixed cover checkered plates complete with frames, anchors, lifting handles and stainless steel flush head screw fastenings.

D. Furnish hinged checkered plate covers complete with frames, anchors, lifting handles and heavy duty hinges. Provide a minimum of two hinges of Type 316L stainless steel, with stainless steel pins and fastenings for each checkered plate section.

2.05 FLOOR ACCESS HATCHES:

A. Manufacturers of Prefabricated Floor Access Hatches:

1. Bilco Company, Type J series

2. Halliday

3. Thompson Fabrication Company

B. Component Fabrication:

1. Provide 316 stainless steel access hatches and frames of type and size as shown on Drawings.

2. Where hatches are noted with drainage channel, drainage channel frame shall be 1/4-inch 316 stainless steel thick trough frame with continuous anchor flange around perimeter. Weld 1-1/2 inch diameter drain coupling to frame trough unless indicated otherwise on Drawings.

3. Where hatches are noted without drainage channel provide 1/4-inch thick minimum 316 stainless steel hatch frame with strap anchors or continuous anchors around frame.

4. Door leaves: 1/4-inch 316 stainless steel diamond plate with reinforcing on underside for live load. Provide stainless steel safety chain and attachments for end of double-leaf door assembly when open.

5. Door Hardware:

a. Equip doors with heavy stainless steel hinges with stainless steel pins. Hinges shall be through bolted to cover and frame with stainless steel bolts.

b. Equip doors with fully enclosed 316 stainless steel compression springs and hold - open arm with positive locking device with conveniently positioned release handle for easy and controlled closing.

c. Hardware shall be Type 316 stainless steel.

d. Stainless steel snap lock mounted on bottom of door leaf with a removable topside handle and socket recessed in cover.

e. Hinged hasp on exterior door surface.

f. Cylinder lock with keyway protected by a threaded cover plug.

6. Manufacturer shall warranty in writing against defects in materials or workmanship for five years.

7. Fall Protection Safety Grate:

   a. Color shall be safety orange.

   b. Provide torsion rod lift assistance for ease of operation.

   c. Provide a stainless steel hold open arm to automatically lock the panel in the fully open 90 degree position.

   d. Provide a stainless steel release handle for closing the grating panel with a provision for locking the panel to prevent unauthorized access.

   e. All other hardware shall be Type 316 stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Upon receipt of material at job site, inspect all materials for shipping damage. Damaged items shall be replaced at no cost to Owner.

B. Examine supports for size, layout and alignment. Surface shall be free of debris.

C. Correct defects considered detrimental to proper installation.

3.02 PROTECTION:

A. Protect aluminum from contact with dissimilar metals or concrete. Under no circumstances shall aluminum directly contact concrete or dissimilar metal.

B. Apply one coat of bituminous paint coating.

C. Before coating application, clean contact surfaces, remove dirt, grease, oil, foreign substances, followed by immersing in, or wipe thoroughly with, an acceptable solvent. Rinse with clean hot water and dry thoroughly.

3.03 INSTALLATION:

A. Install and make connections in accordance with accepted submittals and manufacturer's written instructions.

B. Install materials accurately in location and elevation, level and plumb. Field fabricate as necessary for accurate fit.

C. Coordinate and furnish anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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DIVISION 06

WOODS, PLASTICS, AND COMPOSITES

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SECTION 06 10 00

ROUGH CARPENTRY

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide materials to perform the rough carpentry work as indicated and in compliance with Contract Documents.

1. Section Includes:

a. Wood blocking and nailers

b. Plywood backing panels for telephone and electrical back boards

c. Wood blocking for support of toilet and bath accessories

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B18.2.1: Square and Hex Bolts and Screws (Inch Series)

2. B18.6.1: Wood Screws (Inch Series)

B. ASTM International (ASTM):

1. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

2. A307: Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

3. A563: Specification for Carbon and Alloy Steel Nuts

4. A666: Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

5. B633: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

6. D2559: Standard Specification for Adhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions

7. D2898: Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing

8. D3201: Standard Test Method for Hygroscopic Properties of Fire-Retardant Wood and Wood-Based Products

9. D3498: Standard Specification for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems

10. D5055: Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists

11. D5456: Standard Specification for Evaluation of Structural Composite Lumber Products

12. D5664: Standard Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber

13. D6841: Standard Practice for Calculating Design Value Treatment Adjustment Factors for Fire-Retardant-Treated Lumber

14. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

15. E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.

16. F593: Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

17. F594: Specification for Stainless Steel Nuts

18. F738M: Standard Specification for Stainless Steel Metric Bolts, Screws, and Studs

19. F836M: Standard Specification for Style 1 Stainless Steel Metric Nuts

20. F1667: Specification for Driven Fasteners: Nails, Spikes, and Staples

C. American Wood Preserver's Association Standard (AWPA):

1. M4: Standard for the Care of Preservative Treated Wood Products

2. U1: User Specification for Treated Wood

D. California Department of Public Health (CDPH)

1. Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

1.03 DEFINITIONS:

A. Exposed Framing: Framing not concealed by other construction.

B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

C. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association

2. NLGA: National Lumber Grades Authority

3. RIS: Redwood Inspection Service

4. SPIB: The Southern Pine Inspection Bureau

5. WCLIB: West Coast Lumber Inspection Bureau

6. WWPA: Western Wood Products Association

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.

2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

C. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood

2. Fire-retardant-treated wood

3. Power-driven fasteners

4. Powder-actuated fasteners

5. Expansion anchors

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 WOOD PRODUCTS, GENERAL:

A. Certified Wood: Materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship for the following:

1. Miscellaneous lumber

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

2. Provide dressed lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

2.02 WOOD-PRESERVATIVE-TREATED LUMBER:

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

2. Wood sills, sleepers, blocking, furring, stripping and similar concealed members in contact with masonry or concrete.

2.03 MISCELLANEOUS LUMBER:

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking

2. Nailers

3. Rooftop equipment bases and support curbs

4. Cants

5. Furring

6. Grounds

7. Utility shelving

B. For concealed boards, provide lumber with 15 percent maximum moisture content any of the following species and grades:

1. Mixed southern pine; No. 2 grade; SPIB.

2. Hem-fir or hem-fir (north); Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.

3. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common

4. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.04 PLYWOOD BACKING PANELS:

A. Equipment Backing Panels: DOC PS 1, Exterior, AC in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

1. Plywood shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.05 FASTENERS:

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153

B. Nails, Brads, and Staples: ASTM F1667

C. Power-Driven Fasteners: NES NER-272

D. Wood Screws: ASME B18.6.1

E. Lag Bolts: ASME B18.2.1

F. Bolts: Steel bolts complying with ASTM A307, Grade A; with ASTM A563 hex nuts and, where indicated, flat washers.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E488 conducted by a qualified independent testing and inspecting agency.

H. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.

1. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

I. Hemmed edges

2.06 MISCELLANEOUS MATERIALS:

A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

B. Adhesives for Gluing to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

C. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.

C. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.

D. Do not splice structural members between supports unless otherwise indicated.

E. Provide blocking as indicated and as required to support facing materials, fixtures, specialty items, and trim.

F. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

G. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.

2. Use copper naphthenate for items not continuously protected from liquid water.

H. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.

2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

I. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

J. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

1. Comply with accepted fastener patterns where applicable

2. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.02 WOOD BLOCKING, AND NAILER INSTALLATION:

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

D. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.03 PROTECTION:

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 06 60 10

FIBERGLASS REINFORCED PRODUCTS AND FABRICATIONS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes:

1. FRP Grating

2. FRP Structural Shapes

3. FRP Railing

B. Furnish all labor, materials, equipment and incidentals necessary to install the fiberglass polymer products as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. D70: Standard Test Method for Density of Semi-Solid Bituminous Materials (Pycnometer Method).

2. D256: Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.

3. D635: Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

4. D638: Standard Test Method for Tensile Properties of Plastics.

5. D695: Standard Test Method for Compressive Properties of Rigid Plastics.

6. D696: Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between-30 Degree C and 30 Degree C with a Vitreous Silica Dilatometer.

7. D732: Standard Test Method for Shear Strength of Plastics by Punch Tool.

8. D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

9. D792: Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

10. D2583: Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

11. D3918: Standard Terminology Relating to Reinforced Plastic Pultruded Products.

12. E84: Standard Test Method for Surface Burning Characteristics of Building Materials.

13. G152: Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

14. G153: Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Detail shop drawings indicating:

a. Dimensions

b. Sectional assembly

c. Location and identification mark

d. Connections, connections to structure and fastening methods

e. Size and location of supporting frames required

f. Materials of construction

g. Installation instructions

2. Catalog data and design tables showing limits for span length and deflection under various and concentrated loads.

3. Comprehensive calculations showing the codes or standards used, loads considered, member stresses, and associated deflections. Calculations shall be signed and sealed by a Professional Structural Engineer registered in Utah.

4. Stamped by Professional Structural Engineer registered in Utah.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

B. Product Data for Credits MR 4.1 and Credit MR 4.2: For products having recycled content, provide documentation indicating percentages (by weight) of post-consumer and pre-consumer recycled content.

1. For each recycled product used, include a statement indicating costs.

C. Product Certificates for Credit MR 5.1: For products extracted, harvested and manufactured within 500 miles of the project site, provide documentation indicating percentages (by weight) of regional materials that meet the criteria.

1. For each regional product used, include a statement indicating costs.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Furnish material from an ISO-9001 certified manufacturer of proven ability who has regularly engaged in the manufacture and installation of FRP systems.

C. Provide documentation showing that the Contractor doing this work has a minimum of 5 years' experience in the manufacture and installation of FRP systems similar to that indicated for this project, with sufficient capacity to produce required units without causing delay of work.

D. Install materials in accordance with the manufacturer's instructions.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Store materials during and after shipment to prevent cracking, twisting, bending, breaking, chipping or damage of any kind to materials, including damage due to over exposure to sun.

C. Remove material that is damaged from the site, at no cost to the Owner.

D. Identify and match-mark all materials, items, and fabrications for installation and field assembly.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Seasafe, Inc.

B. Strongwell

C. IMCO Reinforced Plastics, Inc.

D. International Grating, Inc.

E. Fibergrate Composite Structures, Inc.

F. If the Contractor chooses to substitute equipment other than a named manufacturer, any additional costs required to accommodate such equipment shall be made without a change in the Contract Price or Contract Time and at no additional cost to the Owner.

2.02 GENERAL:

A. Provide new materials free from defects and imperfections that might affect performance of finished product.

B. After fabrication, seal cut ends, holes and abrasions of FRP shapes with a compatible resin coating to prevent intrusion of corrosion and moisture.

C. Fabricate so that exposed surfaces are smooth and true to form.

D. Manufacture FRP products using vinyl ester resin with flame retardant and UV inhibitor additives. Provide synthetic surface veil covering exterior surface. Provide FRP shapes with flame spread of 25 or less in accordance with ASTM E84.

E. Provide FRP products exposed to weather with ultraviolet inhibitor and one mil thick UV coating to shield from ultra-violet light.

F. Provide Type 316L stainless steel metal accessories unless noted otherwise. Provide concrete anchors that comply with Section 05 50 00.

2.03 FRP GRATING:

A. Design Requirements:

1. Grating:

a. Design grating and support system to sustain dead loads and superimposed live loads.

b. 100 psf uniform live load or 300 pound concentrated live load, whichever produces maximum stress.

B. Fabricate grating from pultruded bearing bars and cross rods. Assemble grating using a locking cross-rod design that makes a permanent connection between the cross-rod and bearing bar, and is completely bond into a one-piece panel.

C. Color shall be gray.

D. Provide grating with a slip resistant epoxy grit surface.

E. Use Type 316L stainless steel grating hold down clamps spaced as required by manufacturer, but not greater than 4 feet on center. Provide two at each support with a minimum of four per panel.

F. Position grating sections flat and square with ends bearing minimum 1-1/4 inches on supporting structure.

G. Provide embedded angle support frames with continuous integral anchor for grating set in concrete openings unless noted otherwise.

H. Maximum Grating Clearances:

1. 1/4-inches from vertical steel sections

2. 1/2-inches from concrete and masonry walls

3. 1/4-inches between sections and at ends

2.04 STRUCTURAL SHAPES:

A. Design requirements:

1. Design Loads:

a. Design structural framing to sustain dead loads and superimposed live loads.

b. 100 psf uniform live load or 300 pound concentrated live load, whichever produces maximum stress.

2. Deflection:

a. Span: L/240 maximum

B. Manufacture structural shapes by the pultrusion process.

C. Provide structural shapes with a UV inhibitor.

D. Provide structural shapes containing a glass fiber reinforced polyester ester resin matrix, approximately 50 percent glass by weight with a synthetic surface veil outer layer covering the exterior surfaces. Provide glass strand rovings shall be for longitudinal strength. Provide continuous strand glass mats or stitched reinforcements shall for transverse strength.

E. Provide Type 316L stainless steel bolts and washers.

F. Abrade joint surfaces to be bonded to remove surface gloss and be free of burrs or other foreign materials that would prevent proper adhesion.

2.05 RAILING:

A. Design Requirement:

1. Design railing system to meet the configuration and loading requirements of OSHA, IBC or local buildings codes. Apply requirements of the most stringent code.

B. Fully bond all post to rail connections with an epoxy adhesive and with an internal connection for added strength and durability. Provide smooth transitions between post and rail connections.

C. Provide kickplates where required by OSHA. Kick plate shall be 4 inches by 1/2-inch (corrugated) by 1/4-inch thick pultruded shape attached to posts with stainless connectors.

D. Color shall be safety yellow.

E. Fabricate handrail to standard two-rail design unless noted otherwise.

1. Post Locations:

a. No greater than 12 inches from horizontal or vertical change in handrail direction.

b. Post centers shall be no greater than 60 inches apart on any straight run of rail.

c. Post centers shall be no greater than 48 inches apart on inclined rail section.

F. Provide side mounted, base mounted, embedded, or removable anchorage mounted handrail as noted on Drawings.

G. Accurately locate handrail sections and erect plumb and level.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Remove and replace damaged items at no cost to Owner.

B. Examine supports for size, layout and alignment. Maintain surfaces free of debris.

3.02 INSTALLATION:

A. Install and make connections in accordance with accepted submittals and manufacturer's written instructions.

B. Install materials accurately in location and elevation, level and plumb. Field fabricate as necessary for accurate fit.

C. Coordinate and furnish anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 06 68 10

POLYETHYLENE BOLLARD COVERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide materials and installation of colored polyethylene bollard covers as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. A13.1: Scheme for Identification of Piping Systems

2. Z535.1: Safety Colors

1.03 SUBMITTALS:

A. Submit shop drawings in accordance with Section 01 33 00.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 BOLLARD COVERS:

A. Fabricate covers of 1/8-inch-thick high-density polyethylene, with integral UV protection. Color shall be yellow or as noted on the drawings.

1. Product: Seton Bollard Covers

2. Product: Thermoprene “Bollard Gard™”.

2.02 REFLECTIVE TAPE MARKINGS:

A. Provide two 1-inch-wide reflective tapes, located approximately 3.25 and 14.25 inches from the top of the bollard. Tape color shall be red or as noted on the drawings.

1. Products: 3M Reflective Tape

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Place the bollard covers over the bollard posts. Attach per manufacturer's instructions using the gripper tab attachment accessories provided. Apply one row of tabs approximately 6 inches from the top of the bollard and a second row approximately 6 to 12 inches from the base of the bollard. Slide the cover over the bollard. The installation shall be firm and tight.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

DIVISION 07

THERMAL AND MOISTURE PROTECTION

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SECTION 07 21 00

BUILDING INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide building insulation as indicated and in compliance with Contract Documents:

1. Section includes:

a. Foam-plastic board insulation

b. Concrete faced board insulation

c. Mineral-Wool insulation

1.02 REFERENCES:

A. ASTM International (ASTM):

1. C1289: Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

2. C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

3. C578: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation

4. C665: Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

5. D696: Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer

6. D1621: Standard Test Method for Compressive Properties of Rigid Cellular Plastics

7. D2842: Standard Test Method for Water Absorption of Rigid Cellular Plastics

8. E84: Standard Test Method for Surface Burning Characteristics of Building Materials.

9. E96: Standard Test Methods for Water Vapor Transmission of Materials

10. E119: Standard Test Methods for Fire Tests of Building Construction and Materials

11. E136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.

1.03 DEFINITIONS:

A. Thermal Resistivity: Where the thermal resistivity of insulation products is designated by "r values," they represent the reciprocal of thermal conductivity (k values). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperatures indicated.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Product Data: For each type of product indicated.

2. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

3. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

C. Fire Performance Characteristics: Provide insulation materials that meet the following:

1. Surface Burning Characteristic: ASTM E84.

2. Fire Resistance Ratings: ASTM E119.

3. Combustion Characteristics: ASTM E136.

D. Single Source Responsibility for Insulation Products: Obtain each type of building insulation from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

C. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.01 FOAM-PLASTIC BOARD INSULATION:

A. Extruded-Polystyrene Board Insulation: ASTM C578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

1. Manufacturers:

a. DiversiFoam Products.

b. Dow Chemical Company (The).

c. Owens Corning.

d. Pactiv Building Products.

B. Adhesive for Bonding Insulation: Provide manufacturers recommended product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

2.02 CONCRETE FACED INSULATION BOARD:

A. Extruded Polystyrene board, ASTM C 578, Type IV, rigid, closed cell, with integral high density 5/16-inch thick latex modified concrete facing.

1. Board Size: 2-feet by 4-feet by 2 5/16-inches.

2. Edges: tongue and groove sides, square edge ends.

3. Maximum Use Temperature: 165 degrees F

4. Thermal resistance (ASTM C 518): Long term aged R-value of 5 per-inch.

5. Foam Compression Strength: ASTM D1621, minimum: 35 psi.

6. Compressive Strength: ASTM D 1621, minimum 40 psi.

7. Water Absorption: ASTM D 2842, <0.1 (0.7% by volume maximum).

8. Water Vapor Permeance: ASTM E 96, 0.8 (50 ng/Pas M)

9. Coefficient of lineal Thermal Expansion: ASTM D 696, in/in x degrees F: 3.5 x 10-5 (6.3 x 10-2).

B. Manufacturers:

a. T. Clear/FinPan: WallGUARD.

b. Tech-Crete Processors Ltd.: CFI Insulated Wall Panels

C. Concrete Faced Insulation Accessories:

1. Provide manufacturers recommended accessories as required for installation and to protect any exposed edges from UV exposure.

2. Metal cap flashing: 24-gauge galvanized steel J-channel; 2 1/4 -inches wide, 4-inches short leg; prefinished in color as selected.

3. Clips and fasteners: Corrosion resistant type, sized to suit application.

2.03 UNFACED MINERAL-WOOL BATT INSULATION

A. Manufacturers:

1. Fibrex Insulations Inc.

2. Owens Corning.

3. Roxul Inc.

4. Thermafiber.

B. Unfaced, Mineral-Wool Blanket Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics.

2.04 FACED MINERAL-WOOL BATT INSULATION:

A. Manufacturers:

1. Fibrex Insulations Inc.

2. Owens Corning.

3. Roxul Inc.

4. Thermafiber.

B. Foil-Faced, Mineral-Wool Board Insulation: ASTM C612; faced on one side with foil-scrim; with maximum flame-spread and smoke-developed indexes of 25 and 5, respectively, per ASTM E84.

1. Nominal density of 4 lb/cu. ft. (64 kg/cu. m), Types IA and IB, thermal resistivity of 4 degrees F x h x sq. ft./Btu x in. at 75 degrees F (27.7 K x m/W at 24 degrees C).

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.02 INSTALLATION, GENERAL:

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.03 INSTALLATION OF BELOW-GRADE INSULATION:

A. On vertical footing and foundation wall surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line where there are no below grade spaces. At exterior walls with below grade spaces, extend insulation 10 feet below grade line or to the level of the lowest floor, whichever is less.

2. Provide concrete faced insulation board where the insulation is exposed above grade and extend 12 inches minimum below grade. Where insulation is required to extend beyond 12 inches below grade, beyond the 12 inches below grade, the insulation is permitted to be foam plastic board insulation.

3.04 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES:

A. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten foam board insulation to concrete substrates with insulation adhesive according to insulation manufacturer's written instructions.

2. Fasten concrete faced insulation board to concrete substrates with accessories according to insulation manufacturer's written instructions.

3.05 PROTECTION:

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 07 72 00

ROOF ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide roof accessories as indicated and in compliance with Contract Documents.

B. Section Includes:

1. Confined Space Davit Base

1.02 REFERENCES:

A. American Architectural Manufacturers Association (AAMA):

1. 611: Voluntary Specification for Anodized Architectural Aluminum

2. 2603: Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

B. American National Standards Institute (ANSI):

1. A10.32: Requirements for Safety Belts, Harnesses, Lanyards, Lifelines-Construction and Demolition

2. Z359: Fall Protection Code

C. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel.

2. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. A240: Standard Specification for heat-resisting chromium and chromium-nickel stainless steel plate, sheet, and strip for pressure vessels.

4. A500: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

5. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

6. A666: Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

7. A747: Standard Specification for Steel Castings, Stainless, Precipitation Hardening.

8. A755: Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products

9. A792: Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

10. A1011: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

11. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

12. D256: Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

13. D1785: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

14. D4802: Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet

15. G90: Standard Practice for Performing Accelerated Outdoor Weathering of Materials Using Concentrated Natural Sunlight

D. American Welding Society (AWS):

1. AWS D1.1: Structural Welding Code - Steel

E. National Fire Protection Association (NFPA):

1. 204: Standard for Smoke and Heat Venting

F. Occupational Safety and Health Administration (OSHA):

1. OSHA 1926.502 Fall Prevention Systems and Criteria and Practices

G. Underwriters' Laboratories, Inc. (UL):

1. 793: Standard for Safety Automatically Operated Roof Vents for Smoke and Heat

2. 972: Standard for Safety Burglary Resisting Glazing Material

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of roof accessory indicated.

C. Shop Drawings: Show fabrication and installation details for roof accessories.

D. Samples: For each type of exposed factory-applied color finish required and for each type of roof accessory indicated, prepared on Samples of size to adequately show color.

E. Confined Space Davit Base:

1. Product Data: Manufacturer's data and product information indicating the sizes, descriptions, capacities, test certifications, and other descriptive data showing in sufficient detail that the product complies with the contract requirements.

2. Shop Drawings: Layout drawings of each base in relation to the supporting structure indicating the locations of properly labeled components.

3. Installer's Certification: Furnish proof of installer's certification approval by manufacturer in the form of the installer's current certificate issued by the manufacture.

4. Product Certificate: Containing the manufacturer's batch number on each individual component used in the systems.

5. Qualifications Statement: For engineer performing delegated design.

6. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

7. Delegated-Design Submittal: For confined space davit base, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

C. Fall Protection Systems:

1. Manufacturer Qualifications: Minimum 5 years' experience manufacturing similar products.

2. Installer Qualifications: Minimum 2 years' experience installing similar products, authorized, trained, and certified by manufacturer.

3. Engineer for Delegated Design: Licensed in Utah and with a minimum of 2 years engineering fall protection systems.

4. Coordination: Coordinate the installation of horizontal fall protection system with structural supports and finish materials.

5. Secure materials and equipment required under this section from a single manufacturer

D. Confined Space Davit Base:

1. Manufacturer Qualifications: Minimum 5 years' experience manufacturing similar products.

2. Installer Qualifications: Minimum 2 years' experience installing similar products, authorized, trained, and certified by manufacturer.

3. Engineer for Delegated Design: Licensed in Utah and with a minimum of 2 years engineering fall protection systems.

4. Coordination: Coordinate the installation of confined space davit base with owner selected confined space davit system.

5. Secure materials and equipment required compatible with and from the same manufacturer as owner selected confined space davit system.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers listed in other Part 2 articles.

2.02 METAL MATERIALS:

A. Galvanized Steel Sheet: ASTM A653, G90 coated and mill phosphatized for field painting.

B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792, AZ50 coated.

C. Pre-painted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by hot-dip process and pre-painted by coil-coating process to comply with ASTM A755.

1. Galvanized Steel Sheet: ASTM A653, G90 coated.

2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792, Class AZ50 coated.

3. Exposed Finishes: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight.

D. Aluminum Sheet: ASTM B209, alloy and temper recommended by manufacturer for type of use and mill finish. Coil-coat finish as follows**:**

1. Factory-Prime Coating: Where painting after installation is indicated, provide pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat; with a minimum dry film thickness of 0.2 mil.

2. Anodic Finish: Architectural Class II, complying with AAMA 611.

a. Color: As selected by Architect/Engineer from manufacturer's full range.

3. Baked-Enamel Finish: Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils, medium gloss.

a. Color and Gloss: As selected by Architect/Engineer from manufacturer's full range.

4. High-Performance Organic Finish: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight.

a. Color and Gloss: As selected by Architect/Engineer from manufacturer's full range.

5. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish.

a. Color and Gloss: As selected by Architect/Engineer from manufacturer's full range.

E. Stainless-Steel Shapes or Sheet: ASTM A240 or ASTM A666, Type 304 or Type 316, No. 2D finish.

2.03 CONFINED SPACE DAVIT BASE:

A. Manufacturers:

1. 3M Fall Protection Business: DBI-SALA Flush Mount Sleeve Model#8512828 (Dewatering) 8512831 (Liquid Train).

B. Description:

1. Dewatering: Floor mount cast-in-place sleeve davit base with built-in pins for fresh concrete

2. Liquid Train: Floor mount sleeve davit base with PVC sleeve liner and all required mounting hardware.

3. Rated Capacity(working load) 450 pounds @ minimum 4:1 Design Factor (see appl. restriction 2) Mast Moment Proof Load 90.000 In.-lbs Mast Rotation 360°PVC davit mast sleeve liner

4. Heavy duty stainless steel sleeve cap at each base installation

5. General Construction:

a. Welded Steel/Stainless Steel Weld Certification CWB-47.1

b. Structure Material 304 SS

c. Sleeve Material 304 SS

d. Sleeve Bearing Material PVC Pipe - ASTM-D-1785

e. Thrust Bearing Material High Density Polyethene

f. Finish (Stainless Steel) Brush Blast

6. The Structure and mounting hardware must be capable of withstanding a 90,000 in.-lbs moment and a 5000 lbs. vertical load.

7. Installation MUST BE approved to local regulations by a qualified engineer.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Install roof accessories to fit substrates and to result in watertight performance.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum, or stainless-steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.

3. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.

D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

E. Seal joints with elastomeric or butyl sealant as required by manufacturer of roof accessories.

F. Coordinate location of fall protection and confined space davit equipment indicated to be attached to structural substrate or surface of roofing system, and furnish anchoring devices with templates, and diagrams.

G. Examine areas and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fall protection and confined space davit equipment.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

2. Adjust fall protection components to function smoothly and safely.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

B. Fall protection and confined space davit equipment:

1. Demonstration: Demonstrate operation of system to Owner's personnel.

   a. Briefly describe function, operation, and inspection of each component.

2. Training: Train Owner's personnel on operation and inspection of system.

   a. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

   b. Provide minimum of one hour of training

   c. Location: At project site

3. Training to take place at the completion of the installation.

4. Recertification: Coordinate annual recertification program per manufacturers recommendation.

END OF SECTION

SECTION 07 84 00

FIRESTOPPING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide firestopping as indicated and in compliance with Contract Documents.

1. Section includes:

a. Penetrations through fire resistance rated floor and roof construction including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.

b. Penetrations through fire resistance rated walls and partitions including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.

c. Penetrations through smoke barriers and construction enclosing compartmentalized areas involving both empty openings and openings containing penetrating items.

d. Sealant joints in fire resistance rated construction, including gypsum drywall partitions, concrete walls and adjacent construction.

B. General Contractor shall be responsible for providing firestopping for the project.

C. General Contractor shall be responsible for providing firestopping for the project, including all filed sub-bids work.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

2. E814: Standard Test Method for Fire Tests of Penetration Firestop Systems

3. E2174: Standard Practice for On-Site Inspection of Installed Fire Stops

4. Guide #40U19

B. FM Global (FM):

1. 4991: Approval of Firestop Contractors

C. Underwriters' Laboratories, Inc. (UL).

1. 1479: Standard for Safety Fire Tests of Through-Penetration Firestops

1.03 DEFINITIONS:

A. Firestopping: Asbestos free closures to fire and smoke at openings around penetrations, gaps and joints within fire separations and assemblies having a fire-resistance rating and no fire-resistance rating, including openings and spaces at perimeter edge conditions.

1. Draft tight barriers to retard passage of flame and smoke, and firefighter's hose stream and passage of liquids around outside of mechanical and electrical assemblies where they penetrate fire separations.

2. Maintain fire resistance rating of adjacent floor, wall or other fire separation assembly acceptable to authorities having jurisdiction.

3. Conform to both the temperature and flame ratings of ASTM E814, and other requirements of authorities having jurisdiction.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated.

1. Product Schedule: For each penetration and joint firestopping system. Include location and design designation of qualified testing and inspecting agency.

2. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular firestopping condition, submit illustration, with modifications marked, approved by firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

C. Qualification Data: For qualified Installer

D. Installer Certificates: From Installer indicating firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for firestopping.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

C. Installer Qualifications: A firm experienced in installing firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

D. Fire-Test-Response Characteristics: Firestopping shall comply with the following requirements:

1. Firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.

2. Firestopping is identical to those tested per testing standard referenced. Provide rated systems complying with the following requirements:

a. Firestopping products bear classification marking of qualified testing and inspecting agency.

b. Classification markings on firestopping correspond to designations listed by the following:

(1) UL in its "Fire Resistance Directory."

(2) Intertek ETL SEMKO in its "Directory of Listed Building Products."

(3) FM Global in its "Building Materials Approval Guide."

E. Preinstallation Conference: Conduct conference at Project site.

F. Regulatory Requirements: Be responsible for securing approval from authority having jurisdiction where project conditions require modification to tested and listed systems.

1. Submit authority having jurisdiction approval for modified systems.

1.06 PERFORMANCE CRITERIA:

A. Ratings according ASTM E814, "Fire Tests of Through Penetration Fire Stops" are

1. F-rating, Flame Ratings:

a. The F-rating is expressed in hours and the number indicates the specific length of time that a barrier can withstand fire before being consumed or before permitting the passage of flame through the opening.

b. A F-rated opening shall also withstand a hose stream test.

2. T-rating, Thermal Ratings:

a. The T-rating is expressed in hours and the number indicates the length of time that the temperature on the non-fire side of the penetration does not exceed 325 degrees F above the ambient temperature. This ensures that the temperature on the side of the wall away from the flame does not reach the flash point of any materials on that side of the wall.

3. L-rating, Smoke Ratings:

a. The L-rating is the amount of air (or cold smoke) that can leak through a penetration and the number indicates the amount of air in cubic feet per minute.

b. L-rating is tested under a differential pressure of 0.30 inches water column at 75 degrees F and at 400 degrees F.

4. A W-rating may also be established for a through-penetration firestop system. The W-rating is based on the water resistance of the test sample.

1.07 PROJECT/SITE CONDITIONS:

A. Environmental Limitations: Do not install firestopping when ambient or substrate temperatures are outside the limits permitted by firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.08 COORDINATION:

A. Coordinate construction of joints, openings and penetrating items to ensure that firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate firestopping.

C. Notify Owner's testing agency at least seven days in advance of firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Grace Construction Products

B. 3M Fire Protection Products

C. Tremco, Inc.; Tremco Fire Protection Systems Group

2.02 FIRESTOPPING:

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. Fire-resistance-rated walls include fire walls fire-barrier walls smoke-barrier walls and fire partitions.

2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. Horizontal assemblies include floors floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.

2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.

3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.

E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L

2. Sealant Primers for Nonporous Substrates: 250 g/L

3. Sealant Primers for Porous Substrates: 775 g/L

H. Accessories: Provide components for each firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:

a. Slag-wool-fiber or rock-wool-fiber insulation

b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.

c. Fire-rated form board

d. Fillers for sealants

2. Temporary forming materials

3. Substrate primers

4. Collars

5. Steel sleeves

2.03 FILL MATERIALS:

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Preformed, Pre-Compressed, Self-Expanding, Fire Rated Sealant System with Tensionless Silicone Pre-Coated Surface, Watertight, 1 Hour UL2079 Rated, 100 percent movement, for Vertical Expansion Joints for Interior and Exterior Walls

J. Silicone Foams: Multi-component, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

K. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and non-sag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of non-sag grade for both opening conditions.

2.04 MIXING:

A. For those products requiring mixing before application, comply with firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Surface Cleaning: Clean out openings immediately before installing firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of joints and opening substrates and from penetrating items foreign materials that could interfere with adhesion of firestopping.

2. Clean joints, opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.03 INSTALLATION:

A. General: Install firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION:

A. Identify firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Firestopping - Do Not Disturb. Notify Building Management of Any Damage."

2. Contractor's name, address, and phone number

3. Designation of applicable testing and inspecting agency

4. Date of installation

5. Manufacturer's name

6. Installer's name

3.05 FIELD QUALITY CONTROL:

A. Owner may engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or firestopping is damaged or removed because of testing, repair or replace firestopping to comply with requirements.

C. Proceed with enclosing firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.06 CLEANING AND PROTECTION:

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated firestopping and install new materials to produce systems complying with specified requirements.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide joint sealants as indicated and in compliance with Contract Documents.

1. Section Includes:

a. Silicone joint sealants

b. Urethane joint sealants

c. Polysulfide joint sealants

d. Solvent-release-curing joint sealants

1.02 REFERENCES:

A. ASTM International (ASTM):

1. C834: Standard Specification for Latex Sealing Compounds

2. C919: Standard Practice for Use of Sealants in Acoustical Applications

3. C920: Standard Specification for Elastomeric Joint Sealants

4. C1021: Standard Practice for Laboratories Engaged in Testing of Building Sealants

5. C1087: Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems

6. C1193: Standard Guide for Use of Joint Sealants

7. C1247: Standard Test Method for Durability of Sealants Exposed to Continuous Immersion in Liquids

8. C1248: Standard Test Method for Staining of Porous Substrate by Joint Sealants

9. C1311: Standard Specification for Solvent Release Sealants

10. C1330: Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid- Applied Sealants

11. C1521: Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints

12. E90: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

B. California Department of Public Health (CDPH):

1. Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each joint-sealant product indicated

C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

D. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

E. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation

2. Joint-sealant manufacturer and product name

3. Joint-sealant formulation

4. Joint-sealant color

F. Product Certificates: For each kind of joint sealant and accessory, from manufacturer

G. Field-Adhesion Test Reports: For each sealant application tested

H. Warranties: Sample of special warranties

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

C. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

D. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

E. Preinstallation Conference: Conduct conference at Project site.

1.05 PROJECT CONDITIONS:

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.

2. When joint substrates are wet.

3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.06 WARRANTY:

A. Comply with general requirements specified in Section 01 78 36.

B. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

C. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

D. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.

2. Disintegration of joint substrates from natural causes exceeding design specifications.

3. Mechanical damage caused by individuals, tools, or other outside agents.

4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL:

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L

2. Sealant Primers for Nonporous Substrates: 250 g/L

3. Sealant Primers for Porous Substrates: 775 g/L

C. Liquid-Applied Joint Sealants: Comply with ASTM C920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C920 classifications for type, grade, class, and uses related to exposure and joint substrates.

D. Low-Emitting Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Liquid-Applied Joint Sealants: Comply with ASTM C920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

F. Stain-Test-Response Characteristics: Where sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C1248 and have not stained porous joint substrates indicated for Project.

G. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

H. Colors of Exposed Joint Sealants: As selected by Engineer from manufacturer's full range.

2.02 SILICONE JOINT SEALANTS:

A. Manufacturers:

1. Pecora Corporation

2. Sika Corporation, Construction Products Division

3. Tremco Incorporated

2.03 URETHANE JOINT SEALANTS:

A. Manufacturers:

1. Sika Corporation, Construction Products Division

2. Tremco Incorporated

3. Pecora Corporation

2.04 POLYSULFIDE JOINT SEALANTS:

A. Manufacturers:

1. W. R. Meadows, Inc.

2. Pecora Corporation

3. BASF Building Systems

2.05 SOLVENT-RELEASE-CURING JOINT SEALANTS:

A. Manufacturers:

1. Tremco Incorporated

2.06 PREFORMED JOINT SEALANTS:

A. Preformed Foam Joint Sealant: Manufacturer's silicone pre-coated, preformed, pre-compressed, self-expanding, sealant system. Expanding foam to be cellular foam

impregnated with a water-based, non-drying, 100 percent acrylic dispersion. Seal shall combine factory-applied, low-modulus silicone and a backing of acrylic-impregnated expanding foam into a unified hybrid sealant system. Material shall be capable of movements of +50 percent, -50 percent (100 percent total) of nominal material size.

B. Factory produce in pre-compressed sizes in stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.

1. Products:

a. EMSEAL Joint Systems, Ltd.; Colorseal/Seismic

b. Dayton Superior Specialty Chemicals

c. Sandell Manufacturing Co., Inc.

2.07 JOINT SEALANT BACKING:

A. General: Provide sealant backings of material that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) Type O (open-cell material) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.08 MISCELLANEOUS MATERIALS:

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Non-porous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

a. Concrete

b. Masonry

3. form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

a. Metal

b. Glass

c. Glazed surfaces of ceramic tile

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALANTS:

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.

2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.

2. Completely fill recesses in each joint configuration.

3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.

2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Provide concave joint profile per Figure 8A in ASTM C1193, unless otherwise indicated.

4. Provide flush joint profile where indicated per Figure 8B in ASTM C1193.

5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

G. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written recommendations.

3.04 FIELD QUALITY CONTROL:

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

    a. Perform 1 test for each 1,000 feet of joint length thereafter or 1 test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

    a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

    a. Whether sealants filled joint cavities and are free of voids.

    b. Whether sealant dimensions and configurations comply with specified requirements.

    c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether

joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.

5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.05 CLEANING:

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.06 PROTECTION:

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

3.08 JOINT-SEALANT SCHEDULE:

A. General: The Joint Sealant Schedule indicates the design intent as required by the Construction Documents for joint substrates, conditions, and materials. The final approval for the joint sealant systems to be used on all project conditions shall be accomplished through the Engineer's approval of the Joint-Sealant Schedule submitted by the Contractor as required by Article 1.7.G of this section. The submittal shall indicate application, joint location, designation, joint sealant

1. Manufacturer and product name and joint sealant formulation for all conditions required to execute the design intent as required by the Construction Documents.

B. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Locations: Expansion joint between concrete slab-on-grade and building walls or other elements.

2. Urethane Joint Sealant: Multicomponent, self-leveling, traffic grade, Class 25.

3. Joint-Sealant Color: As selected by the Engineer from the manufacturer's full range of colors.

C. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:

a. Perimeter of exterior openings where aluminum window and door frames meet adjacent building materials.

2. Silicone Joint Sealant: Single-component, non-sag, neutral-curing, Class 50.

3. Joint-Sealant Color: As selected by the Engineer from the manufacturer's full range of colors.

D. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:

a. Joints between Precast architectural concrete panels.

b. Joints between different materials listed above.

c. Perimeter joints between materials listed above and frames of doors, windows, and louvers.

d. Other joints as indicated.

2. Urethane Joint Sealant: Multi-component, non-sag, Class 50.

3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.

E. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:

a. Floor control and expansion joints. (Except at chemical storage areas or areas with the possibility of being exposed to chemicals from adjacent chemical areas or rooms.

b. Horizontal joints between dissimilar materials.

2. Urethane Joint Sealant: Multi-component, self-leveling, traffic grade, Class 25.

3. Joint-Sealant Color: As selected by Engineer.

F. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:

a. Wall control and expansion joints on exposed interior surfaces of exterior walls.

b. Perimeter joints of exterior door and window opening frames where indicated.

c. Vertical joints on exposed surfaces of interior unit masonry and precast concrete walls.

d. Joints on underside of precast structural concrete tees, beams and planks.

e. Perimeter joints between interior wall surfaces and frames of interior doors and windows.

f. Other joints as indicated.

2. Urethane Joint Sealant: Multi-component, non-sag, Class 50, non-traffic.

3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.

G. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

a. Seal interior perimeters of exterior aluminum openings as shown on the Drawings.

2. Silicone Joint Sealant: single component, non-sag, neutral curing, Class 50.

3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.

H. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Sealant Location:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.

2. Silicone Joint Sealant: Single component, non-sag, mildew resistant, acid curing, Class 25.

3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.

I. Joint-Sealant Application: Interior joints in vertical surfaces and overhead horizontal non-traffic surfaces.

1. Joint Location:

a. Field-painted joints not otherwise indicated.

2. Joint Sealant: Acrylic latex or siliconized acrylic latex, Type OP, Grade NF.

3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range.

J. Joint-Sealant Application: Interior joints in horizontal surfaces at chemical storage areas and areas subject to exposure to chemicals from adjacent chemical areas or rooms.

1. Joint Location:

a. Expansion joint between concrete slab-on-grade and building walls or other elements.

2. Polysulfide Joint Sealant: Multi-component, non-sag, Class 25.

3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range.

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DIVISION 08

OPENINGS

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SECTION 08 11 00

METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide doors, frames, vision panels, sidelights and accessories as indicated and in compliance with Contract Documents.

1. Section Includes:

a. Custom hollow metal doors and frames

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

2. A591: Standard Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight (Mass) Applications.

3. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

4. A1008: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

5. A1011: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

6. C143: Standard Test Method for Slump of Hydraulic-Cement Concrete.

7. C665: Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

8. C1363: Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus

9. E136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degree C.

B. Door And Hardware Institute (DHI):

1. A115: Guide Specifications for Commercial Hollow Metal Doors & Frames

2. A115.1G: Installation Guide for Doors and Hardware

C. Hollow Metal Manufacturers Association (HMMA):

1. 840: Installation and Storage of Hollow Metal Doors and Frames.

2. 861: Guide Specifications for Commercial Hollow Metal Doors and Frames.

D. National Fire Protection Association (NFPA):

1. 80: Standard for Fire Doors and Other Opening Protectives

2. 105: Standard for Smoke Door Assemblies and Other Opening Protectives

3. 252: Standard Methods of Fire Tests of Door Assemblies

4. 257: Standard on Fire Test for Window and Glass Block Assemblies

E. Steel Door Institute (SDI):

1. 111e: Recommended Selection and Usage Guide for Standard Steel Doors, Frames and Accessories

2. 117: Manufacturing Tolerances Standard Steel Doors and Frames

3. A250.3: Test Procedure and Acceptance Criteria for Factory Applied Finish Painted Steel Surfaces for Steel Doors and Frames.

4. A250.4: Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcing

5. A250.6: Hardware on Standard Steel Doors (Reinforcement & Application)

6. A250.8: Recommended Specifications for Standard Steel Doors and Frames

7. A250.10: Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames

8. A250.11: Recommended Erection Instructions for Steel Frames.

F. Uniform Building Code (UBC):

1. Standard 7-2: Fire Test of Door Assemblies

2. Standard 7-4: Fire Tests of Window Assemblies

G. Underwriters' Laboratories, Inc. (UL):

1. 9: Standard for Safety Fire Tests of Window Assemblies.

2. 10B: UL Standard for Safety Fire Tests of Door Assemblies - Tenth Edition; Reprint with Revisions through and Including April 13, 2009

3. 10C: Standard for Safety Positive Pressure Fire Tests of Door Assemblies.

4. 1784: Standard for Safety Air Leakage Tests of Door Assemblies.

1.03 DEFINITIONS:

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/ NAAMM-HMMA 861.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.

1. Elevations of each door design.

2. Details of doors, including vertical and horizontal edge details and metal thicknesses.

3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

4. Locations of reinforcement and preparations for hardware.

5. Details of each different wall opening condition.

6. Details of anchorages, joints, field splices, and connections.

7. Details of accessories.

8. Details of moldings, removable stops, and glazing.

9. Details of conduit and preparations for power, signal, and control systems.

10. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL 10C.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Before delivery, identify type and size of each door with markings that will not damage finish.

C. Preassemble frames and door mullions in shop and deliver to project site with spreader bar at sill, or tie in pairs to form box.

D. Store all doors and frames in a weathertight enclosure and do not expose to the elements.

E. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

F. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

G. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.07 PROJECT CONDITIONS:

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.08 COORDINATION:

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts,

anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 PREPARATION:

A. Verify details; obtain copy of accepted hardware schedule templates and other information.

B. Verify size, design and fire-resistive rating of each opening.

C. Coordinate details of construction with other work supporting or adjoining frames and doors.

2.02 MANUFACTURERS:

A. Manufacturers:

1. Southwestern Hollow Metal

2. Stiles Custom Metal

3. West Central Manufacturing

2.03 MATERIALS:

A. Cold-Rolled Steel Sheet: ASTM A1008, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

D. Frame Anchors: ASTM A591, Commercial Steel (CS), 40Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008 or ASTM A1011, hot-dip galvanized according to ASTM A153, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153.

F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Grout: ASTM C476, except with a maximum slump of 4 inches, as measured according to ASTM C143.

H. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

I. Glazing: Comply with requirements in Section 08 81 00.

J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.04 CUSTOM HOLLOW METAL DOORS:

A. General: Provide doors not less than 1-3/4 inches thick, of seamless hollow construction unless otherwise indicated. Construct doors with smooth surfaces without visible joints or seams on exposed faces. Comply with ANSI/NAAMM-HMMA 861.

B. Exterior Door Face Sheets: Fabricated from metallic-coated steel sheet, minimum 0.053 inch thick.

C. Interior Door Face Sheets: Fabricated from metallic-coated steel sheet, minimum 0.053 inch thick.

D. Core Construction: Provide thermal-resistance-rated cores for exterior doors and interior doors where indicated.

1. Steel-Stiffened Core: 0.026-inch-thick, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart, spot welded to face sheets a maximum of 5 inches o.c. Spaces filled between stiffeners with glass- or mineral-fiber insulation.

a. Fire Door Core: As required to provide fire-protection ratings indicated.

b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 degrees F x h x sq. ft./Btu when tested according to ASTM C1363.

E. Vertical Edges for Single-Acting Doors: Beveled 1/8 inch in 2 inches.

F. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.

G. Top and Bottom Channels: Closed with continuous channels, minimum 0.053 inch thick, of same material as face sheets and spot welded to both face sheets.

H. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as door face sheets.

2.05 CUSTOM HOLLOW METAL FRAMES:

A. General: Fabricate frames of construction indicated. Close contact edges of corner joints tight with faces mitered and stops butted or mitered. Continuously weld faces and soffits and finish faces smooth. Comply with ANSI/NAAMM-HMMA 861.

1. Door Frames for Openings 48 Inches Wide or Less: Fabricated from 0.053-inch-thick steel sheet.

2. Door Frames for Openings More Than 48 Inches Wide: Fabricated from 0.067-inch-thick steel sheet.

3. Transom Frames: Fabricated from same thickness material as adjacent door frame.

4. Borrowed-Light Frames: Fabricated from 0.053-inch-thick steel sheet.

B. Exterior Frames: Formed from metallic-coated steel sheet.

C. Interior Frames: Formed from metallic-coated steel sheet.

D. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as frame.

E. Head Reinforcement: Provide minimum 0.093-inch-thick, steel channel or angle stiffener for opening widths more than 48 inches.

2.06 FRAME ANCHORS:

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.

2. Stud Wall Type: Designed to engage stud, weld back of frames; not less than 0.042 inch thick.

3. Post-installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.07 HOLLOW METAL PANELS:

A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

2.08 STOPS AND MOLDINGS:

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.09 LOUVERS:

A. Provide louvers for interior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of 0.020 inch thick cold rolled steel sheet set into 0.032 inch thick steel frame.

1. Sight proof louver: Stationary louvers constructed with inverted V shaped or Y shaped blades.

2.10 ACCESSORIES:

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch-wide steel.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.11 FABRICATION:

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper

assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/NAAMM-HMMA 861.

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

2. Glazed Lites: Factory cut openings in doors.

3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4-inch beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

2. Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.

6. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

(1) Three anchors per jamb up to 60 inches high.

(2) Four anchors per jamb from 60 inches to 90 inches high.

(3) Five anchors per jamb from 90 to 96 inches high.

(4) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions

b. Post-installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

7. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Section 08 71 00.

1. Locate hardware as indicated, or if not indicated, according to ANSI/NAAMM-HMMA 861.

2. Reinforce doors and frames to receive non-templated, mortised and surface-mounted door hardware.

3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.

4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.

2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite are capable of being removed independently.

3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

4. Provide loose stops and moldings on inside of hollow metal work.

5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.12 STEEL FINISHES:

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

2. Alignment: plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

3. Twist: plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

4. Plumbness: plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.03 INSTALLATION:

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with HMMA 840.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a. At fire-protection-rated openings, install frames according to NFPA 80.

b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at accepted locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.

c. Install frames with removable glazing stops located on secure side of opening.

d. Install door silencers in frames before grouting.

e. Remove temporary braces necessary for installation only after frames have been properly set and secured.

f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

g. Field apply bituminous coating to backs of frames that are filled with grout containing anti-freezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

a. Floor anchors may be set with powder-actuated fasteners instead of post-installed expansion anchors if so indicated and accepted on Shop Drawings.

3. Metal stud partitions: Solidly pack mineral fiber insulation behind frame.

4. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

5. In-Place Concrete Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

6. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

   a. Squareness: plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

   b. Alignment: plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

   c. Twist: plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

   d. Plumbness: plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

   a. Jambs and Head: 1/8 inch, plus or minus 1/16 inch.

   b. Between Edges of Pairs of Doors: 1/8 inch, plus or minus 1/16 inch.

   c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.

   d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Glazing: Comply with installation requirements in Section 08 81 00 and with hollow metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.04 ADJUSTING AND CLEANING:

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

3.05 PROTECTION:

A. After erection, protect doors, frames, vision panels and finishing hardware from damage due to installation of other work or from lime, acid, cement, or other harmful compounds.

B. After erection, protect doors, frames and finishing hardware from damage due to installation of other work or from lime, acid, cement, or other harmful compounds.

C. Replace damaged doors, frames and finishing hardware as determined by the Engineer with new items and at no additional expense to the Owner.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 08 41 13

ALUMINUM FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide exterior entrances and aluminum window systems and accessories as indicated and in compliance with Contract Documents.

1. Section Includes:

a. Storefront systems for punched openings

b. Entrance doors and storefront systems

1.02 REFERENCES:

A. Aluminum Association (AA):

1. M12C22A31: Mechanical Finish

2. M12C22A31/A34: Mechanical Finish

3. M12C22A32/A34: Mechanical Finish

4. M12C22A41: Anodized Plus Finish

5. M12C22A42/A44: Mechanical Finish

B. American Architectural Manufacturers Association (AAMA):

1. 501.1: Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure

2. 501.2: Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems

3. 501.4: Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts

4. 501.5: Test Method for Thermal Cycling of Exterior Walls

5. 506: Voluntary Specifications for Impact and Cycle Testing of Fenestration Products

6. 611: Voluntary Specification for Anodized Architectural Aluminum

7. 701: Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals

8. 1503: Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

9. 2603: Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

10. 2604: Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

11. 2605: Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

12. TIR-A11: Maximum Allowable Deflection of Framing Systems for Building Cladding Components at Design Wind Loads

C. Americans with Disabilities Act (ADA):

1. ADA-ABA Accessibility Guidelines.

D. American National Standards Institute (ANSI):

1. A117.1: Accessible and Usable Buildings and Facilities.

E. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

3. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

4. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

5. A1008: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

6. A1011: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

7. B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

8. B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

9. B308: Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles

10. B429: Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

11. C920: Standard Specification for Elastomeric Joint Sealants.

12. C1184: Standard Specification for Structural Silicone Sealants

13. C1401: Standard Guide for Structural Sealant Glazing

14. D2000: Standard Classification System for Rubber Products in Automotive Applications.

15. D2287: Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.

16. E90: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

17. E283: Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

18. E330: Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

19. E331: Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

20. E413: Classification for Rating Sound Insulation

21. E699: Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components

22. E783: Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors

23. E1105: Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference

24. E1332: Standard Classification for Determination of Outdoor-Indoor Transmission Class

25. E1886: Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials

26. E1996: Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

F. American Welding Society (AWS):

1. A5.10: Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods

2. D1.2: Structural Welding Code - Aluminum

G. International Building Code (IBC):

1. 2003: International Building Code

H. National Glass Association (with GANA):

1. Glazing Manual

I. National Fire Protection Association (NFPA):

1. 101: Life Safety Code

J. The Society for Protective Coatings (SSPC):

1. Guide 12: Guide for Illumination of Industrial Painting Projects

2. Paint 12: Cold-Applied Asphalt Mastic (Extra Thick Film)

3. SP COM: Surface Preparation Commentary for Steel and Concrete Substrates

K. Underwriters' Laboratories, Inc. (UL).

1. 305: Safety Panic Hardware

1.03 PERFORMANCE REQUIREMENTS:

A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:

1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.

2. Dimensional tolerances of building frame and other adjacent construction.

3. Failure includes the following:

a. Deflection exceeding specified limits.

b. Thermal stresses transferring to building structure.

c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.

d. Glazing-to-glazing contact.

e. Noise or vibration created by wind and by thermal and structural movements.

f. Loosening or weakening of fasteners, attachments, and other components.

g. Sealant failure.

B. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Loads:

1. Seismic Loads: As indicated on Structural Drawings

2. Wind Loads: As indicated on Structural Drawings

D. Deflection of Framing Members:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed L/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4-inch, whichever is less.

2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components directly below them to less than 1/8-inch and clearance between members and operable units directly below them to less than 1/16-inch.

E. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E330 as follows:

1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.

2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.

3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.

F. Windborne-Debris-Impact-Resistance Performance: Provide aluminum-framed systems that pass missile-impact and cyclic-pressure tests when tested according to ASTM E1886 and testing information in ASTM E1996.

1. Large-Missile Impact: For aluminum-framed systems located within 30 feet of grade.

2. Small-Missile Impact: For aluminum-framed systems located more than 30 feet above grade.

G. Story Drift: Provide aluminum-framed systems that accommodate design displacement of adjacent stories indicated.

1. Test Performance: Meet criteria for passing, based on building occupancy type, when tested according to AAMA 501.4 at design displacement and 1.5 times design displacement.

H. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft.

I. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.

J. Water Penetration under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.

1. Maximum Water Leakage: No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior and water that cannot damage adjacent materials or finishes.

K. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.

2. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 degrees F

b. Low Exterior Ambient-Air Temperature: 0 degrees F

3. Interior Ambient-Air Temperature: 75 degrees F

L. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 51 when tested according to AAMA 1503.

M. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.36 Btu/sq. ft. x h x degrees F when tested according to AAMA 1503.

N. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by aluminum-framed systems without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.

2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

O. Structural-Sealant Joints: Designed to produce tensile or shear stress of less than 20 psi.

1.04 SUSTAINABLE DESIGN:

A. Comply with requirements specified in Section 01 81 13.01.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.

1. Product Data for Credit IEQ 4.1: For adhesives and sealants used inside of the weatherproofing system, documentation including printed statement of VOC content.

C. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.

1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.

D. Fabrication Sample: Of each vertical-to-horizontal intersection of aluminum-framed systems, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds

2. Anchorage

3. Expansion provisions

4. Glazing

5. Flashing and drainage

E. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of aluminum-framed systems.

2. Include design calculations.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems, indicating compliance with performance requirements.

G. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

H. Warranties: Sample of special warranties.

I. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

C. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not revise intended aesthetic effects, as judged solely by Engineer, except with Engineer’s acceptance. If revisions are proposed, submit comprehensive explanatory data to Engineer for review.

D. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.

E. Preinstallation Conference: Conduct conference at Project site.

1. Convene minimum one week prior to commencing Work of this section.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Handle Products of this section in accordance with AAMA MCWM-1 - Curtain Wall Manual #10.

C. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.

1.08 PROJECT/SITE CONDITIONS:

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

B. Environmental Conditions: Do not install sealants nor glazing materials when ambient temperature is less than 40 degrees F during and 48 hours after installation.

1.09 WARRANTY:

A. Comply with general requirements specified in Section 01 78 36.

B. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.

b. Noise or vibration caused by thermal movements.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

d. Adhesive or cohesive sealant failures.

e. Water leakage through fixed glazing and framing areas.

2. Warranty Period: 10 years from date of Substantial Completion.

C. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Aluminum-framed storefront system includes tubular aluminum sections, shop fabricated, factory finished, glass and glazing, insulated metal panel infill, related flashings, anchorage and attachment devices.

B. System Assembly: Shop unitized assembly

2.02 MANUFACTURERS:

A. Aluminum Entrances and Storefronts:

1. EFCO Corporation; X-Therm Series 403X

2. Kawneer North America; an Alcoa Company; Trifab 451 UT

3. United States Aluminum; Series 45X

B. Aluminum Infill Panels

1. Mapes Industries, Inc.; Mapes-R panel

2. NUDO; Endure 525

3. Laminators Inc.; Omega Foam-Ply

2.03 MATERIALS:

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B209

2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221

3. Extruded Structural Pipe and Tubes: ASTM B429

4. Structural Profiles: ASTM B308

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

1. Structural Shapes, Plates, and Bars: ASTM A36

2. Cold-Rolled Sheet and Strip: ASTM A1008

3. Hot-Rolled Sheet and Strip: ASTM A1011

2.04 FRAMING SYSTEMS:

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: Thermally broken

2. Glazing System: Retained mechanically with gaskets on four sides

3. Glazing Plane: Center

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, non-ferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.

2. Reinforce members as required to receive fastener threads.

3. Provide concealed fasteners except where unavoidable use exposed fasteners with countersunk Phillips screw heads, finished to match framing system

D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A123 or ASTM A153.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, non-staining, nonbleeding flashing and end dams compatible with adjacent materials.

F. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.

2.05 ENTRANCE DOOR SYSTEMS

A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.

1. Door Construction: 2-inch overall thickness, with 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated, and fillet welded or that incorporate concealed tie rods.

a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.

2. Door Design: 5-inch nominal width stiles *and 10-inch bottom rail*.

3. Glazing Stops and Gaskets: snap-on, extruded-aluminum stops and preformed gaskets.

a. Provide nonremovable glazing stops on outside of door.

4. Finish: Match adjacent storefront framing finish.

2.06 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 71 00.

B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule on drawings.

C. Continuous-Gear Hinges: BHMA A156.26.

D. Weather Stripping: Manufacturer's standard replaceable components.

1. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.

2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

E. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

F. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.

2.07 GLAZING SYSTEMS:

A. Glazing: As specified in Section 08 81 00.

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

1. Weatherseal Sealant: ASTM C920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; single-component neutral-curing formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and aluminum-framed-system manufacturers for this use.

2.08 ACCESSORY MATERIALS:

A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Section 07 92 00.

B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

2.09 FABRICATION:

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.

2. Accurately fitted joints with ends coped or mitered.

3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.

4. Physical and thermal isolation of glazing from framing members.

5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.

6. Provisions for field replacement of glazing from interior.

7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

2.10 ALUMINUM FINISHES:

A. Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify dimensions and method of attachment with other work.

C. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this Section.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. General:

1. Comply with manufacturer's written instructions.

2. Do not install damaged components.

3. Fit joints to produce hairline joints free of burrs and distortion.

4. Rigidly secure non-movement joints.

5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.

6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.

2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Section 07 92 00 to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Section 08 81 00.

3.03 ERECTION TOLERANCES:

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:

1. Location and Plane: Limit variation from true location and plane to 1/8-inch in 12 feet; 1/4-inch over total length.

2. Alignment:

a. Where surfaces abut in line, limit offset from true alignment to 1/16-inch.

b. Where surfaces meet at corners, limit offset from true alignment to 1/32-inch.

B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8-inch.

3.04 CLEANING:

A. Perform cleaning in accordance with Section 01 74 23.

B. Remove protective material from pre-finished aluminum surfaces.

C. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

D. Remove excess sealant by method acceptable to sealant manufacturer.

3.05 PROTECTION OF INSTALLED CONSTRUCTION:

A. Protect installed aluminum entrances in accordance with Section 01 74 23.

B. Protect finished Work from damage.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 08 63 00

METAL-FRAMED SKYLIGHTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide metal-framed skylights as indicated and in compliance with Contract Documents.

1. Section includes skylights with metal framing.

1.02 REFERENCES:

A. Aluminum Association (AA):

1. M12C22A31: Mechanical Finish

2. M12C22A32/A34: Mechanical Finish

3. M12C22A41: Anodized Plus Finish

4. M12C22A42/A44: Mechanical Finish

B. American Architectural Manufacturers Association (AAMA):

1. 501.1: Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure

2. 501.2: Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems

3. 611: Voluntary Specification for Anodized Architectural Aluminum

4. 1503: Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

5. 2603: Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

6. 2604: Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

7. 2605: Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

8. SDGS-1: Structural Design Guidelines for Aluminum Framed Skylights.

9. TIR-A11: Maximum Allowable Deflection of Framing Systems for Building Cladding Components at Design Wind Loads

C. ASTM International (ASTM):

1. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

3. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications

4. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

5. A307: Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

6. B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

7. B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

8. B308: Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles

9. B429: Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

10. C920: Standard Specification for Elastomeric Joint Sealants.

11. C1184: Standard Specification for Structural Silicone Sealants

12. C1401: Standard Guide for Structural Sealant Glazing

13. E283: Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

14. E330: Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

15. E331: Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

16. E699: Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components

17. E1105: Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference

18. E1886: Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials

19. E1996: Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

20. F568M: Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.

D. American Welding Society (AWS):

1. A5.10: Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods

2. D1.2: Structural Welding Code - Aluminum

E. Federal Regulations:

1. 40 CFR 59, Subpart D: National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

F. Glass Association of North America (GANA): Glazing Manual.

G. Leadership in Energy and Environmental Design (LEED):

1. CI: Commercial Interiors

2. CS: Core & Shell

3. NC: New Construction

H. National Fenestration Rating Council (NFRC):

1. 100: Procedure for Determining Fenestration Product U-factors

2. 200: Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal-framed skylights.

C. Shop Drawings: For metal-framed skylights. Include plans, elevations, sections, details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.

2. Include full-size isometric details of each vertical-to-horizontal intersection of assembly, showing the following:

a. Joinery including concealed welds.

b. Anchorage.

c. Expansion provisions.

d. Glazing.

e. Flashing and drainage.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Delegated-Design Submittal: For metal-framed skylights and fall protection mesh indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

G. Qualification Data: For qualified Installer.

H. Welding certificates.

I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for metal-framed skylights.

J. Field quality-control reports.

K. Warranties: Sample of special warranties.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: An experienced installer who has specialized in installing metal-framed skylights similar to those indicated for this Project and who is acceptable to manufacturer.

C. Professional Engineer Qualifications: A professional engineer who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of skylights that are similar to those indicated for this Project in material, design, and extent.

D. Product Options: Information on Drawings and in Specifications establishes requirements for skylights' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including testing conducted by an independent testing agency and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Engineer, except with Engineer's approval. If modifications are proposed, submit comprehensive explanatory data to Engineer for review.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum

F. Provide metal-framed skylights that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies.

G. Preinstallation Conference: Conduct conference at Project site.

1.05 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.06 WARRANTY:

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-framed skylights that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.

b. Noise or vibration caused by thermal movements.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

d. Water leakage. Water leakage; defined as uncontrolled water appearing on normally exposed interior surfaces of skylights from sources other than condensation, resulting from defects in skylight materials or workmanship. Water leakage resulting from improper installations not part of this warranty.

B. System Warranty Period: Five years from date of Substantial Completion.

C. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.

1. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.

D. Plastic Warranty: Provide written warranty signed by manufacturer agreeing to repair or replace work that has or develops defects in the plastic. "Defects" is defined as abnormal aging or deterioration.

1. Warranty Period for polycarbonate: 10 years from date of Substantial Completion.

E. Finish Warranty: Provide written warranty signed by manufacturer agreeing to repair or replace work with finish defects. "Defects" is defined as peeling, chipping, chalking, fading, abnormal aging or deterioration, and failure to perform as required.

1. Warranty Period for Kynar 500 Finish: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 Manufacturers:

A. Manufacturers:

1. Basis of design: Wasco Products, Inc. – Pinnacle 350

2. Bristolite Skylights.

3. Kawneer North America; an Alcoa company.

2.02 PERFORMANCE REQUIREMENTS:

A. General: Metal-framed skylights shall withstand the effects of the following without failure due to defective manufacture, fabrication, installation, or other defects in construction:

1. Structural loads.

2. Thermal movements.

3. Movements of supporting structure.

4. Dimensional tolerances of support system and other adjacent construction.

5. Failure includes, but is not limited to, the following:

a. Deflection exceeding specified limits.

b. Thermal stresses transferring to building structure.

c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.

d. Noise or vibration created by wind and by thermal and structural movements.

e. Loosening or weakening of fasteners, attachments, and other components.

f. Sealant failure.

B. Delegated Design: Design metal-framed skylights and fall protection mesh, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Loads:

1. Wind Loads: See Section 01 41 20 Seismic and Wind Requirements

2. Seismic Loads: See Section 01 41 20 Seismic and Wind Requirements

3. Concentrated Load: 250 lbs applied to framing members at location that produces the most severe stress or deflection.

4. Snow Loads: As required by codes in force

D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Glazing Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each

individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4-inch, whichever is less.

2. Deflection Parallel to Glazing Plane: Limited to /360 of clear span or 1/8-inch, whichever is smaller

E. Lateral Bracing of Framing Members: Compression flanges of flexural members are laterally braced by cross members with minimum depth equal to 50 percent of flexural member that is braced. Glazing does not provide lateral support.

F. Structural-Test Performance: Provide metal-framed skylights tested according to ASTM E330, as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.

2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.

3. Test Durations: As required by design wind velocity, but not less than 10seconds.

G. Air Infiltration: Provide metal-framed skylights with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft.

H. Water Penetration under Static Pressure: Provide metal-framed skylights that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft

I. Water Penetration under Dynamic Pressure: Provide metal-framed skylights that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.

1. Maximum Water Leakage: No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation.

J. Thermal Movements: Provide metal-framed skylights that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 100 degrees F , ambient; 180 degrees F, material surfaces.

K. Condensation Resistance: Provide metal-framed skylights with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 88 when tested according to NFRC 500.

L. Energy Performance: Provide metal-framed skylights with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below and certified and labeled according to NFRC:

1. Thermal Transmittance (U-Factor): Fixed glazing and framing areas shall have U-factor of not more than 0.180 Btu/sq. ft. x h x degrees F as determined according to NFRC 100.

2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than .49 as determined according to NFRC 200.

2.03 FRAMING SYSTEMS:

A. Framing Members: Extruded aluminum alloy 6063-T5 or T6, ASTM B221 with minimum effective thickness of 0.109 inches.

B. Exterior Pressure Caps: Extruded aluminum alloy 6063-T5 or T6, ASTM B221 with minimum effective thickness of 0.090 inches.

C. Concealed Flashing: Manufacturer’s standard corrosion-resistant, non-staining, non-bleeding flashing; compatible with adjacent materials.

D. Exposed Flashing and Closures: Aluminum sheet alloy and temper of 1100-H14, thickness as require for proper performance.

1. Minimum Thickness: 0.032 inch Apron Flashing.

2. Minimum Thickness: 0.062 inch Closures.

E. Fasteners and Accessories: Manufacturer’s standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories; compatible with adjacent materials.

1. Aluminum Retaining Cap Fasteners and Framing Members Fasteners: ASTM A193, Series 300 stainless-steel screws; type as recommended by manufacturer.

2. Connections to Supporting Structure: Series 300 Stainless Steel or ASTM A307, hot dipped galvanized steel fasteners by installer.

F. Framing-System Sealants: Single-component, non-sag, high performance, non-priming, gun-grade elastomeric polyurethane sealant furnished by skylight manufacturer.

1. Sealant complies with ASTM C920, Type S, Grade NS, Class 25, Use T, NT, M, A, G, and O. Canadian Specification CAN/CGSB-19.13-M87, Classification MCG-2-25-A-N.

2. Sealant conforms to USDA approval standards.

G. Bituminous Paint: Cold-applied asphalt mastic paint complying with SSPC-Paint 12, except containing no asbestos, and formulated for 30-mil thickness per coat.

2.04 GLAZING:

A. Multiwall Polycarbonate: 25MM multiwall polycarbonate panels

1. Clear/Crystal with Lumira Aerogel.

a. No fiberglass allowed.

B. Glazing Gaskets: Manufacturer's proprietary pressure-glazing gaskets of elastomer type and hardness selected by the skylight manufacturer to comply with requirements. Glazing gaskets to be extruded thermoplastic elastomer by the skylight manufacturer.

C. Spacers, Edge Blocks, and Setting Blocks: Manufacturer's standard permanent non-migrating type of elastomer type and hardness selected to comply with requirements. Spacers, Edge Blocks, and Setting Blocks to be extruded thermoplastic elastomer by the skylight manufacturer.

D. Glazing Weatherseal Sealant: Neutral-curing silicone sealant recommended by skylight and sealant manufacturers for this use and furnished by skylight manufacturer.

1. Sealant is capable of withstanding 50 percent movement in both extension and compression (total of 100 percent movement) when tested for adhesion and cohesion under maximum cyclic movement according to ASTM C719.

2. Sealant complies with ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and, as applicable to substrates including other sealants with which it comes in contact, O.

3. Color: Black.

E. Flashing Sealant: Single-component, non-sag, high performance, non-priming, gun-grade elastomeric polyurethane sealant furnished by skylight manufacturer.

1. Sealant complies with ASTM C920, Type S, Grade NS, Class 25, Use T, NT, M, A, G, and O.

2. Sealant conforms to USDA approval standards.

2.05 FALL PROTECTION SCREEN

A. MATERIALS

1. Screen: Welded steel wire mesh, 4" x 4" spacing, wire diameter - .188" min. hot dipped galvanized finish on carbon steel.

2. Frame: Extruded aluminum alloy 6063-T5 (min). ASTM B 221 (ASTM B 221 M) with minimum effective thickness of 0.090 inch (2.2 mm).

3. Frame includes a pocket for the edges of the screen material, and a downward leg for attachment to any vertical surface of a skylight retainer or frame.

4. Adjustment Bar: Extruded aluminum bar stock, ¼" x 1", alloy 6063-T5 (min). ASTM B 221 (ASTM B 221 M).

5. Adjustment bar is slotted for width adjustment in the field.

6. Fasteners: Nonmagnetic stainless steel or other non-corrosive metal as recommended by manufacturer.

7. OSHA compliant per 29 CFR SS1910.23 and SS1926.501.

B. FABRICATION

1. Fabricate frame components to factory specifications.

2. Assemble frame legs (2 sides) and adjustment bar (2 sides) into a frame using ¼-14 x 1" hex hd. stainless steel fasteners.

3. Install screen in frame and fix into frame with 1/4-14 x 1" hex hd. stainless steel fasteners.

2.06 FABRICATION:

A. Framing Components: As follows:

1. Factory fit and assemble components, where practical.

2. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.

3. Fabricate components to drain water passing joints and to drain condensation and moisture occurring or migrating within skylight system to the exterior.

4. Fabricate components to accommodate expansion, contraction, and field adjustment, and to provide for minimum clearance and shimming at skylight perimeter.

5. Fabricate components to ensure that glazing is thermally and physically isolated from framing members.

6. Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.

7. Fit and assemble components to greatest extent practicable before finishing.

8. Reinforce members as required to retain fastener threads.

9. Attach retainer bars with gasketed stainless steel fasteners spaced at a maximum of 12 inches on center.

10. Weld components before finishing and in concealed locations to greatest extent practicable to minimize distortion.

11. Before shipping, shop assemble, mark, and disassemble components that cannot be permanently shop assembled.

B. Provide continuous aluminum frame with weatherproof splice joints and locked and sealed or fully welded corners. Locate weep holes in the frame at each rafter connection to drain condensation.

C. Prepare framing to receive anchor and connection devices and fasteners.

D. Field Glazing: Locate and size extruded elastomeric setting blocks and spacers in accordance with the glazing manufacturer’s recommendations. At no point shall the glazing come in contact with the skylight frame or fasteners.

2.07 ALUMINUM FINISHES:

A. High-Performance Organic Finish: Four-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: As selected by Engineer from manufacturer's full range.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

B. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Where aluminum will contact pressure-treated wood, separate dissimilar materials by methods recommended by manufacturer.

3.03 INSTALLATION:

A. General:

1. Comply with manufacturer's written instructions.

2. Fit frame joints to produce hairline joints free of burrs and distortion.

3. Rigidly secure non-movement joints.

4. Accommodate thermal and mechanical movements.

5. Install framing components to drain water passing joints and to drain condensation and moisture occurring or migrating within skylight system to the exterior.

6. Coordinate installation of flashings and crickets at skylight perimeters to maintain continuity of water barriers.

7. Set continuous curbs and flashings in a full sealant bed, unless otherwise indicated. Comply with requirements in Division 7 Section “Joint Sealants.”

B. Metal Protection: Where aluminum will contact dissimilar materials, protect against galvanic action by painting contact surfaces with protective coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.

C. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.

D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.

E. Install components plumb and true in alignment with established lines and elevations.

F. Install weatherseal sealant according to Section 07 92 00 and according to weatherseal-sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind weatherseal sealant as recommended in writing by weatherseal-sealant manufacturer.

G. Erection Tolerances: Install skylight components true in plane, accurately aligned, and without warp or rack. Adjust framing to comply with the following tolerances:

1. Variation from Plane: Limit variation from plane or location shown to 1/8 inch in 10 feet; 1/4 inch over total length.

2. Alignment: Where surfaces abut in line and at corners and where surfaces are separated by less than 3 inches, limit offset from true alignment to less than 1/32 inch; otherwise, limit offset from true alignment to 1/8 inch.

H. Field Glazing: Locate and size extruded elastomeric setting blocks and spacers in accordance with the glazing manufacturer's recommendations. At no point shall the glazing come in contact with the skylight frame or fasteners

I. Install secondary-sealant weatherseal according to sealant manufacturer's written instructions to provide weatherproof joints. Install joint fillers behind sealant as recommended by sealant manufacturer.

3.04 CLEANING

A. Clean skylights inside and outside, immediately after installation and after sealants have cured, according to manufacturer's written recommendations.

1. Remove temporary protective coverings and strippable coatings from pre-finished metal surfaces. Remove labels and markings from all components.

B. Remove excess sealant according to sealant manufacturer's written recommendations.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 08 71 00

FINISH HARDWARE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide finish hardware as indicated and in compliance with Contract Documents.

1. Section Includes:

a. Finish hardware for doors as specified and as listed in "Hardware Groups" and required by actual conditions. Mechanical door hardware as indicated on the drawings.

b. Cylinders for door hardware specified in other Sections.

c. Electrified door hardware.

d. Screws, special screws, bolts, special bolts, expansion shields, and other devices for proper application of hardware.

B. General Requirements:

1. Provide items, articles, materials, operations and methods listed, mentioned or scheduled herein or on drawings, in quantities as required to complete project. Provide hardware that functions properly. Prior to furnishing hardware, advise Engineer of items that will not operate properly, are improper for conditions, or will not remain permanently anchored.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. A117.1: Accessible and Usable Buildings and Facilities.

B. ASTM International (ASTM):

1. E283: Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

C. Builders Hardware Manufacturers Association (BHMA):

1. A156.1: Butts and Hinges.

2. A156.2: Bored and Preassembled Locks & Latches.

3. A156.3: Exit Devices.

4. A156.4: Door Controls - Closers.

5. A156.5: Auxiliary Locks & Associated Products.

6. A156.6: Architectural Door Trim.

7. A156.8: Door Controls - Overhead Stops and Holders.

8. A156.12: Interconnected Locks.

9. A156.13: Mortise Locks & Latches.

10. A156.14: Sliding & Folding Door Hardware.

11. A156.15: Sliding & Folding Door Hardware.

12. A156.16: Auxiliary Hardware.

13. A156.17: Self Closing Hinges & Pivots.

14. A156.18: Materials and Finishes.

15. A156.21: Thresholds.

16. A156.22: Door Gasketing and Edge Seal Systems.

17. A156.23: Electromagnetic Locks.

18. A156.24: Delayed Egress Locking Systems.

19. A156.25: Electrified Locking Devices.

20. A156.26: Continuous Hinges.

21. A156.28: Recommended Practices for Mechanical Keying Systems.

22. A156.29: Exit Locks, Exit Alarms, Alarms for Exit Devices.

23. A156.30: High Security Cylinders.

24. A156.31: Electric Strikes and Frame Mounted Actuators.

D. Hollow Metal Manufacturers Association (HMMA):

1. 831: Recommended Hardware Locations for Hollow Metal Doors and Frames.

E. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

2. 80: Standard for Fire Doors and Other Opening Protectives.

3. 105: Standard for Smoke Door Assemblies and Other Opening Protectives.

4. 252: Standard Methods of Fire Tests of Door Assemblies.

F. Steel Door Institute (SDI):

1. A250.6: Hardware on Standard Steel Doors (Reinforcement & Application).

2. A250.8: Recommended Specifications for Standard Steel Doors and Frames

G. Underwriters' Laboratories, Inc. (UL):

1. 10C: Safety Positive Pressure Fire Tests of Door Assemblies

2. 1784: Safety Air Leakage Tests of Door Assemblies

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

C. Shop Drawings: Details of electrified door hardware, indicating the following:

1. Wiring Diagrams: For power, signal, and control wiring and including the following:

a. Details of interface of electrified door hardware and building safety and security systems

b. Schematic diagram of systems that interface with electrified door hardware

c. Point-to-point wiring

d. Risers

e. Elevations of doors controlled by electrified door hardware

2. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.

D. Samples for Initial Selection: For plastic protective trim units in each finish, color, and texture required for each type of trim unit indicated.

E. Samples for Verification: For exposed door hardware of each type required, in each finish specified, prepared on Samples of size indicated below. Tag Samples with full description for coordination with the door hardware schedule. Submit Samples before, or concurrent with, submission of door hardware schedule.

1. Sample Size: Full-size units or minimum 2 by 4-inch samples for sheet and 4-inch long Samples for other products.

a. Full-size Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

2. Other Submittals:

a. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

(1) Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.

(2) Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.

(3) Content: Include the following information:

(a) Identification number, location, hand, fire rating, size, and material of each door and frame.

(b) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.

(c) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

(d) Description of electrified door hardware sequences of operation and interfaces with other building control systems.

(e) Fastenings and other pertinent information.

(f) Explanation of abbreviations, symbols, and codes contained in schedule.

(g) Mounting locations for door hardware.

(h) List of related door devices specified in other Sections for each door and frame.

b. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

F. Qualification Data: For Installer and Architectural Hardware Consultant.

G. Product Certificates: For electrified door hardware, from the manufacturer.

1. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.

H. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

I. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

J. Warranty: Special warranty specified in this Section.

K. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

L. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Engineer, and Owner about door hardware and keying.

1. Warehousing Facilities: In Project's vicinity.

2. Scheduling Responsibility: Preparation of door hardware and keying schedules.

3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

C. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as follows:

1. For door hardware, an Architectural Hardware Consultant (AHC) who is also an Electrified Hardware Consultant (EHC).

D. Source Limitations: Obtain each type of door hardware from a single manufacturer.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

E. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.

F. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.

G. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

H. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

I. Accessibility Requirements: For door hardware on doors in an accessible route, comply with ICC/ANSI A117.1.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.

2. Comply with the following maximum opening-force requirements:

a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.

b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.

4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

J. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 "Project Management and Coordination" Section. In addition to Owner, Contractor, and Engineer, conference participants shall also include Installer's Architectural Hardware Consultant and Owner's security consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.

2. Preliminary key system schematic diagram.

3. Requirements for key control system.

4. Requirements for access control.

5. Address for delivery of keys.

K. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

2. Inspect and discuss preparatory work performed by other trades.

3. Inspect and discuss electrical roughing-in for electrified door hardware.

4. Review sequence of operation for each type of electrified door hardware.

5. Review required testing, inspecting, and certifying procedures.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

C. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

D. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

E. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.07 COORDINATION:

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

D. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.08 WARRANTY:

A. Comply with general requirements specified in Section 01 78 36.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection, cracking, or breakage.

b. Faulty operation of doors and door hardware.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

a. Exit Devices: Two years from date of Substantial Completion.

b. Closers: 10 years from date of Substantial Completion.

1.09 MAINTENANCE SERVICE:

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

B. Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Provide parts and supplies that are the same as those used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.01 SCHEDULED DOOR HARDWARE:

A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article and on as indicated Drawings to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products complying with BHMA designations referenced.

2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.

2.02 HINGES:

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

1. Manufacturers:

a. Hager Companies

b. McKinney Products Company; an ASSA ABLOY Group company

c. Stanley Commercial Hardware; Div. of The Stanley Works

2.03 CONTINUOUS HINGES:

A. Continuous hinges: BHMA A156.26; minimum 0.120-inch thick, hinge leaves with minimum overall width of 4-inches; fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.

1. Pin-and-Barrel-Type Hinges:

a. Hager Companies

b. IVES Hardware; an Ingersoll-Rand company

c. McKinney Products Company; an ASSA ABLOY Group company

2. Continuous, gear-type hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded- aluminum channel cap; with concealed, self-lubricating thrust bearings.

a. Hager Companies

b. IVES Hardware; an Ingersoll-Rand company

c. McKinney Products Company; an ASSA ABLOY Group company

2.04 MECHANICAL LOCKS AND LATCHES:

A. Manufacturers:

1. Bored Locks.

a. Best Access Systems; Div. of Stanley Security Solutions, Inc.

B. Lock Functions: As indicated in door hardware schedule.

C. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch latchbolt throw.

D. Lock Backset: 2-3/4 inches, unless otherwise indicated.

E. Lock Trim:

1. Levers: Cast.

a. Best 15D.

2. Escutcheons (Roses): Wrought.

3. Dummy Trim: Match lever lock trim and escutcheons.

4. Operating Device: Lever with escutcheons (roses).

F. Strikes: Provide Manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-lip strikes: For locks with three-piece antifriction latchbolts, as recommended by Manufacturer.

2. Extra-long-lip strikes: For locks used on frames with applied wood casing trim.

3. Aluminum-frame strike box: Manufacturer's special strike box fabricated for aluminum framing.

4. Rabbet front and strike: Provide on locksets for rabbeted meeting stiles.

G. Bored locks: BHMA A156.2; Grade 1; Series 4000.

2.05 AUXILIARY LOCKS:

A. Bored Auxiliary Locks: BHMA A156.5: Grade 1; with strike that suits frame.

1. Manufacturers:

a. Best Access Systems; Div. of Stanley Security Solutions, Inc.

B. Mortise Auxiliary Locks: BHMA A156.5; Grade 1; with strike that suits frame.

1. Manufacturers:

a. Best Access Systems; Div. of Stanley Security Solutions, Inc.

2.06 ELECTRIC STRIKES:

A. Electric Strikes: BHMA A156.31; Grade 1; with faceplate to suit lock and frame.

1. Manufacturers:

a. HES, Inc.; an ASSA ABLOY Group company

b. Rutherford Controls Int'l. Corp.

c. Von Duprin; an Ingersoll-Rand company

2.07 PUSH/PULL UNITS:

A. Where door pulls are scheduled on one side of door and push plates on other side issue installations instructions to ensure that the pull is secured through door from reverse side and countersunk flush with door installation of push plate. Locate push plate to cover fasteners for door pulls.

1. Manufacturers:

a. Trimco

b. Hiawatha

c. Metalcraft

2.08 ELECTROMECHANICAL LOCKS:

A. Electromechanical locks: BHMA A156.25; Grade 1; motor or solenoid driven; bored; with strike that suits frame.

1. Manufacturers:

a. Best Access Systems; Div. of Stanley Security Solutions, Inc.

2.09 MANUAL FLUSH BOLTS:

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

1. Manufacturers:

a. Hiawatha, Inc.

b. IVES Hardware; an Ingersoll-Rand company

c. Trimco

2.10 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS:

A. Automatic and self-latching flush bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

1. Manufacturers:

a. Door Controls International, Inc.

b. IVES Hardware; an Ingersoll-Rand company

c. Trimco

2.11 EXIT DEVICES AND AUXILIARY ITEMS:

A. Exit Devices and Auxiliary Items: BHMA A156.3.

B. Lock cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

C. Standard lock cylinders: BHMA A156.5; Grade 1; permanent cores that are interchangeable; face finished to match lockset.

D. Construction cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

1. Manufacturers:

a. Precision Hardware, Inc.; Division of Stanley Security Solutions, Inc.

b. Von Duprin; an Ingersoll-Rand company

2.12 LOCK CYLINDERS:

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

1. Manufacturers:

a. Best Access Systems; Div. of Stanley Security Solutions, Inc.

B. Standard Lock Cylinders: BHMA A156.5; Grade 1; permanent cores that are interchangeable; face finished to match lockset.

C. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.13 KEYING:

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

1. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.

2. Existing System:

a. Master key or grand master key locks to Owner's existing system.

B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: "DO NOT DUPLICATE."

2. Quantity: In addition to one extra key blank for each lock, provide the following:

a. Cylinder Change Keys: Three

b. Master Keys: Five

c. Grand Master Keys: Five

d. Great-Grand Master Keys: Five

2.14 KEY CONTROL SYSTEM:

A. Key Control Cabinet: BHMA A156.5; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, 2 sets of key tags with self-locking key holders,

key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.

1. Manufacturers:

    a. American Key Boxes and Cabinets

    b. GE Security, Inc.

    c. Lund Equipment Co., Inc.

2. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.

B. Key Lock Boxes: Designed for storage of two keys.

1. Manufacturers:

    a. GE Security, Inc.

    b. HPC, Inc.

    c. Knox Company

C. Cross-Index System: Single-index system for recording key information. Include three receipt forms for each key-holding hook. Set up by Installer.

1. Manufacturers:

    a. Lund Equipment Co., Inc.

    b. MMF Industries

    c. Tri Palm International

2.15 OPERATING TRIM:

A. Operating Trim: BHMA A156.6; brass or , unless otherwise indicated.

1. Manufacturers:

    a. Hager Companies

    b. IVES Hardware; an Ingersoll-Rand company

    c. Trimco

2.16 ACCESSORIES FOR PAIRS OF DOORS:

A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.

B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.

C. Astragals: BHMA A156.22.

2.17 SURFACE CLOSERS:

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

1. Manufacturers:

a. LCN Closers; an Ingersoll-Rand company, 4040XP

b. Stanley Closers QDC100

2.18 MECHANICAL STOPS AND HOLDERS:

A. Wall- and floor-mounted stops: BHMA A156.16; cast brass or bronze, base metal.

1. Manufacturers:

a. Hager Companies

b. IVES Hardware; an Ingersoll-Rand company

c. Trimco

2.19 DOOR GASKETING:

A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturers:

a. National Guard Products

b. Reese Enterprises, Inc.

c. Zero International

2.20 THRESHOLDS:

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturers:

a. National Guard Products

b. Reese Enterprises, Inc.

c. Zero International

2.21 PROTECTION PLATES

A. Manufacturers:

1. Hager

2. Trimco

B. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units. Machine screws or self-tapping screw.

C. Fabricate protection plates (armor, kick or mop) not more than 1-1/2 inch less than door width on stop side and not more than 1/2 inch less than door width on pull side, by height indicated.

1. Metal Plates: Stainless steel, 0.050 inch (U.S. 18 ga) beveled edges, with countersunk screw holes of intervals of not over 6 inch on all four sides.

2.22 METAL PROTECTIVE TRIM UNITS:

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick chrome plated steel; with manufacturer's standard machine or self-tapping screw fasteners.

1. Manufacturers:

a. Hiawatha, Inc.

b. IVES Hardware; an Ingersoll-Rand company

c. Trimco

2.23 AUXILIARY DOOR HARDWARE:

A. Auxiliary Hardware: BHMA A156.16.

1. Manufacturers:

a. Hager Companies

b. Stanley Commercial Hardware; Div. of The Stanley Works

c. Trimco

2.24 AUXILIARY ELECTRIFIED DOOR HARDWARE:

A. Auxiliary Electrified Door Hardware: BHMA A156.25.

1. Manufacturers:

a. GE Security, Inc.

b. Securitron Magnalock Corporation; an ASSA ABLOY Group company

c. Security Door Controls

2.25 FABRICATION:

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise accepted by Engineer.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where

through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Fire-Rated Applications:

a. Machine Screws: For the following:

(1) Hinges mortised to doors or frames.

(2) Strike plates to frames.

(3) Closers to doors and frames.

b. Steel Through Bolts: For the following unless door blocking is provided:

(1) Surface hinges to doors.

(2) Closers to doors and frames.

(3) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.26 FINISHES:

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of accepted Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of accepted Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.03 INSTALLATION:

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Permanent cores to be Owner purchased and Owner installed.

E. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

F. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, [in equipment room. Verify location with Engineer.

1. Configuration: Provide least number of power supplies required to adequately serve doors with electrified door hardware.

G. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07 92 00.

H. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

I. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

K. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.04 FIELD QUALITY CONTROL:

A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.05 ADJUSTING:

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.

2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

3.06 CLEANING AND PROTECTION:

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

3.08 DOOR HARDWARE SCHEDULE:

A. The Schedule is a partial list to establish quality and clarify hardware requirements of certain items.

B. Provide fasteners, accessories, and other devices required for complete and proper installation for each particular location.

C. Manufacturer's reference number indicated is first Manufacturer on Manufacturer's list.

D. See Door Schedule on Drawings for hardware group application.

Manufacturer List

Code	Name
AB	ABH MANUFACTURING INC.
BE	BEST ACCESS SYSTEMS
BY	BY OTHERS
DM	DORMA DOOR CONTROLS
NA	NATIONAL GUARD
PR	PRECISION
RC	RUTHERFORD CONTROLS
SD	STANLEY DOOR CLOSERS
SE	SENTROL
ST	STANLEY
TR	TRIMCO

Option List

Code	Description
FL	FIRE EXIT HARDWARE
S3	ANSI STRIKE PACKAGE
SN	SEX NUTS (PKG. OF 4)
3RO	PREFIX OPTION FOR 2000 APEX SERIES
AVB	ADVANCED VARIABLE BACKCHECK
BFI	BARRIER FREE OPENING FORCE (5 LB)
CFH	CUT FOR HARDWARE
CSK	COUNTER SINKING OF KICK AND MOP PLATES
SIA	ABRASIVE COATING-5" WIDTH-AL OR SS
SRI	SPECIAL RUST INHIBITOR
R704	STRAIGHT CYLINDER RING - 1/4"
R708	STRAIGHT CYLINDER RING - 1/2"
R804	TAPERED CYLINDER RING - 1/4"
S301	OPT. ROLLER. STRK - RIM AND TOP OF SVR
105/HO	105 DEGREE HOLD OPEN
SNB (2)	SEX BOLTS (2)
SSMS/LA	STAINLESS MACHINE SCREWS/LEAD ANCHOR

Finish List

Code	Description
D	BRONZE ANODIZED ALUMINUM
AL	ALUMINUM
626	SATIN CHROMIUM PLATED
628	SATIN ALUMINUM, CLEAR ANODIZED
630	SATIN STAINLESS STEEL
689	ALUMINUM PAINTED
626W	WEATHERIZED SATIN CHROME

GREY	GREY
626AM	SATIN CHROME - ANTIMICROBIAL COATING
US26D	CHROMIUM PLATED, DULL
US32D	STAINLESS STEEL, DULL

E. Table 08 71 00-1 is partial list to establish quality and clarify hardware requirements of certain items.

F. Provide fasteners, accessories, and other devices required for complete and proper installation for each particular location.

G. Manufacturer's reference number indicated is first manufacturer on manufacturer's list.

H. See Door Schedule on Drawings for hardware group application.

TABLE 08 71 00 - 1

SET #10 - HM - Ext Entry (CR)				
3	Hinges	CB199 4 1/2 X 4 1/2 NRP	US32D	ST
1	Exit Device	3RO 2103 X 1703A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R804	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer | Stop	CLD-4550 CS AVB SN SRI	689	SD
1	Drip Cap	16 A - 4" ODW		NA
1	Weatherstrip	700 ES (HEAD & JAMBS)		NA
1	Threshold	896HD S x SSMS/LA	AL	NA
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY
SET #11 - HM - Ext Entry PR (CR)				
8	Hinges	CB199 4 1/2 X 4 1/2 NRP	US32D	ST
1	E/Removable Mullion	1340 KR EL	600	DM
1	Mortise Cylinder (Mull)	1E-74 PATD	626	BE
1	Exit Device	3RO 2101 X 1701 S301 SNB (2)	626W	PR
1	Exit Device	3RO 2103 X 1703A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R804	626	BE
1	Electric Strike	0162	630	RC
2	Door Closer | Stop	CLD-4550 CS AVB SN SRI	689	SD
1	Mullion Seal	5100 S		NA
1	Weatherstrip	700 ES (HEAD & JAMBS) - PR		NA
1	Drip Cap	16 A - 4" ODW		NA
1	Threshold	896HD x SSMS/LA - PR	AL	NA
2	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY
SET #12 - HM – Roof (CR)				
3	Hinges	CB199 4 1/2 X 4 1/2 NRP	US26D	ST
1	Storeroom Lockset	9K3-7D15D PATD S3	626	BE
1	Door Closer | C/Stop | HO	CLD-4550 HCS AVB SN	689	SD

1	Drip Cap	16 A - 4" ODW		NA
1	Weatherstrip	700 ES (HEAD & JAMBS)		NA
1	Threshold	896HD S x SSMS/LA	AL	NA
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR

SET #13 - HM - Ext Entry (CR) 10/0

5	Hinges	CB199 4 1/2 X 4 1/2 NRP	US32D	ST
1	Exit Device	3RO 2103 X 1703A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R804	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer | Stop	CLD-4550 CS AVB SN SRI	689	SD
1	Weatherstrip	700 ES (HEAD & JAMBS)		NA
1	Threshold	896HD S x SSMS/LA	AL	NA
1	Drip Cap	16 A - 4" ODW		NA
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #20 - FRP - Ext Entry PR (CR)

2	Continuous Hinge	A111HD		AB
1	Exit Device	3RO 2103 X 1703A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R804	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer | Stop	CLD-4550 CS AVB SN SRI	689	SD
1	Spacer Block	P45HD-110	689	SD
1	Angle Bracket	P45HD-112	689	SD
1	Drip Cap	16 A - 4" ODW		NA
1	Perimeter Gasket	BY DOOR & FRAME MFG	628	BY
1	Threshold	896HD S x SSMS/LA	AL	NA
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #30 - Alum - Ext Entry (CR)

1	Continuous Hinge	BY DOOR & FRAME SUPPLIER		BY
1	Exit Device	3RO 2103 CD	630	PR
1	Rim Cylinder	12E-72 PATD R804	626	BE
1	Mortise Cylinder	1E-74 PATD R704	626	BE
1	Electric Strike	0162	630	RC
1	Door Pull	1192-3	630	TR
1	Door Closer	CLD-4550 EDA AVB SN	689	SD
1	Drop Plate	P45-180D	689	SD
1	Spacer Block	P45HD-110	689	SD
1	Door Stop	1214	626	TR
1	Perimeter Gasket	BY DOOR & FRAME MFG	628	BY
1	Threshold	8433 V x SSMS/LA		NA
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #40 - MTL - OHD

See Section 08 83 00 for hardware requirements
NOTE: All Hardware by OHD Manufacturer

SET #100 - HM - Int (Passage)

3	Hinges	CB199 4 1/2 X 4 1/2	US32D	ST
1	Exit Device (Passage)	3RO FL 2114 X 4914A S301 SNB (2)	626W	PR
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD

SET #101 - HM - Int Panic UL

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	US26D	ST
1	Exit Device	3RO 2103 X 4903A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R704	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
3	Door Silencers	1229A	GREY	TR
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY
1	Perimeter Gasket	BY DOOR & FRAME MFG	628	BY

SET #102 - HM - Int Janitor

4	Hinges	CB179 4 1/2 X 4 1/2	US26D	ST
1	Storeroom Lockset	9K3-7D15D PATD S3	626	BE
1	Kick Plate	K0050 - 10" x 2" LDW CSK	630	TR
1	Floor Stop	1211	626	TR
3	Door Silencers	1229A	GREY	TR

SET #103 - HM – Int RR

3	Hinges	CB199 4 1/2 X 4 1/2	US26D	ST
1	Privacy Set	9K3-0L15D S3	626AM	BE
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
3	Door Silencers	1229A	GREY	TR

SET #200 - FRP - Int (Passage)

1	Continuous Hinge	A111HD		AB
1	Exit Device (Passage)	3RO FL 2114 X 4914A S301 SNB (2)	626W	PR
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
1	Spacer Block	P45HD-110	689	SD
1	Angle Bracket	P45HD-112	689	SD

SET #201 - FRP - Int (Passage) PR

2	Continuous Hinge	A111HD		AB
1	Removable Mullion	KR822	689	PR
1	Exit Device	3RO 2101 X 4901 S301 SNB (2)	626W	PR
1	Exit Device (Passage)	3RO 2114 X 4914A S301 SNB (2)	626W	PR
1	Rim Cylinder (Mull)	12E-72 PATD R708	626	BE
1	Spacer Block	P45HD-110	689	SD
1	Angle Bracket	P45HD-112	689	SD
2	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
2	Door Silencers	1229A	GREY	TR

SET #202 - FRP - Int (Passage) UL

1	Continuous Hinge	A111HD		AB
1	Exit Device (Passage)	3RO FL 2114 X 4914A S301 SNB (2)	626W	PR
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
1	Spacer Block	P45HD-110	689	SD
1	Angle Bracket	P45HD-112	689	SD
1	Perimeter Gasket	BY DOOR & FRAME MFG	628	BY

SET #203 - FRP - Int (Passage) UL (CR)

1	Continuous Hinge	A111HD		AB
1	Exit Device (Passage)	3RO FL 2114 X 4914A S301 SNB (2)	626W	PR
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD

1	Spacer Block	P45HD-110	689	SD
1	Angle Bracket	P45HD-112	689	SD
1	Perimeter Gasket	BY DOOR & FRAME MFG	628	BY
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #204 - FRP - Int (Passage) (CR)

1	Continuous Hinge	A111HD		AB
1	Exit Device (Passage)	3RO FL 2114 X 4914A S301 SNB (2)	626W	PR
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
1	Spacer Block	P45HD-110	689	SD
1	Angle Bracket	P45HD-112	689	SD
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #205 - FRP - Int (Passage) PR (CR)UL

2	Continuous Hinge	A111HD		AB
1	Removable Mullion	KR822	689	PR
1	Exit Device	3RO 2101 X 4901 S301 SNB (2)	626W	PR
1	Exit Device (Passage)	3RO 2114 X 4914A S301 SNB (2)	626W	PR
1	Rim Cylinder (Mull)	12E-72 PATD R708	626	BE
1	Spacer Block	P45HD-110	689	SD
1	Angle Bracket	P45HD-112	689	SD
2	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
2	Door Silencers	1229A	GREY	TR
2	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY
1	Perimeter Gasket	BY DOOR & FRAME MFG	628	BY

SET #206 - FRP - Int (Passage) RR

1	Continuous Hinge	A111HD		AB
1	Privacy Set	9K3-0L15D S3	626AM	BE
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
3	Door Silencers	1229A	GREY	TR

SET #210 - FRP - Int Panic

1	Continuous Hinge	A111HD		AB
1	Exit Device	3RO 2103 X 4903A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R704	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
3	Door Silencers	1229A	GREY	TR

SET #211 - FRP - Int Panic PR

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	US26D	ST
1	Exit Device	3RO 2103 X 4903A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R704	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
3	Door Silencers	1229A	GREY	TR

1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #212 - FRP - Int Panic UL

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	US26D	ST
1	Exit Device	3RO 2103 X 4903A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R704	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
3	Door Silencers	1229A	GREY	TR
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #213 - FRP - Int Panic PR (CR)

2	Continuous Hinge	A111HD		AB
1	Removable Mullion	KR822	689	PR
1	Exit Device	3RO 2103 X 4903A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R704	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer | Stop	CLD-4550 CS SN SRI	689	SD
3	Door Silencers	1229A	GREY	TR
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

END OF SECTION

SECTION 08 81 00

GLASS AND GLAZING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide glazing as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Architectural Manufacturers Association (AAMA):

1. 800: Voluntary Specifications and Test Methods for Sealants

2. 806.3: Back-Bedding Mastic Glazing Tapes

3. 807.3: Back-Bedding Mastic Glazing Tapes

4. 810.1: Expanded Cellular Glazing Tapes

B. American National Standards Institute (ANSI):

1. Z97.1: Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test

C. ASTM International (ASTM):

1. C509: Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material

2. C542: Standard Specification for Lock-Strip Gaskets

3. C716: Standard Specification for Installing Lock-Strip Gaskets and Infill Glazing Materials

4. C864: Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers

5. C920: Standard Specification for Elastomeric Joint Sealants.

6. C1036: Standard Specification for Flat Glass

7. C1048: Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass

8. C1281: Standard Specification for Preformed Tape Sealants for Glazing Applications

9. C1330: Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid- Applied Sealants

10. E1300: Standard Practice for Determining Load Resistance of Glass in Buildings

11. E2190: Standard Specification for Insulating Glass Unit Performance and Evaluation

D. California Department of Public Health (CDPH):

1. Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

E. Consumers Product Safety Commission (CPSC):

1. 16 CFR 1201

F. Glass Association of North America (GANA):

1. Engineering Standards Manual

2. Laminated Glazing Reference Manual

3. Glazing Manual.

G. Institute for Sustainable Infrastructure (ISI):

1. Envision – v3

H. National Fire Protection Association (NFPA):

1. 252: Standard Methods of Fire Tests of Door Assemblies

I. National Fenestration Rating Council (NFRC):

1. 100: Procedure for Determining Fenestration Product U-factors

2. 200: Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

3. 300: Standard Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems

4. CAP1: Certification Agency Program

J. South Coast Air Quality Management District (SCAQMD):

1. Rule 1168: Adhesive and Sealant Applications

1.03 DEFINITIONS:

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C1036.

C. Interspace: Space between lites of an insulating-glass unit.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each glass product and glazing material indicated, evidencing compliance with specifications.

C. Glass Samples: For each type of glass product other than clear monolithic vision glass.

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations shown on the Drawings.

E. Product Certificates: For glass and glazing products, from Manufacturer.

1. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for insulating glass.

2. Warranties: Sample of special warranties.

F. Warranty documentation as specified in Section 01 78 36.

G. O&M documentation as specified in Section 01 78 23.

H. Sustainable Design Submittals:

1. Comply with the requirements as specified in Section 01 81 13.01.

I. Submit product data or other published information verifying compliance with CDPH Standard Method v1.1, using the applicable exposure scenario. Manufacturer's claims of compliance shall also state the range of total VOCs after 14 days.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.

C. Installer Qualifications: A qualified installer who employs glass installers for this project who are certified under the National Glass Association's Certified Glass Installer Program.

D. Glass Testing Agency Qualifications: A qualified independent testing agency accredited in accordance with the NFRC CAP1 Certification Agency Program.

E. Single Source Responsibility for Glass: To ensure consistent quality of appearance and performance, provide materials produced by a single Manufacturer or fabricator for each kind and condition of glass indicated and composed of primary glass obtained from a single source for each type and class required.

F. Glazing Publications: In accordance with published recommendations of glass product Manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."

G. Safety Glazing Products: Where required by code provide in accordance with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.

1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.

H. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate Manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 degrees F, and the fire-resistance rating in minutes.

I. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

J. Performance Requirements:

1. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or

installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

2. Delegated Design: Design glass, including comprehensive engineering analysis in accordance with ASTM E1300 by a qualified professional Engineer, using the following design criteria:

3. Design Wind Pressures: As shown on the Drawings.

   a. Ultimate design wind speed: Speed (VULT): 175 mph.

   b. Risk category: III.

   c. Exposure category: C.

K. Glass Design: Glass thicknesses shown on the Drawings are for detailing only. Confirm glass thicknesses by analyzing project loads and in-service conditions. Provide glass lites for various size openings in the thicknesses and strengths (annealed or heat-treated) to meet or exceed the following criteria:

1. Minimum glass thickness, nominally, of lites in exterior walls is 0.23 inch.

2. Minimum glass thicknesses of lites, whether composed of annealed or heat-treated glass, are selected so the worst-case probability of failure does not exceed the following:

   a. 8 lites per 1000 for lites set vertically or not over 15 degrees off vertical and under wind action. Determine minimum thickness of monolithic annealed glass in accordance with ASTM E1300. For other than monolithic annealed glass, determine thickness per Glass Manufacturer's standard method of analysis including applying adjustment factors to ASTM E1300 based on type of glass.

   b. 1 lite per 1000 for lites set over 15 degrees off vertical and under action of wind or snow.

L. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components. Base engineering calculations on materials' actual surface temperature due to both solar heat gain and nighttime sky heat loss.

1. Temperature change: 120 degrees F, ambient; 180 degrees F, material surfaces.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.07 PROJECT CONDITIONS:

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 degrees F.

1.08 WARRANTY:

A. Warranty requirements as specified in Section 01 78 36.

B. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to Manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of substantial completion.

C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to Manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of substantial completion.

D. Mirror Glass: Fifteen (15) years against silver spoilage.

1.09 O&M SPECIAL REQUIREMENTS:

A. O&M data requirements as specified in Section 01 78 23.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Glass Products:

1. Float Glass:

a. AFG Industries, Inc.

b. Guardian Industries Corp.

c. Pilkington North America

d. PPG Industries, Inc.

B. Insulating Glass:

1. J. E. Berkowitz

2. Oldcastle Building Envelope

3. Viracon

C. Fire Protection Rated Laminated Ceramic Glazing:

1. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products), FireLite Plus

2. Schott North America, Inc., Laminated Pyran Crystal

3. Vetrotech Saint-Gobain, SGG Keralite FR-L

2.02 MATERIALS:

A. Sustainable Design Product Requirements:

1. Comply with the requirements as specified in Section 01 81 13.01.

2. ISI Envision:

a. Sustainable procurement practices (RA1.2): Maximize the procurement of materials that follow sustainable procurement practices.

b. Recycled materials (RA1.3): Maximize the procurement of materials with recycled content.

c. Locally sourced materials (RA1.4): Maximize the procurement of materials within the radius as specified in Section 01 81 13.01.

B. Glass Products, General:

1. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

   a. Minimum glass thickness for exterior lites: Not less than 1/4-inch.

   b. Thickness of tinted glass: Provide same thickness for each tint color indicated throughout project.

2. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to be in accordance with Performance Requirements specified in this Section. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements". Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

3. Thermal and optical performance properties: Provide glass with performance properties specified, as indicated in Manufacturer's published test data, based on procedures indicated below:

   a. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.

   b. For laminated-glass lites, properties are based on products of construction indicated.

   c. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.

   d. U-Factors: Center-of-glazing values, in accordance with NFRC 100, expressed as Btu/square feet x h x degrees F.

   e. Solar heat-gain coefficient and visible transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on LBL's WINDOW 5.2 computer program.

4. Visible reflectance: Center-of-glazing values, in accordance with NFRC 300.

C. Glass:

1. Float glass: ASTM C1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated, minimum 6 mm thick.

2. Heat-treated float glass: ASTM C1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated, minimum 1/4-inch thick.

    a. Fabrication process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

    b. For uncoated glass, comply with requirements for Condition A.

    c. For coated vision glass, comply with requirements for Condition C (other coated glass).

3. Uncoated tinted float glass: Class 2, complying with other requirements specified.

    a. Basis-of-design product: Viracon VE33-2M.

        (1) Tint color: Gray, as selected by Engineer from Manufacturer's full range in accordance with the procedures specified in Section 01 33 00.

        (2) Visible light transmittance: 52 percent minimum.

4. Ceramic-coated vision glass: Heat-treated float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's Tempering Division's "Engineering Standards Manual" and with other requirements specified.

    a. Glass: Clear float.

    b. Tint color: Gray.

    c. Ceramic coating color and pattern: As selected by Engineer from Manufacturer's full range in accordance with the procedures specified in Section 01 33 00.

D. Insulating Glass:

1. Insulating-glass units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190, and complying with other requirements specified.

    a. Sealing system: Dual seal, with Manufacturer's standard polyisobutylene and silicone primary and secondary.

    b. Spacer: Manufacturer's standard black aluminum spacer material and construction.

    c. Desiccant: Molecular sieve or silica gel, or blend of both.

2. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating- Glass Types" Article.

E. Fire-Protection-Rated Glazing:

1. Fire-protection-rated glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 252 for door assemblies.

2. Laminated ceramic glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch total nominal thickness; in accordance with testing requirements in 16 CFR 1201 for Category II materials.

2.03 COMPONENTS:

A. Monolithic-Glass Types:

1. Glass type clear float glass, heat-strengthened float glass or fully tempered float glass.

a. Thickness: 1/4 or 1/2-inch.

b. Provide safety glazing.

B. Insulating-Glass Types:

1. Glass type: Low-e-coated, tinted insulating glass. Basis of design: Viracon VE33-2M.

a. Overall unit thickness: 1 inch.

b. Thickness of each glass lite: 1/4-inch.

c. Outdoor lite: Tinted heat-strengthened float glass.

d. Interspace content: Air.

e. Indoor lite: Clear float glass or heat-strengthened float glass.

f. Low-E coating: Sputtered on second surface.

g. Visible light transmittance: 52 percent minimum.

h. Winter nighttime U-Factor: 0.30 maximum.

i. Summer daytime U-Factor: 0.26 maximum.

j. Solar heat gain coefficient: 0.31 maximum.

k. Provide safety glazing.

2. Glass Type: Ceramic-coated, tinted insulating vision glass. Basis of design: Viracon VE33-2M with Silkscreen #3.

a. Overall unit thickness: 1 inch.

b. Thickness of each glass lite: 1/4-inch.

c. Outdoor lite: Heat-strengthened float glass.

d. Interspace content: Air.

e. Indoor lite: Heat-strengthened float glass.

f. Coating location: VE-2M coating second surface.

(1) Silk screen location: Standard Viracon silk screen, ceramic frit color V933 Warm Gray, #3 surface, performance data based on 40 percent silk screen coverage

g. Visible light transmittance: 34 percent minimum.

h. Winter nighttime U-Factor: 0.30 maximum.

i. Summer daytime U-Factor: 0.26 maximum.

j. Solar heat gain coefficient: 0.28 maximum.

k. Provide safety glazing labeling.

C. Fire-Protection-Rated Glazing Types:

1. Glass type: 20-minute fire-rated glazing; laminated ceramic glazing.

a. Provide safety glazing labeling.

2.04 ACCESSORIES:

A. Glazing Gaskets:

1. Dense compression gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal.

2. Soft compression gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C509, Type II, black; of profile and hardness required to maintain watertight seal.

    a. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

    b. Lock-strip gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C542, black.

B. Glazing Sealants:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant Manufacturer based on testing and field experience.

2. Suitability: Comply with sealant and the Glass Manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

4. Elastomeric sealant standard: Provide Manufacturer's standard chemically curing, elastomeric sealant of base polymer in accordance with ASTM C920 requirements, including those for type, grade, class and uses.

5. Sealants used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Indoor Sources Using Environmental Chambers"

6. Colors of exposed glazing sealants: As selected by Engineer from Manufacturer's full range.

C. Glazing Tapes:

1. Back-bedding mastic glazing tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; non-staining and non- migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and the

Glass Manufacturers for application indicated; and in accordance with ASTM C1281 and AAMA 800 for products indicated below:

a. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.

b. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2. Expanded cellular glazing tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and in accordance with AAMA 800 for the following types:

a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.

b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

D. Miscellaneous Glazing Materials:

1. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of Manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

2. Cleaners, primers, and sealers: Types recommended by sealant or gasket Manufacturer.

3. Setting blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

4. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass Manufacturer to maintain glass lites in place for installation indicated.

5. Edge blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

6. Cylindrical glazing sealant backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

7. Perimeter insulation for fire-resistive glazing: Product that is approved by testing agency that listed and labeled fire- resistant glazing product with which it is used for application and fire-protection rating indicated.

2.05 FABRICATION:

A. Fabricate glazing units in sizes required to fit openings indicated for project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product Manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Examine framing, glazing channels, and stops, with installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.

2. Presence and functioning of weep systems.

3. Minimum required face and edge clearances.

4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

D. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed Work.

3.02 ERECTION / INSTALLATION / APPLICATION:

A. Glazing, General:

1. Comply with combined written instructions of Manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

2. Adjust glazing channel dimensions as required by project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

3. Protect glass edges from damage during handling and installation. Remove damaged glass from project site and legally dispose of off project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

4. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

5. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by Glass Manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

6. Do not exceed edge pressures stipulated by Glass Manufacturer for installing glass lites.

7. Provide spacers for glass lites where length plus width is larger than 50-inches.

    a. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

    b. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

8. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by Glass Manufacturer and in accordance with requirements in referenced glazing publications.

9. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

10. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

11. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

12. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket Manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by Gasket Manufacturer.

B. Tape Glazing:

1. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

2. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

3. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

4. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape Manufacturer.

5. Do not remove release paper from tape until right before each glazing unit is installed.

6. Apply heel bead of elastomeric sealant.

7. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

8. Apply cap bead of elastomeric sealant over exposed edge of tape.

C. Gasket Glazing (Dry):

1. Cut compression gaskets to lengths recommended by gasket Manufacturer to fit openings exactly, with allowance for stretch during installation.

2. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

3. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket Manufacturer.

4. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket Manufacturer.

5. Install gaskets so they protrude past face of glazing stops.

D. Sealant Glazing (Wet):

1. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

2. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

3. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

E. Lock-Strip Gasket Glazing:

1. In accordance with ASTM C716 and gasket Manufacturer's written instructions. Provide supplementary wet seal and weep system unless otherwise indicated.

3.03 REPAIRS / RESTORATION:

A. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

3.04 PROTECTION:

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by the Glass Manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by the Glass Manufacturer.

3.05 CLEANING:

A. Wash glass on both exposed surfaces in each area of project not more than four days before date scheduled for inspections that establish date of substantial completion. Wash glass as recommended in writing by the Glass Manufacturer.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 08 91 00

LOUVERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide louvers as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Architectural Manufacturers Association (AAMA):

1. 2605: Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

B. Air Movement and Control Association Inc. (AMCA):

1. 500-L: Laboratory Methods of Testing Louvers for Rating

2. 501: Louver Application Manual and Design Guide

C. ASTM International (ASTM):

1. B26: Standard Specification for Aluminum-Alloy Sand Castings

2. B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

3. B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

4. D1187: Type II – Specification for Asphalt-Base Emulsions (For Metal Surfaces)

5. E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

D. American Welding Society (AWS):

1. D1.2: Structural Welding Code - Aluminum

E. Institute for Sustainable Infrastructure (ISI):

1. Envision – v3

F. National Association of Architectural Metal Manufacturers (NAAMM):

1. Metal Finishes Manual for Architectural and Metal Products

G. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1. Architectural Sheet Metal Manual

1.03 DEFINITIONS:

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

D. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Warranty documentation as specified in Section 01 61 00.

C. O&M documentation as specified in Section 01 78 23.

D. Submit the following as specified in Section 01 33 00.

1. Product data: For each type of product indicated.

a. For louvers specified to bear AMCA seal, include printed catalog catalogue pages showing specified models with appropriate AMCA Certified Ratings Seals.

2. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show frame profiles and blade profiles, angles, and spacing.

a. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

b. Show mullion profiles and locations.

3. Samples Color Selection: Color Selector showing the full range of manufacturer’s standard colors.

4. Samples for Verification: Two samples of each color requested by the Engineer for selection:

5. Delegated-design submittal: For louvers to comply with structural performance requirements and design criteria specified in this Section, including analysis data signed and sealed by the qualified professional Engineer responsible for their preparation.

6. Product test reports: Based on evaluation of comprehensive tests performed in accordance with AMCA 500-L by a qualified testing agency or by Manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified in this Section.

E. Sustainable Design Submittals:

1. As specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Performance Requirements:

1. Delegated design: Design louvers, including comprehensive engineering analysis by a qualified professional Engineer, using structural performance requirements and design criteria indicated.

2. Structural performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

C. Wind loads: Determine loads based on pressures as shown on the Drawings.

1. Ultimate design wind speed (VULT): 175 mph

2. Risk Category: III

3. Exposure Category: C

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

1. Temperature change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.

E. Louver Performance Ratings: Provide louvers in accordance with requirements specified, as demonstrated by testing Manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.

F. Comply with the requirements specified in Section 01 45 00.

G. Source Limitations: Obtain louvers and vents from single source from a single Manufacturer where indicated to be of same type, design, or factory-applied color finish.

H. Welding: Qualify procedures and personnel in accordance with AWS D1.2.

I. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

1.06 PROJECT CONDITIONS:

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1. Brace and support units to prevent deformation during delivery.

2. Factory wrap units with accepted materials to protect finish during delivery and storage.

3. Handle units with care to prevent bending or scratching.

4. Placement:

a. Material shall be placed in accordance with sound material handling practices and in such a way as to minimize racking.

b. Louver sections may be hoisted by attaching straps to the jambs and lifting the section while it is in a vertical position.

c. Louver sections should only be lifted and carried by the jambs. Heads, sills and blades are not to be used for lifting or hoisting louver sections.

5. Shop assembly for architectural screen: Coordinate field measurements and shop Drawings with fabrication and shop assembly to minimize field adjustments, mechanical attachment and field assembly of units. Pre-assemble units in ship to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.

1.08 WARRANTY:

A. Warranty requirements as specified in Section 01 78 36.

1.09 O&M SPECIAL REQUIREMENTS:

A. O&M data requirements as specified in Section 01 78 23.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Fixed, Extruded-Aluminum Louvers:

1. Horizontal, Drainable-Blade Louver:

a. Construction Specialties, Inc., A4097

b. Greenheck Fan Corporation, ESD-403

c. Nystrom Building Products, Drainable Louvers

d. Ruskin Company; Tomkins PLC, ELF 375 Series

2.02 MATERIALS:

A. Sustainable Design Product Requirements:

1. Comply with the requirements as specified in Section 01 81 13.01.

2. ISI Envision:

a. Sustainable procurement practices (RA1.2): Maximize the procurement of materials that follow sustainable procurement practices.

b. Recycled Materials (RA1.3): Maximize the procurement of materials with recycled content.

c. Locally sourced materials (RA1.4): Maximize the procurement of materials within the radius as specified in Section 01 81 13.01.

B. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.

C. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

D. Aluminum Castings: ASTM B26, Alloy 319.

2.03 COMPONENTS:

A. Fixed, Extruded-Aluminum Louvers:

1. Horizontal, Drainable-Blade Louver:

a. Louver Depth: 4-inches.

b. Frame and Blade Nominal Thickness: Not less than 0.080-inch for blades and 0.080-inch for frames.

c. Mullion Type: Sliding interlock with internal drains.

d. Heads, sills, jambs and mullions to be one-piece structural aluminum members with integral caulking slot and retaining beads.

e. Blades to be one-piece aluminum extrusions with gutter(s) designed to catch and direct water to jamb and mullion drains.

f. Louver Performance Ratings:

(1) Free area: Not less than 8.0 square feet for 48-inch wide by 48-inch high louver.

(2) Free area velocity at point of beginning water penetration: Not less than 1040 fpm.

(3) Intake pressure drop at point of beginning water penetration: Not more than 0.20-inch wg static pressure drop.

(4) Air performance: Not more than 0.18-inch wg static pressure drop at 1000-fpm free-area exhaust velocity.

(5) AMCA Seal: Mark units with AMCA Certified Ratings Seal.

B. Louver Screens:

1. General: Provide screen at each exterior louver.

a. Screen location for fixed louvers: Interior face.

b. Screening Type: Bird screening.

2. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6-inches from each corner and at 12-inches on center (o.c.).

3. Louver screen frames: Fabricate with mitered corners to louver indicated.

   a. Metal: Same kind and form of metal as indicated for louver which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.

   b. Finish: Same finish as louver to which louver screens are attached.

   c. Type: Re-wireable frames with a driven spline or insert.

4. Louver screening for aluminum louvers:

   a. Bird screening: Aluminum, 1/2-inch square mesh, 0.063-inch wire.

   b. Blank-off panels:

      (1) Insulated, blank-off panels: Laminated panels consisting of insulating core surfaced on back and front with metal sheets and attached to back of louver.

         (a) Thickness: 2-inches.

         (b) Metal facing sheets: Aluminum sheet, not less than 0.032-inch nominal thickness.

         (c) Insulating core: extruded-polystyrene foam.

         (d) Edge treatment: Trim perimeter edges of blank-off panels with louver Manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch nominal thickness channel frames, with corners mitered and with same finish as panels.

         (e) Seal perimeter joints between panel faces and louver frames with gaskets or sealant.

         (f) Panel finish: Same type of finish applied to louver.

         (g) Attach blank-off panels with clip.

2.04 ACCESSORIES:

A. Fasteners: Use types and sizes to suit unit installation conditions.

   1. Use tamper-resistant screws for exposed fasteners unless otherwise indicated.

   2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.

   3. For color-finished louvers, use fasteners with heads that match color of louvers.

B. Post-installed fasteners for concrete and masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing in accordance with ASTM E488, conducted by a qualified independent testing agency.

C. Jamb trim: Provide jamb trim at louvers where stone facing returns to the louver frames as shown on the Drawings. Jamb trim shall be fabricated from material matching the louver construction and finished to match.

D. Bituminous paint: Cold-applied asphalt emulsion in accordance with ASTM D1187.

2.05 FABRICATION:

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.

1. Horizontal mullions: Provide horizontal mullions at joints where shown on drawings or required due to height of louver.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Heads, sills, jambs and mullions to be one-piece structural aluminum members with integral caulking slot and retaining beads.

F. Blades to be one-piece aluminum extrusions with gutter(s) designed to catch and direct water to jamb and mullion drains.

1. Provide vertical mullions of sliding interlock type and at spacings indicated, but not more than recommended by Manufacturer, or 72-inches o.c., whichever is less.

2. Exposed mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.

G. Provide sub-sills made of same material as louvers or extended sills for recessed louvers as shown on the Drawings.

H. Join frame members to each other and to fixed louver blades mechanically with stainless steel or aluminum fasteners. Match louver color where exposed to view.

2.06 FINISHES:

A. Provide finishes in accordance with NAAMM for recommendations for applying and designating finishes.

B. Aluminum Finishes:

1. Apply finishes in factory.

2. High-performance organic finish: 2-coat fluoropolymer finish in accordance with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to in accordance with coating and resin Manufacturers' written instructions.

a. Color and gloss: As selected by Engineer from Manufacturer's full range in accordance with the procedures specified in Section 01 33 00.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Examine substrates and openings, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Coordinate setting Drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.02 ERECTION / INSTALLATION / APPLICATION:

A. Locate and place louvers and vents level, plumb, and t alignment specified in this Section with adjacent Work.

B. Use concealed anchorages where possible. Use non-ferrous metal or hot-dip galvanized anchors and inserts for installation and elsewhere as required for corrosion resistance. Use stainless steel or lead expansion bolt devices for drilled-in place anchors. Furnish inserts, as required, to be set into concrete or masonry Work.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Do not erect warped, bowed, deformed or otherwise damaged or defaced members. Remove and replace any members damaged in the erection process as directed.

F. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective Work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

G. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

H. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Seal joints between units and substrate to provide a weathertight installation at all joints and intersections and at opening perimeters. Comply requirements as specified in Section 07 92 00 for sealants applied during louver installation.

I. Erection Tolerances:

1. Maximum variation from plane or location shown on the approved shop Drawings: 1/8-inch per 12-feet of length, but not exceeding 1/2-inch in any total building length or portion thereof (non-cumulative).

2. Maximum offset from true alignment between two members abutting end to end, edge-to-edge in line or separated by less than 3-inch: 1/16-inch (shop or field joints). This limiting condition shall prevail under both load and no load conditions.

3.03 PROTECTION:

A. Initiate and maintain protection and other precautions required through the remainder of the construction period, to ensure that, except for normal weathering, louver units will be free of damage or deterioration at the time of final inspection.

3.04 STARTUP AND COMMISSIONING:

A. Startup and commissioning requirements for the equipment specified herein as specified in Section 01 78 25.

3.05 CLEANING:

A. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective Work. If results of restoration are unsuccessful, as determined by Engineer, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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DIVISION 09

FINISHES

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SECTION 09 29 00

DRYWALL CONSTRUCTION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide gypsum board and accessories as indicated and in compliance with Contract Documents.

B. Section Includes:

1. Interior gypsum board

2. Tile backing panels

3. Framing Components

1.02 REFERENCES:

A. ASTM International (ASTM):

1. B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

2. C423: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

3. C475: Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board

4. C665: Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

5. C834: Standard Specification for Latex Sealants

6. C840: Standard Specification for Application and Finishing of Gypsum Board

7. C919: Standard Practice for Use of Sealants in Acoustical Applications

8. c954: Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness

9. C1002: Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs

10. C1047: Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base

11. C1177: Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing

12. C1178: Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel

13. C1278: Standard Specification for Fiber-Reinforced Gypsum Panel

14. C1288: Standard Specification for Discrete Non-Asbestos Fiber-Cement Interior Substrate Sheets

15. C1325: Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cementitious Backer Units

16. C1396: Standard Specification for Gypsum Board

17. C1629: Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels

18. C1658: Standard Specification for Glass Mat Gypsum Panels

19. D3273: Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber

20. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

21. E90: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

22. E119: Standard Test Methods for Fire Tests of Building Construction and Materials

23. E413: Classification for Rating Sound Insulation

B. American National Standards Institute (ANSI):

1. A108.11: Interior Installation of Cementitious Backer Units

2. A118.9: Cementitious Backer Units

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.07 PROJECT/SITE CONDITIONS:

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Low-Emitting Materials: For ceiling and wall assemblies, provide materials and construction identical to those tested in assembly and complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.02 GYPSUM BOARD, GENERAL:

A. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Regional Materials: Gypsum panel products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

C. Regional Materials: Gypsum panel products shall be manufactured within 500 miles of Project site.

D. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.03 INTERIOR GYPSUM BOARD:

A. Manufacturers:

1. CertainTeed Corp

2. Georgia-Pacific Gypsum LLC

3. USG Corporation

B. Moisture- and Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 1/2 inch, regular type

2. Long Edges: Tapered

3. Mold Resistance: ASTM D3273, score of 10

C. Moisture- and Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, regular type

2. Long Edges: Tapered

3. Mold Resistance: ASTM D3273, score of 10

D. Gypsum Wallboard: ASTM C1396.

1. Thickness: 5/8 inch.

2. Long Edges: Tapered for prefilling.

E. Gypsum Board, Type X: ASTM C1396.

1. Thickness: 5/8 inch.

2. Long Edges: Tapered for prefilling.

2.04 TILE BACKING PANELS:

A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178, with manufacturer's standard edges.

1. Products:

a. CertainTeed Corp.; GlasRoc Tile Backer

b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer

2. Core: 1/2 inch , regular type

3. Mold Resistance: ASTM D3273, score of 10

2.05 TRIM ACCESSORIES:

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.

2. Shapes:

a. Cornerbead

b. Bullnose bead

c. LC-Bead: J-shaped; exposed long flange receives joint compound

d. L-Bead: L-shaped; exposed long flange receives joint compound

e. U-Bead: J-shaped; exposed short flange does not receive joint compound

f. Expansion (control) joint

g. Curved-Edge Cornerbead: With notched or flexible flanges

2.06 JOINT TREATMENT MATERIALS:

A. General: Comply with ASTM C475

B. Joint Tape:

1. Interior Gypsum Board: Paper

2. Tile Backing Panels: As recommended by panel manufacturer

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.

2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use drying-type, all-purpose compound.

4. Finish Coat: For third coat, use drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2. Cementitious Backer Units: As recommended by backer unit manufacturer.

3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.07 FRAMING COMPONENTS

A. Manufacturers:

1. Clark Dietrich Steel Framing Systems

2. Dale Industries, Inc. - Dale/Incor

3. National Gypsum Company

B. Steel Studs and Runners: Provide in accordance with ASTM C645.

1. Minimum base metal thickness and strength: 0.0179-inch/33 ksi or 0.0155-inch/50 ksi

2. Depth: 3 5/8-inches, and 6-inches where shown on Drawings

3. At door jambs and walls having a tile finish provide minimum base metal thickness and strength: 0.0312-inch/33 ksi, Depth: 3 5/8-inches

C. Deep-Leg Deflection Track: ASTM C645 top runner with 2-inches deep flanges.

2.08 AUXILIARY MATERIALS:

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Steel Drill Screws: ASTM C1002, unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

2. Recycled Content of Blankets: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 70 percent.

E. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.

1. Products:

a. Pecora Corporation; AIS-919

b. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant

c. USG Corporation; SHEETROCK Acoustical Sealant

2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Acoustical joint sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLING FRAMING COMPONENTS, GENERAL:

A. Steel framing installation standard: Install steel framing in accordance with ASTM C754 and with ASTM C840 requirements that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, and heavy trim, grab bars, toilet accessories, furnishings, or similar construction, in accordance with recommendations of the Gypsum Board Manufacturer or, if none available, with United States Gypsum Co.'s "Gypsum Construction Handbook."

C. Isolate steel framing from building structure at locations as required to prevent transfer of loading imposed by structural movement. In accordance with details shown on the Drawings.

1. Where building structure abuts ceiling perimeter or penetrates ceiling.

2. Where partition framing and wall furring abut structure, except at floor.

a. Provide slip- or cushioned-type joints as detailed to attain lateral support and avoid axial loading.

D. Do not bridge building control and expansion joints with steel framing or furring members. Independently frame both sides of joints with framing or furring members.

3.03 INSTALLING STEEL FRAMING FOR WALLS AND PARTITIONS:

A. Install runners (tracks) at floors, ceilings, and structural walls and columns where gypsum board stud assemblies abut other construction.

B. Installation tolerances: Install each steel framing and furring member so that fastening surfaces do not vary more than 1/8-inches from the plane formed by the faces of adjacent framing.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are shown on Drawings to terminate at suspended ceilings or at another level above ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

1. For STC-rated and fire-resistance-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid structural surfaces to obtain ratings, install framing around structural and other members ex- tending below floor/roof slabs and decks, as needed, to support gypsum board closures needed to make partitions continuous from floor to underside of solid structure.

D. Terminate partition framing at suspended ceilings where shown on Drawings.

E. Install steel studs and furring in sizes and at spacing shown on Drawings.

1. Single-Layer Construction: Space studs 16-inches on center (o.c.), unless otherwise indicated.

2. Tile Backer Unit Construction: Space studs 16-inches o.c., unless otherwise indicated.

F. Install steel studs so flanges point in the same direction and leading edge or end of each gypsum board panel can be attached to open (unsupported) edges of stud flanges first.

G. Frame door openings to in accordance with applicable published recommendations of the Gypsum Board Manufacturer, unless otherwise indicated. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

1. Install 2 studs at each jamb, unless otherwise indicated.

3.04 APPLYING AND FINISHING PANELS, GENERAL:

A. Comply with ASTM C840.

B. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

C. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

D. Form control and expansion joints with space between edges of adjoining gypsum panels.

E. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 square feet in area.

2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.

F. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

H. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.05 APPLYING INTERIOR GYPSUM BOARD:

A. Install interior gypsum board in the following locations:

1. Moisture- and Mold-Resistant Type: Unless indicated otherwise

2. Glass-Mat Interior Type: At surfaces to receive tile

B. Single-Layer Application:

1. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

2. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.06 APPLYING TILE BACKING PANELS:

A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.

B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.07 INSTALLING TRIM ACCESSORIES:

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C840 and in specific locations accepted by Engineer for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated

3.08 FINISHING GYPSUM BOARD:

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated

2. Level 2: Panels that are substrate for tile

3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated

   a. Primer and its application to surfaces are specified in other Division 09 sections.

E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

3.09 PROTECTION:

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

3.10 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 09 30 00

TILE WORK

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide tile work as indicated and in compliance with Contract Documents.

1. Section Includes:

a. Ceramic tile

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. A108.1: Specifications for the Installation of Ceramic Tile

2. A108.1A: Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar

3. A108.2: General Requirements: Materials, Environmental and Workmanship

4. A108.10: Installation of Grout in Tilework

5. A108.11: Interior Installation of Cementitious Backer Units

6. A108.13: Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone

7. A108.17: Installation of Crack Isolation Membranes

8. A118.1: Dry-Set Portland Cement Mortar

9. A118.3: Chemical Resistant, Water Cleanable Tile-Setting and Grouting Epoxy and Water Cleanable Tile Setting Epoxy Adhesive

10. A118.4: Latex Portland Cement Mortar

11. A118.5: Chemical Resistant Furan Mortars and Grouts for Tile Installation

12. A118.6: Standard Cement Grouts for Tile Installations

13. A118.7: Polymer Modified Tile Grouts for Tile Installations

14. A118.9: Cementitious Backer Units

15. A118.10: Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone

16. A118.11: Exterior Glue Plywood Latex-Portland Cement Mortar

17. A136.1: Organic Adhesives for Installation of Ceramic Tile

18. A137.1: Specifications for Ceramic Tile

B. ASTM International (ASTM):

1. A82: Standard Specification for Steel Wire, Plain for Concrete Reinforcement

2. A185: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

3. A666: Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

4. C241: Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic

5. C242: Standard Terminology of Ceramic Whitewares and Related Products

6. C267: Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes

7. C503: Standard Specification for Marble Dimension Stone

8. C615: Standard Specification for Granite Dimension Stone

9. C629: Standard Specification for Slate Dimension Stone

10. C847: Specification for Metal Lath

11. C920: Standard Specification for Elastomeric Joint Sealants

12. C1028: Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method

13. C1288: Standard Specification for Discrete Non-Asbestos Fiber-Cement Interior Substrate Sheets

14. C1325: Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cementitious Backer Units

15. C1353: Standard Test Method Using the Taber Abraser for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic

16. D87: Standard Test Method for Melting Point of Petroleum Wax (Cooling Curve)

17. D226: Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

18. D4397: Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

C. Federal Regulations (CFR:)

1. 40 CFR 59: National Volatile Organic Compound Emission Standards for Architectural Coatings

D. Tile Council of North America (TCA):

1. Handbook for Ceramic Tile Installation.

1.03 DEFINITIONS:

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in "American National Standard Specifications for Installation of Ceramic Tile."

C. Module Size: Actual tile size plus joint width indicated

D. Face Size: Actual tile size, excluding spacer lugs

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated.

C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.

E. Qualification Data: For qualified Installer.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

C. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

D. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

E. Store liquid materials in unopened containers and protected from freezing.

F. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.08 PROJECT/SITE CONDITIONS:

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

B. Do not install adhesives and grouts in an unventilated environment.

C. Maintain ambient and substrate temperature of 50 degrees F during installation of mortar materials.

1.09 MAINTENANCE:

A. Extra Materials:

1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.01 PRODUCTS, GENERAL:

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.

C. FloorScore Compliance: Tile for floors shall comply with requirements of FloorScore Standard.

D. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match accepted Samples.

E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.02 TILE PRODUCTS:

A. Tile Type: Glazed wall tile.

1. Manufacturers:

a. American Marazzi Tile, Inc.

b. American Olean; Division of Dal-Tile International Inc.

c. Daltile; Division of Dal-Tile International Inc.

2. Module Size: 6 by 6 inches.

3. Thickness: 5/16-inch.

4. Face: Plain with modified square edges or cushion edges

5. Finish: Bright, opaque glaze.

6. Tile Color and Pattern: As selected by Engineer from manufacturer's full range.

7. Grout Color: As selected by Engineer from manufacturer's full range.

8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

a. Base for Portland Cement Mortar Installations: Coved, module size 6 by 6 inches.

b. Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose, module size 6 by 6 inches.

c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.

d. External Corners for Portland Cement Mortar Installations: Bullnose shape with radius of at least 3/4-inch unless otherwise indicated.

e. External Corners for Thin-Set Mortar Installations: Surface bullnose, same size as adjoining flat tile.

f. Internal Corners: Field-butted square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

B. Latex-Portland Cement: Flexible mortar consisting of cement-based mix and latex additive.

1. Products:

a. Boiardi Products; a QEP company; Elastiment 323 Cement Based Waterproofing, Anti-Fracture/Crack Suppression Membrane

b. C-Cure; UltraCure 971

c. MAPEI Corporation; Mapelastic (PRP 315)

2.03 SETTING MATERIALS:

A. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1.

1. Manufacturers:

a. Boiardi Products; a QEP company

b. Bonsal American; an Oldcastle company

c. Bostik, Inc.

2. For wall applications, provide mortar that complies with requirements for non-sagging mortar in addition to the other requirements in ANSI A118.1.

B. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.

1. Manufacturers:

a. Boiardi Products; a QEP company

b. Bonsal American; an Oldcastle company

c. Bostik, Inc.

2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.

3. For wall applications, provide mortar that complies with requirements for non-sagging mortar in addition to the other requirements in ANSI A118.4.

2.04 GROUT MATERIALS:

A. Polymer-Modified Tile Grout: ANSI A118.7.

1. Manufacturers:

a. Boiardi Products; a QEP company

b. Bonsal American; an Oldcastle company

c. Bostik, Inc.

2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

2.05 MISCELLANEOUS MATERIALS:

A. Trowelable Underlayments and Patching Compounds: Latex-modified, Portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

1. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.

B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

C. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints and that does not change color or appearance of grout.

1. Products:

a. Bonsal American; an Oldcastle company; Grout Sealer

b. Bostik, Inc.; CeramaSeal C-Cure; Penetrating Sealer 978

c. Custom Building Products; Jamo Inc.

d. MAPEI Corporation; KER Southern Grouts & Mortars, Inc.; Silicone Grout Sealer

e. Summitville Tiles, Inc.; SL-15, Invisible Seal Penetrating Grout and Tile Sealer

f. TEC; a subsidiary of H. B. Fuller Company

2.06 MIXING MORTARS AND GROUT:

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.

2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.

3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Engineer.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Protect surrounding work from damage.

B. Vacuum clean surfaces.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match accepted Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.03 TILE INSTALLATION:

A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.

F. Joint Widths and Grout Types: Unless otherwise indicated, install tile with the following joint widths and grout types:

1. Glazed Wall Tile: 1/16-inch.

G. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

H. Grout Sealer: Apply grout sealer to grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.04 WATERPROOFING INSTALLATION:

A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.

B. Do not install tile or setting materials over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

3.05 CRACK ISOLATION MEMBRANE INSTALLATION:

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.

B. Do not install tile or setting materials over crack isolation membrane until membrane has cured.

3.06 CLEANING AND PROTECTING:

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.

2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

B. Protect installed tile work with Kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 09 51 13

ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide suspended acoustical ceilings, mechanical suspension system and accessories; as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Architectural Manufacturers Association (AAMA):

1. 611: Voluntary Specification for Anodized Architectural Aluminum

B. American Society of Civil Engineers (ASCE):

1. 7: Minimum Design Loads for Buildings and Other Structures - Includes Supplement No. 1

C. ASTM International (ASTM):

1. A580: Standard Specification for Stainless Steel Wire.

2. A641: Standard Specification for Zinc–Coated (Galvanized) Carbon Steel Wire.

3. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

4. B164: Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire

5. B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

6. B633: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

7. C635: Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems or Acoustical Tile and Lay-in Panel Ceilings

8. C636: Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels

9. C834: Standard Specification for Latex Sealants

10. D3273: Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber

11. D3274: Standard Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Fungal or Algal Growth, or Soil and Dirt Accumulation

12. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

13. E90: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

14. E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.

15. E795: Standard Practices for Mounting Test Specimens During Sound Absorption Tests

16. E1190: Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members

17. E1264: Standard Classification for Acoustical Ceiling Products

18. E1512: Standard Test Methods for Testing Bond Performance of Bonded Anchors

19. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

20. F594: Standard Specification for Stainless Steel Nuts

21. G21: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

1.03 PRE-INSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at Project site.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

C. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

1. Samples for Initial Selection: For components with factory-applied color finishes.

2. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.

    a. Acoustical Panel: Set of 6-inch square. Samples of each type, color, pattern, and texture.

    b. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch-long Samples of each type, finish, and color.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.

2. Structural members to which suspension systems will be attached.

3. Size and location of initial access modules for acoustical panels.

4. Items penetrating finished ceiling including the following:

    a. Lighting fixtures

    b. Air outlets and inlets

    c. Speakers

    d. Sprinklers

    e. Access panels

    f. Perimeter moldings

5. Qualification Data: For testing agency.

6. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.

7. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

8. Field quality-control reports.

E. Maintenance Data: For finishes to include in maintenance manuals.

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed

b. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed

c. Hold-Down Clips: Equal to 2 percent of quantity installed

d. Impact Clips: Equal to 2 percent of quantity installed

1.05 SUSTAINABLE DESIGN

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

C. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

D. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.08 PROJECT/SITE CONDITIONS:

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 DEF

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E1264 for Class A materials.

2. Smoke-Developed Index: 50 or less.

C. Dewatering Facility Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.02 ACOUSTICAL PANELS, GENERAL:

A. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.

2. Suspension System: Obtain each type from single source from single manufacturer.

B. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.

C. Recycled Content: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 50 percent.

D. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.

E. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

F. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E1264 and not manufacturers' proprietary product designations, provide products selected by Engineer from each manufacturer's full

range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.03 ACOUSTICAL PANELS:

A. Products: Asbestos free, wet felted mineral fiber faced overlay, antimicrobial treated to inhibit growth of fungus, mold and mildew, factory applied moisture and sag resistant treatment.

B. Manufacturers:

1. Armstrong World Industries, Inc .- Ultima™ High NRC (Basis of Design)

2. CertainTeed Corp.

3. USG Interiors, Inc.; Subsidiary of USG Corporation.

C. Classification: Proved panels as follows:

1. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted; with vinyl overlay on face.

2. Pattern: E (lightly textured)

3. Dewatering Facility: Provide fire resistance-rated panels complying with ASTM E1264 for type, form, and pattern.

D. Color: White

E. LR: Not less than 0.90

F. NRC: Not less than 0.75

G. CAC: Not less than 35

H. AC: Not less than 170

I. Edge/Joint Detail: Reveal sized to fit flange of exposed suspension-system members.

J. Thickness: 3/4 inch

K. Modular Size: 24 by 24

L. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D3273 and evaluated according to ASTM D3274 or ASTM G21.

2.04 METAL SUSPENSION SYSTEMS, GENERAL:

A. Recycled Content: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C635.

C. Attachment Devices: Size for five times the design load indicated in ASTM C635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E488 or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Type: Post-installed bonded anchors.

b. Corrosion Protection: Stainless-steel components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641, Class 1 zinc coating, soft temper.

2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch diameter wire.

E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

F. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

H. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place.

I. Hold-Down Clips: Provide 10 feet to the building interior from face of exterior doors, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.

J. Dewatering Facility Impact Clips: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

2.05 METAL SUSPENSION SYSTEM:

A. Manufacturers:

1. Armstrong World Industries, Inc.

2. CertainTeed Corp

3. USG Interiors, Inc.; Subsidiary of USG Corporation

B. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A653, not less than G30 coating designation; with prefinished 9/16-inch-wide metal caps on flanges.

1. Structural Classification: Intermediate-duty system

2. End Condition of Cross Runners: Override (stepped) type

3. Face Design: Flat, flush

4. Cap Material: Steel cold-rolled sheet

5. Cap Finish: Painted white

2.06 METAL EDGE MOLDINGS AND TRIM:

A. Manufacturers:

1. Armstrong World Industries, Inc.

2. CertainTeed Corp

3. USG Interiors, Inc.; Subsidiary of USG Corporation

B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.

2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.

3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.07 ACCESSORIES:

A. Hold-Down Clips: Manufacturer's standard hold-down.

2.08 ACOUSTICAL SEALANT:

A. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.

1. Exposed and Concealed Joints: Non-sag, paintable, non-staining latex sealant.

2. Concealed Joints: Nondrying, nonhardening, non-skinning, non-staining, gunnable, synthetic-rubber sealant.

3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.03 INSTALLATION:

A. General: Install acoustical panel ceilings to comply with ASTM C636 and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

1. Dewatering Facility: Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

2. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings (Dewatering facility), to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

4. to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

8. Do not attach hangers to steel deck tabs.

9. Do not attach hangers to steel roof deck. Attach hangers to structural members.

10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.

11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.

3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

G. Dewatering Facility: Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

H. Dewatering Facility: Where there is an accessible concealed floor or floor/ceiling all fire barriers shall be permanently identified with signs or stenciling in the concealed space and shall comply with all of the following:

1. Be located in accessible concealed floor, floor/ceiling, or attic spaces

2. Be located within 15 feet of the end of each wall and at intervals not exceeding 30 feet measured horizontally along the wall or partition

3. Include lettering not less than 3 inches in height with a minimum 3/8-inch stroke in a contrasting color

4. Identify the wall type and its fire resistive rating as applicable

3.04 CLEANING:

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge mouldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 09 90 00

PAINTING AND COATING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide general information, products and execution for painting and coating as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. 359-A-85: Colors for Color Identification and Coding

B. ASTM International (ASTM):

1. D523: Standard Test Method for Specular Gloss

2. D4258: Standard Practice for Surface Cleaning Concrete for Coating

3. D6386: Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

C. California Air Resources Board (CARB):

1. 2007: Suggested Control Measure for Architectural Coatings

D. California Department of Public Health (CDPH):

1. Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

E. Environmental Protection Agency (EPA):

1. 40 CFR 261 – Identification and Listing of Hazardous Waste

2. AP-42 – Compilation of Air Pollutant Emission Factors - Volume I: Stationary Point and Area Sources, Chapter 13.2.6 – Abrasive Blasting

F. Institute for Sustainable Infrastructure (ISI):

1. Envision – v3

G. National Association of Corrosion Engineers (NACE):

1. SP0188: Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

2. SP0287: Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape

H. NSF International (NSF):

1. 61: Drinking Water System Components – Health Effects

I. Occupational Safety and Health Administration (OSHA):

1. 29 CFR 1910: Occupational Safety and Health Standards

2. 29 CFR 1926: Safety and Health Regulations for Construction

J. The Society for Protective Coatings (SSPC):

1. PA 2: Procedure for Determining Conformance to Dry Coating Thickness Requirements

2. PA 10: Guide to Safety and Health Requirements for Industrial Painting Projects

3. QP 1: Standard Procedure for Evaluating Qualifications of Industrial/Marine Painting Contractors

4. SP 1: Solvent Cleaning

5. SP 2: Hand Tool Cleaning

6. SP 3: Power Tool Cleaning

7. SP 8: Pickling

8. SP 11: Power-Tool Cleaning to Bare Metal

9. SP 16: Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals

K. The Society for Protective Coatings/National Association of Corrosion Engineers (SSPC/NACE):

1. SP 6/NACE No. 3: Commercial Blast Cleaning

2. SP 7/NACE No. 4: Brush-Off Blast Cleaning

3. SP 10/NACE No. 2: Near-White Blast Cleaning

4. SP 13/NACE No. 6: Surface Preparation of Concrete

5. SP WJ-1/NACE WJ-1: Waterjet Cleaning of Metals-Clean to Bare Substrate

L. South Coast Air Quality Management District (SCAQMD):

1. Rule 1113: Architectural Coatings

1.03 DEFINITIONS:

A. Coverage: Total minimum dry film thickness (DFT) in mils or sf/gallon.

B. Paint: The term paint, as used herein, means coating systems materials including primers, sealers, fillers, emulsions, enamels, epoxy, lacquers, and other applied materials, whether used in prime coats, intermediate coats, or finish coats.

C. Gloss Levels: Paint gloss levels specified herein are based on the following ranges: 1.

Description	Gloss Range	ASTM D523 Test Method
Flat	0 to 15	85°
Eggshell	5 to 20	60°
Satin	15 to 35	60°
Semi-Gloss	30 to 65	60°
Gloss	Over 65	60°

1.04 SEQUENCING AND SCHEDULING:

A. Finishes as shown on the architectural Drawings and as specified in Section 09 90 00.

B. Work Not Included:

1. Surfaces in concealed or inaccessible areas such as furred spaces, foundation spaces, pipe or duct chases, shafts, or utility tunnels.

2. Surfaces of anodized or prefinished aluminum, stainless steel, bronze, brass, and chromium plate.

3. Moving parts of operating equipment, mechanical or electrical moving parts, linkages, sensing devices, and motor shafts.

4. Buried concrete surfaces.

5. Non-metallic materials such as glass and porcelain.

6. Prefinished electrical items such as motors, motor control centers, switchboards, switchgear, panelboards, transformers, and disconnect switches.

7. Prefinished architectural items such as acoustical tile, cabinets, building louvers, overhead coiling doors, sectional doors, and wall panels.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data:

1. Product and safety data and other information for proposed products.

2. A copy of the Manufacturer's coating application quality assurance manual.

C. Submit the product application procedure, current product data sheet (PDS), safety data sheet (SDS), and a copy of the quality assurance/quality control (QA/QC) report for surface preparation and coating application. Include complete surface preparation and cleaning procedures, as well as application equipment. Include anchor profiles, DFT, adhesion tests, temperature, humidity, holiday tests, and any other measurements taken for quality assurance and quality control during surface preparation and application.

D. Field-Applied Coatings Subject to Immersion Service:

1. Provide complete environmental condition information taken before abrasive blasting or coating. Provide environmental data at 2 hours increments if the prepared surface is not coated within 12 hours. Information provided shall include temperature, relative humidity, location description, time, date, technician name, and company.

2. Provide the Engineer with data from the replica tape used to measure surface preparation and corresponding measurements in mils. Provide location reference information for each replica tape.

3. Submit photos for the field application of coatings. Submit one photo of the field-blasted surface prior to the coating application for each area that is measured for anchor profile. Submit photos of each field-applied coat prior to the application of subsequent coats for each DFT measurement taken based on SSPC PA 2. Photos are not required for shop-applied coating application unless otherwise noted by the Engineer.

E. Submit the final field testing report to the Engineer within 2 weeks of the substantial completion date.

F. Samples:

1. Initial selection: Complete fan deck, color card, or actual color chips illustrating the full range of color availability.

2. Samples: Two 12-inches by 12-inches, illustrating colors, glosses, and textures for each surface finishing product scheduled.

G. Quality Control Submittals:

1. Contract closeout submittals: Warranty.

H. Provide the Engineer with a schedule of systems and locations requiring color selection.

I. Warranty Documentation:

1. Sample warranty

2. Warranty

J. Supplements listed in this Section.

K. Sustainable Design Submittals:

1. As specified in Section 01 81 13.01.

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications:

1. A minimum of 5 years of documented experience in the Work of this Section.

2. Approved by the Manufacturer.

C. Provide finish coats compatible with substrate materials or with prime coats specified in other sections.

D. First quality preparation, painting, and finishing is required. Dirt, grit, or dust in the paint or finish; runs, sags, or drips of paint or finish; or irregularity of finish is cause for

rejection. Remove rejected finishes; repair, re-prime, and refinish as required to achieve a first quality finish.

E. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds (VOCs).

2. Perform surface preparation and painting in accordance with the recommendations of the following:

a. The Paint Manufacturer's instructions, Product Data Sheets (PDS).

b. Federal, state, and local agencies having jurisdiction.

F. Coatings for Immersion Service: Under the direction of a NACE CIP Level 3:

1. Provide name and contact information.

2. Currently certified by NACE.

3. Attend progress meetings as required.

4. Oversee surface preparation and coating application and approve coating system.

G. Mockup:

1. Size: As required by the Engineer.

2. Before proceeding with Work under this Section, finish one complete space or item of each paint system and color required to show the quality of workmanship, materials, finish, texture, colors, and special details in compliance with the requirements of this Section. Provide one mockup for finishing process related spaces and items and one mockup for finishing architectural finished spaces and items.

3. Once approved, sample spaces and items shall serve as a standard for similar Work throughout the site.

1.09 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00 and Section 01 61 00 of this manual.

B. Delivery, storage, and handling requirements as specified in Section 01 60 00. Specific requirements in addition to Section 01 60 00 shall be:

1. Container label: Include the Manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

2. Paint materials: Store at an ambient temperature from 45 degrees F to 90 degrees F in a ventilated area or as required by the Manufacturer's instructions.

1.10 PROJECT/SITE CONDITIONS:

A. Do not apply paint in temperatures or moisture conditions outside of the Manufacturer’s recommended maximum or minimum allowable.

B. Work and storage areas shall be free of dust during the application of paint finishes. Do not apply finishes in spaces with accumulated rubbish, dust, or dirt or where construction activity is present.

C. Do not perform final abrasive blast cleaning whenever the relative humidity exceeds 85 percent, or whenever the surface temperature is less than 5 degrees F above the dew point of ambient air.

D. Primed surfaces shall be top-coated within 2 months or as required by the Paint Manufacturer.

E. Provide a lighting level of 80 foot-candles measured mid-height at the substrate surface.

1.11 WARRANTY:

A. Warranty requirements as specified in Section 01 78 36. Specific requirements in addition to Section 01 78 36 shall be:

1. Warranty for 2 years from the Substantial Completion date for the satisfactory performance and installation of the painting and coating system and associated appurtenances, including correction, or at the option of the Owner, removal and replacement of Work found to be defective. The Owner will be named as the beneficiary.

2. The Contractor and the Paint Manufacturer shall jointly furnish the warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. High Performance Coatings:

1. Ameron Protective Coatings
2. Sherwin Williams
3. Tnemec Coatings

B. Paints:

1. Benjamin Moore Paints
2. PPG Architectural Finishes, Inc.
3. Sherwin Williams

C. Specialty:

1. AkzoNobel/Ceilcote
2. AkzoNobel/Devoe High Performance Coatings
3. Darworth Company

D. Elastomeric Coating:

1. 3M Company
2. AkzoNobel/Polibrid
3. Gaco Western

E. Fusion-Bonded Coating:

1. ABC Coating Company
2. Western Coating, Inc.

F. Testing Equipment:

1. Magnetic type DFT gauge:

a. ElektroPhysic, MikroTest

2. Low-voltage wet sponge electrical holiday detector:

a. Tinker and Rasor

G. Fusion-Bonded Polytetrafluoroethylene Lube:

1. 3M Company, No. 62-4621-4830-5

H. Fusion Bonded Grease Lube:

1. Amrep, RL 736

2. McMaster-Carr Co.

2.02 MATERIALS:

A. Sustainable Design Product Requirements:

1. As specified in Section 01 81 13.01.

2. ISI Envision:

a. Sustainable procurement practices (RA1.2): Maximize the procurement of materials that follow sustainable procurement practices.

b. Recycled materials (RA1.3): Maximize the procurement of materials with recycled content.

c. Locally sourced materials (RA1.4): Maximize the procurement of materials within the radius as specified in Section 01 81 13.01.

B. General:

1. Coatings: Ready-mixed, furnished through one Manufacturer, except field-catalyzed coatings, of good flow and brushing properties, capable of drying or curing free of streaks or sags; provide field-applied primers or undercoats produced by the same Manufacturer as the finish coat(s).

2. Thinners, cleaners, driers, and other additives: As recommended by the Paint Manufacturer.

3. Application equipment: Equipment as recommended by the Paint Manufacturer.

C. Maximum VOC Content; Interior Paints, Coatings, and Accessories:

1. Primers: 150 g/L

2. Flat paints and coatings: 50 g/L

3. Non-flat paints and coatings: 150 g/L

4. Anti-corrosive and anti-rust coatings: 250 g/L

5. Other sealers: 200 g/L

Product	Definition
Acrylic Latex	100% acrylic, water reducible corrosion-resistant coating for light to moderate use exposures, finish as specified
Acrylic Sealer	Clear acrylic
Alkyd Enamel	Optimum quality, medium long oil, finish as specified
Bituminous Paint	Single-component, coal-tar pitch based
Epoxy, Filler/Surfacer	100% solids epoxy trowel Grade filler and surfacer, non-shrinking, suitable for application to concrete. Approved for potable water contact and in accordance with NSF/ANSI 61, where required
Epoxy, High Build	Polyamide epoxy, minimum 69% volume solids, capability of 4 to 8 MDFTPC
Epoxy, High Solids	Polyamide epoxy, 80% volume solids, minimum, suitable for immersion service
Epoxy, Non-skid (Aggregated)	Polyamide or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy, NSF	Polyamide epoxy, approved for potable water contact and in accordance with NSF/ANSI 61
Epoxy, Primer – Ferrous Metal	Polyamide, anti-corrosive, converted epoxy primer containing rust-inhibitive pigments
Epoxy, Primer – Other	Epoxy primer, high-build, as recommended by the Paint Manufacturer for specific galvanized metal, copper, or non-ferrous metal alloy to be coated
Epoxy, Water Base	2-component, polyamide epoxy emulsion, finish as required
Fusion-Bonded Coating	100% solids, thermosetting, fusion-bonded, dry powder epoxy or polyurethane resin, suitable for the intended service
Fusion-Bonded, TFE Lube or Grease Lube	TFE, liquid coating or open gear grease

Product	Definition
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats
Polyurethane, Elastomeric	100% solids, plural component, spray-applied, high build, elastomeric polyurethane coating, suitable for the intended service
Polyurethane, Enamel	2-component, aliphatic or acrylic based polyurethane; high-gloss finish
Rust-Inhibitive Primer	Single package steel primers with anti-corrosive pigment loading
Sanding Sealer	Co-polymer oil, clear, dull luster
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
Stain, Concrete	Acrylic, water repellent, penetrating stain
Wash Primer	Vinyl butyral acid
Zinc-Rich Primer, Organic	Converted epoxy, epoxy/phenolic or urethane type, minimum 10 pounds metallic zinc content per gallon

D. Maintenance:

1. Extra materials: One gallon of each color and sheen.

2.03 FINISHES:

A. Shop Coating Requirements:

1. Equipment shall be primed and finish coated in the shop by the Manufacturer and touched up in the field with identical material after installation.

2. Where the Manufacturer's standard coating is not suitable for the intended service condition, the Engineer may approve the use of a tie-coat to be used between the Manufacturer's standard coating and the specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by the Field Finish Coat Manufacturer. Coordinate the details of the Equipment Manufacturer's standard coating with the Paint Manufacturer.

2.04 MIXES:

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by the Paint Manufacturer.

2. No partial batches are permitted.

3. Do not use multiple-component coatings mixed beyond their pot life.

4. Furnish small quantity kits for touchup painting and for painting other small areas.

5. Mix only components specified and furnished by the Paint Manufacturer.

6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

7. Colors: Formulate paints with colorants free of lead and lead compounds.

PART 3 - EXECUTION

3.01 PREPARATION:

A. General: Inspect and provide substrate surfaces prepared in accordance with the Contract Documents and the most stringent recommendations of the Paint Manufacturer whose product is to be applied. The more stringent requirements shall apply. If any surface is found to be unsuitable to produce a proper finish, do not apply material until the surfaces are made satisfactory. Application of paint to any surface shall be deemed to be acceptance of that surface and full responsibility shall be borne by the Contractor.

B. Shop Abrasive Blasting:

1. Notify the Engineer at least 7 days prior to the start of shop-blast cleaning to allow for inspection of the Work during surface preparation and shop application of paints.

2. Structural steel and similar items, as approved by the Engineer, may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternative to shop-blast cleaning.

C. Field Abrasive Blasting: Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop-blasted or field-blasted and primed or coated.

D. Metal Surface Preparation:

1. In accordance with the SSPC Specification.

2. The words solvent cleaning, hand tool cleaning, wire brushing, and blast cleaning, or similar words of equal intent in the contract documents or in the Paint Manufacturer's Specification, refer to the applicable SSPC Specification.

3. Where OSHA 29 CFR 1910, OSHA 29 CFR 1926, EPA 40 CFR 261, EPA AP-42, or SSPC PA 10 regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. The Paint Manufacturer's recommendations for wet-blast additives and first coat application shall apply.

4. Hand tool clean areas that cannot be cleaned by power tool cleaning.

5. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.

6. Welds and adjacent areas:

    a. Prepare such that there is the following:

        (1) No undercutting or reverse ridges on weld bead.

        (2) No weld spatter on or adjacent to weld or any area to be painted.

        (3) No sharp peaks or ridges along weld bead.

    b. Grind embedded pieces of electrode or wire flush with the adjacent surface of weld bead.

7. Pre-blast cleaning requirements:

    a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.

    b. Cleaning methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing. Waterjetting in accordance with SSPC/NACE SP WJ-1/NACE WJ-1.

    c. Clean small isolated areas as above or solvent clean with suitable solvent and a clean cloth.

8. Blast cleaning requirements:

    a. Type of equipment and speed of travel: Design to obtain a specified degree of cleanliness; minimum surface preparation is as specified herein and takes precedence over the Paint Manufacturer's recommendations.

    b. Select the type and size of abrasive to produce a surface profile that meets the Paint Manufacturer's recommendations for the particular primer to be used.

c. Use only dry blast cleaning methods.

(1) Do not reuse abrasive, except for designed recyclable systems.

(2) Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.

d. Post-blast cleaning and other cleaning requirements:

(1) Clean surfaces of dust and residual particles from cleaning operations by dry air blast cleaning (no oil or water vapor) or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.

(2) Paint surfaces the same day they are blasted. Re-blast surfaces that have begun to rust prior to painting.

9. Concrete Surface Preparation:

a. Do not begin until 30 days after concrete has been placed.

b. In accordance with SSPC/NACE SP 13/NACE No. 6 and ASTM D 4258.

c. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.

d. Verify that the required acid-alkali balance has been achieved.

e. Brush-off blast concrete surface to remove loose concrete and laitance and provide a tooth for binding. Upon approval by the Engineer, the surface may be cleaned by the acid etching method. Approval is subject to producing a desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.

f. Secure the Paint Manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.

g. Concrete wall surface preparation:

(1) Patch tie holes.

(2) Sack-rub with grout to fill voids.

h. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

10. Plastic Surface Preparation:

    a. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for the coating system.

    b. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so the surface is roughened without removing excess material.

    c. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as selected.

11. Non-Ferrous Metal Preparation for Coating: The non-ferrous surface shall be coated within 2 days if it is stored in an environmentally controlled space to avoid coating over the zinc oxide and zinc hydroxide layer that forms. After 2 days, the surface shall be sweep blasted and the coating applied within one hour of the blasting. The blasting shall be performed in accordance with ASTM D6386 and SSPC SP 16, including:

    a. Reduced blast pressure, 40 psi or less.

    b. Reduced blasting dwell time.

    c. Increased distance of blast nozzle from the surface, 18-inches to 24-inches.

    d. Reduced blast angle, 30 degrees to 60 degrees rather than 90 degrees.

    e. A softer blast media: Aluminum/magnesium silicate, corncobs, walnut shells, corundum, limestone, or mineral sands with a Mohr's hardness level 5 or less.

    f. No resurfacing with sanders or grinders.

    g. If the item is stored outside after galvanizing, the surface preparation shall be performed as weathering has begun.

    h. A minimum surface profile of 0.75-mil on the bare metal surface is required.

    i. Intact coatings are required to be roughened to the degree specified for the coating to be used.

12. Provide the Engineer a minimum of 7 days advance notice to the start of field surface preparation Work and coating application Work.

13. Schedule an inspection of cleaned surfaces and all coats prior to successive coat in advance with the Engineer.

14. Factory-Finished Items:

    a. Schedule an inspection with the Engineer before repairing damage to factory-finished items delivered to the site.

    b. Repair abraded or otherwise damaged areas on factory-finished items as recommended by the Paint Manufacturer. Carefully blend repaired areas into the original finish. If required to match colors, provide a full finish coat in the field.

15. Measure the moisture content of surfaces using an electronic moisture meter. Do not apply paint unless the moisture content of surfaces is below the following maximums:

    a. Concrete floors: 8 percent

16. Colors:

    a. Color code non-submerged metal piping; paint fittings and valves the same color as the pipe.

    b. New Work: Color coding in accordance with the piping color code schedule.

    c. Repair Work: Match existing color.

    d. Proprietary identification of colors is for identification only; the Selected Manufacturer may supply matches.

    e. Equipment Colors:

        (1) Equipment includes the machinery or vessel itself and the structural supports and fasteners and attached electrical conduits.

        (2) Paint equipment and piping one color as selected.

        (3) Paint non-submerged portions of equipment the same color as the piping it serves, except as itemized below:

            (a) Dangerous parts of equipment and machinery: OSHA orange.

            (b) Fire protection equipment and apparatus: OSHA red.

            (c) Radiation hazards: OSHA purple.

            (d) Physical hazards in normal operating area and energy lockout devices including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA yellow.

3.02 ERECTION/INSTALLATION/APPLICATION:

A. General:

1. Paint new interior and exterior metal surfaces, except as specified otherwise. Do not paint exterior concrete surfaces unless specified otherwise.

2. Immersion Coatings: Apply coatings to exposed metal subject to immersion service, including but not limited to internal vessel and pipe surfaces, nozzle bores, and carbon steel internals, unless otherwise specified.

   a. Coatings subject to immersion shall be applied by an SSPC QP 1 certified applicator and have a minimum surface preparation of SSPC SP 10/NACE No. 2.

   b. Obtain a full cure for completed system. Consult the Paint Manufacturer's instructions for these requirements. Do not immerse coating until completion of the curing cycle. Environmental conditions recommended by the Manufacturer shall be maintained throughout the duration of the curing cycle.

3. Apply paint in accordance with the contract documents and the Paint Manufacturer's recommendations. The more stringent requirements shall apply. Allow sufficient time between coats to ensure thorough drying or curing of previously applied paint.

4. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying the next coat.

5. Fusion-bonded coatings method application: Electrostatic, fluidized bed, or flocking.

6. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.

7. On pipelines, terminate coatings along pipe runs to 1-inch inside pipe penetrations.

8. Follow the Manufacturer's recommended storage procedures. Do not store coatings in direct sunlight.

9. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing the required number of coats have been applied.

B. Workmanship:

1. If surfaces are not in proper shape for coating application, repair, rebuild, or refinish before proceeding with the Work. Assume responsibility for inadequate

Work caused by improper surface preparation. The application of the first coat does not relieve the responsibility for the base. Do not apply any coats on damp or wet surfaces and in no case until the preceding coat has cured. Avoid contamination or damage to prepared or intercoat surfaces. Clean and re-repair as required.

2. Application: Spread materials evenly without runs or sags and thoroughly brush out. Provide a finish that is free of abrasions, dirt, or other debris and uniform in color and appearance.

    a. The number of coats specified is the minimum to be applied. Apply additional coats when undercoats, or other conditions show through the final finish coat until the paint film is of uniform finish, color, and appearance.

3. Roller application: Use a fine nap roller to roll and backroll so a nearly flat or orange peel texture is achieved. Do not use a roller application on metal or wood surfaces. Coating application shall be uniform in color, texture, and shade. Aesthetic defects shall be cause for rejection.

4. Spray application: Apply with airless or air pressure spray equipment as recommended by the Paint Manufacturer for the particular product. Apply each coat in a uniform manner to provide the equivalent thickness of brush coats. Do not double back to build up the film thickness of 2 coats in one pass.

5. Brush application: Brush paint with equipment and the technique required to achieve a flat and smooth surface without brush marks. Brush out and Work paint onto the surfaces in a uniform, even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, and other surface imperfections are not acceptable.

6. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing only after finishing has completely dried and hardened. Use workmen skilled in the installation of the items removed; install in a manner that does not void warranties.

C. Shop-Primed and Factory-Finished Surfaces:

1. Schedule an inspection with the Engineer before shop priming or top coating factory-finished items are delivered to the site.

2. Prepare surfaces and spot prime using the specified primer.

3. Apply a mist coat of primer, 1-mil DFT.

4. After welding, prepare and prime holdback areas as required for the paint system. Apply primer in accordance with the Manufacturer's instructions.

D. Manufacturer-Applied Paint Systems:

1. Repair abraded areas on factory-finished items as recommended by the Manufacturer.

2. Carefully blend repaired areas into the original finish.

3. Fusion-bonded coatings: Provide appropriate liquid repair kits for field use.

E. Galvanized Metal, Copper, and Non-Ferrous Metal Alloys:

1. Concealed galvanized, copper, and non-ferrous metal alloy surfaces behind building panels or walls do not require painting.

2. Prepare the surface and apply primer in accordance with the System No. 10 requirements.

3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

F. Porous Surfaces, such as Concrete:

1. Filler/Surfacer: Use the Paint Manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.

2. Prime Coat: May be thinned to provide maximum penetration and adhesion.

a. Type and amount of thinning: Determined by the Paint Manufacturer and dependent on surface density and type of coating.

3. Surface specified to receive water base coating: Damp but free of running water, just prior to the application of coating.

G. Film Thickness and Coverage:

1. Number of Coats:

a. The minimum required without regard to coating thickness.

b. Additional coats may be required to obtain the minimum required paint thickness depending on method of application, differences in the Manufacturer's products, and atmospheric conditions.

2. Application Thickness:

a. Do not exceed the Manufacturer's recommendations.

b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.

3. Visually inspect concrete non-ferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.

4. Give particular attention to edges, angles, flanges, and other similar areas where insufficient film thicknesses are likely to be present, and ensure proper DFT in these areas.

5. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

H. Factory-Applied Priming:

1. Priming or priming and finishing of certain surfaces may be specified to be factory-applied or shop-applied by fabricators.

2. Carefully examine the contract documents for priming or finishing Work installed by other trades to avoid duplications or omissions.

I. Pipe Identification:

1. Pipe labels shall be stenciled/painted on painted pipes and snap-on labels on non-painted piping.

2. Bands on piping shall be:

a. Material: Stenciled/painted on painted pipes and tape on other piping.

b. Frequency: Must have a band/ set of band in each visible section and at bends.

c. Thickness:

(1) Pipe outside diameter less than 2.5-inches = 8-inch band

(2) Pipe outside diameter less than 8-inches and greater than or equal to 2.5-inches = 12-inch band

(3) Pipe outside diameter less than 10-inches and greater than or equal to 8-inches = 24-inch band

(4) Pipe outside diameter greater than or equal to 10-inches = 32-inch band

3. Flow Arrows:

a. Separate from pipe label.

b. Flow arrows should be stenciled/painted on painted pipes and stickers on other piping.

3.03 PROTECTION:

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and the painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces from overspray that are adjacent to or downwind of the Work area.

3.04 QUALITY CONTROL:

A. ORT Pre-Requisite Activities (ORT-PR): The following specified activities will generally conclude with acceptance of the certificate of proper installation (COPI) by the Owner. Compliance with these requirements shall be the sole responsibility of the Contractor. Any modifications, re-testing or additional expense resulting from the failure to pass these testing requirements on the initial tests, including costs incurred by the Owner and the Engineer, will be paid by the Contractor.

B. Testing:

1. Surface Preparation Testing:

a. Measure prepared surface profile using magnetic type gauge or replica tape in accordance with NACE SP0287.

b. Verify surface is free of debris and particulate prior to coating application using clear tape.

2. Thickness Testing:

a. Measure coating thickness specified in mils with magnetic type, DFT gauge, in accordance with SSPC PA 2.

b. Check each coat for correct DFT.

c. Wait a minimum of 1 day after the application of coating before testing.

3. Continuity Testing:

a. Holiday detect coatings 20-mils thick or less, except zinc primer and galvanizing, with low-voltage wet sponge electrical holiday detector in accordance with NACE SP0188.

b. After repaired and recoated areas have dried sufficiently, retest each repaired area.

c. Final tests may also be conducted by the Engineer.

C. Inspection: Leave staging and lighting in place until the Engineer has inspected the surface or coating. Replace staging removed prior to approval by the Engineer. Provide additional staging and lighting as requested by the Engineer.

D. Unsatisfactory Application:

1. If an item has an improper finish color or insufficient film thickness, clean the surface and topcoat with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the Paint Manufacturer.

2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.

3. Repair defects in accordance with the written recommendations of the Paint Manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with the recommendations of the Paint Manufacturer.

2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on the extent of repair and appearance, a finish sanding and topcoat may be required.

3. Apply finish coats, including touch up and damage-repair coats, in a manner that will present a uniform texture and color-matched appearance.

F. Manufacturer's Services:

1. The Paint Manufacturer's Representative shall be present at the site:

a. On the first day of the application of any coating system.

b. A minimum of 2 additional site inspection visits, to provide the Manufacturer's certificate of proper installation.

c. As required to resolve field problems attributable to or associated with the Manufacturer's product.

d. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.05 CLEANING:

A. Brush-off Blast Cleaning:

1. The equipment, procedure, and degree of cleaning in accordance with SSPC/NACE SP 7/NACE No. 4 or SSPC SP 16.

2. Abrasive: Wet or dry blasting sand, grit, or nutshell.

3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that the surface is cleaned without pitting, chipping, or other damage.

4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.

5. The Engineer will approve the trial blast cleaned area and, if acceptable, use the area as a representative sample of surface preparation.

6. Repair or replace surface damaged by blast cleaning.

B. Acid Etching:

1. After pre-cleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by 2 parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.

2. Application:

a. Rate: 2 gallons/100 sf.

b. Work acid solution into the surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.

c. Acid will react vigorously for a few minutes during which time brushing shall be continued.

d. After bubbling subsides, in approximately 10 minutes, hose down the remaining slurry with high-pressure clean water.

e. Rinse immediately to avoid the formation of salts on the surface that are difficult to remove.

f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.

3. Ensure surface is completely dry before the application of paint.

4. Apply acid etching to obtain a grit sandpaper surface profile. If the surface is not achieved, repeat the treatment.

C. Solvent Cleaning:

1. In accordance with SSPC SP 1.

2. Consists of the removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.

D. Power Tool Cleaning: In accordance with SSPC SP 11.

E. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

F. Upon the Substantial Completion date, remove staging, scaffolding, and containers from the site or destroy in a legal manner.

G. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave the entire job clean.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

3.07 SCHEDULES:

A. Paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from the Engineer before starting the Work.

B. Stripe coat edges and corners for any surface subject to a highly corrosive or submerged environment.

C. System No. 4, Interior and Exterior Exposed *Ferrous* Metal – Highly Corrosive: Structures including, but not limited to, vaults, maintenance holes, reservoirs, tank interiors, and other areas where metal is exposed to high humidity and the possibility of dripping moisture or immersion service. Also includes areas in contact with fumes from chlorine gas, hydrogen sulfide gas, or other corrosive gasses.

Surface Preparation	Paint Material	Minimum Coats, Cover
SSPC SP 10/NACE No. 2	Epoxy, Primer – Ferrous Metal	1 coat, 2.5 MDFT
	Epoxy, High Build	1 coat, 4 MDFT

D. System No. 5, Interior and Exterior Exposed *Ferrous* Metal – Mildly Corrosive: Structures including, but not limited to, above ground buildings, predominantly dry interiors, and other surfaces that will be subjected to minimal or no dripping. Relative humidity exceeding 85 percent during normal operation or presence of corrosive gasses are considered a highly corrosive environment.

Surface Preparation	Paint Material	Minimum Coats, Cover
SSPC SP 10/NACE No. 2	Epoxy, Primer – Ferrous Metal	1 coat, 2.5 MDFT
	Polyurethane, Enamel	2 coats, 3 MDFT

E. System No. 6, Interior and Exterior Exposed *Ferrous* Metal – Atmospheric: Structures including, but not limited to, dry building interiors, electrical rooms, office spaces, or other surfaces that will not be subjected to humidity, corrosive gasses, or dripping moisture.

Surface Preparation	Paint Material	Minimum Coats, Cover
Commercial Blast Cleaning (SP 6/NACE	Rust-Inhibitive Primer	1 coat, 2.5 MDFT
	Alkyd Enamel	2 coats, 4 MDFT

F. System No. 10, Galvanized Metal, Copper, and Non-ferrous Metal Alloy Conditioning:

Surface Preparation	Paint Material	Minimum Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2) or Power Tool (SP 3) or Brush-Off Blast (SP 16)	Wash Primer or The Paint Manufacturer's Recommendation	1 coat, 0.4 MDFT

G. System No. 11, Galvanized Metal Repair:

Surface Preparation	Paint Material	Minimum Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool	Zinc-Rich Primer, Organic	1 coat, 3 MDFT

Surface Preparation	Paint Material	Minimum Coats, Cover
(SP 2), Power Tool (SP 3), or Brush-off Blast (SP 7/NACE No. 4)		

H. System No. 21, Skid-Resistant – Concrete (Interior):

Surface Preparation	Paint Material	Minimum Coats, Cover
In accordance with Concrete Surface Preparation	Epoxy, Non-skid (Aggregated)	1 coat, 200 sfpg
	40 to 60 mesh silica sand	Broadcast sand into first coat

I. System No. 21A, Skid-Resistant – Concrete (Exterior):

Surface Preparation	Paint Material	Minimum Coats, Cover
In accordance with Concrete Surface Preparation	Polyurethane, Elastomeric	1 coat, 100 sfpg
	35 to 65 mesh silica sand at 8 lbs/100 sf	Broadcast sand into topcoat and backroll to encapsulate sand

J. System No. 23, Chemical-Resistant Wall – Concrete:

Surface Preparation	Paint Material	Minimum Coats, Cover
In accordance with Concrete Surface Preparation	Epoxy, Filler/Surfacer	1 coat, as required to fill voids
	Epoxy, High Build (Gloss)	1 coat, 160 sfpg

K. System No. 24, Plastic and Exposed FRP:

Surface Preparation	Paint Material	Minimum Coats, Cover
In accordance with Plastic and FRP Surface Preparation	Polyurethane, Enamel	1 coat, 320 sfpgpc

L. System No. 27, Aluminum and Dissimilar Metal Insulation:

Surface Preparation	Paint Material	Minimum Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with the Manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

M. System No. 29, Fusion-Bonded Coating:

Surface Preparation	Paint Material	Minimum Coats, Cover
SSPC SP 10/NACE No. 2	Fusion-Bonded Coating	1 or 2 coats, 7 MDFT

N. System No. 29A, Fusion-Bonded, Steel Dowel Coating:

Surface Preparation	Paint Material	Minimum Coats, Cover
SSPC SP 10/NACE No. 2 or SSPC SP 8	Fusion-Bonded Coating (100% Solids Epoxy)	1 or 2 coats, 7 MDFT
TFE Lube, Shop-Applied; Grease Lube Alternative, Field-Applied Just Prior to Installation	Fusion-Bonded, TFE Lube or Grease Lube	1 coat, as required

3.08 SUPPLEMENTS:

A. Supplement A – Piping Color Code Schedule (PCCS)

B. Supplement B – Paint System Data Sheet (PSDS)

C. Supplement C – Paint Product Data Sheet (PPDS)

SUPPLEMENT 09 90 00-A – PIPING COLOR CODE SCHEDULE

Legend	Pipe System[1]	Paint Color[2]	Pittsburgh Paint Solid Color Chart[3]	Pipe Banding Color
BWA	Backwash Air	N/A	N/A	Federal Safety Green and Blue
BWS	Backwash Supply	Medium Blue	PC842	Yellow
BWW	Backwash Waste	Light Brown	PC753	None
BWW/ FTW	Backwash Waste/ Filter to Waste	Light Brown	PC753	None
CA	Air, Compressed[4]	CST: Federal Safety Green Cu: N/A	PC855	CST: None Cu: Federal Safety Green
CO2	Carbon Dioxide	N/A	N/A	Federal Safety Orange and Yellow
CO2S	Carbon Dioxide, Solution	N/A	N/A	Federal Safety Orange and Blue
COAG	Coagulant	N/A	N/A	Federal Safety Orange
D	Drain (Process)	N/A	N/A	Black
DC	Chemical Drain	N/A	N/A	MATCH SERVICE
DEC	Decant	Light Brown	PC753	None
DHW	Domestic Hot Water	Dark Blue	PC824	Red
DHWR	Domestic Hot Water Recirculation	Dark Blue	PC824	White
FE	Filter Effluent	Medium Blue	PC842	None
FI	Filter Influent	Aqua	PC822	None
FL	Fluoride	N/A	N/A	Light Blue and Red
FS	Fire Sprinkler	N/A	N/A	N/A
FTW	Filter-to-Waste	Light Brown	PC753	Yellow
HYPO	Sodium Hypochlorite	N/A	N/A	Federal Safety Orange and Red

Legend	Pipe System[1]	Paint Color[2]	Pittsburgh Paint Solid Color Chart[3]	Pipe Banding Color
KMNO4	Potassium Permanganate Solution	N/A	N/A	Violet
LAS	Liquid Ammonium Sulfate	N/A	N/A	Federal Safety Orange and White
LIME	Hydrated Lime	N/A	N/A	Light Green
NA	Sodium Hydroxide, Caustic Soda	N/A	N/A	Federal Safety Yellow and Green
ORD	Overflow Roof Drain	Black	PC828	None
OVFL	Overflow	Match Service (Except at BWS Tank)	Match Service	Match Service
PHOS	Phosphoric Acid	N/A	N/A	Light Green and Red
POA	Polymer, Anionic	N/A	N/A	Federal Purple Orange and Safety Yellow
POC	Polymer, Coagulant Aid	N/A	N/A	Federal Brown Orange and Safety Yellow
PON	Polymer, Nonionic	N/A	N/A	Federal Safety Orange and Green
PW	Potable Water	Dark Blue	PC824	None
R	Return Flow	Light Brown	PC753	None
RD	Roof Drain	Black	PC828	None
RW	Raw Water	Olive Green	PC861	None
RW/LP	Raw Water/Low Pressure	Olive Green	PC861	None
SA	Sample Water	N/A	N/A	Green
SAN	Sanitary, Sanitary Sewer	Dark Grey	PC848	None
SAN VTR	Sanitary Vent	Dark Grey	PC848	Black Band
SPD	Sump Pump Discharge	Dark Grey	PC848	None

Legend	Pipe System[1]	Paint Color[2]	Pittsburgh Paint Solid Color Chart[3]	Pipe Banding Color
SPDC	Sump Pump Discharge Chemical	N/A	N/A	Match Service
SVW	Service Water	N/A	N/A	Blue
TS	Thickened Sludge	Dark Brown	PC764	None
TW	Tempered Water	Federal Safety Yellow	PC875	Orange
US	Unthickened Sludge	Dark Brown	PC764	None
V	Vent	Light Grey	PC846	Red
VC	Chemical Vent	N/A	N/A	Match Service
WSH	Washdown	Medium Blue	PC842	Red

NOTES:

[1] All pipe system labels shall be black letters with a yellow background, unless noted otherwise.
[2] Copper, stainless steel, and plastic piping are not painted.
[3] Pittsburgh paint color reference is used solely to facilitate color selection. Other Manufacturers listed in the Section are acceptable with similar matching colors.
[4] Pipe system label shall be white letters with a dark green background.

In accordance with ANSI/ASME A13.1 Designation of Colors for items for specifically covered in the PCC.

SUPPLEMENT 09 90 00-B – PAINT SYSTEM DATA SHEET

Complete this PSDS for each coating system. Include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Minimum Coats, Coverage**

SUPPLEMENT 09 90 00-C – PAINT PRODUCT DATA SHEET

Complete and attach the Manufacturer's Technical Data Sheet to this PPDS for each product submitted. Provide the Manufacturer's recommendations for the following parameters at temperature (°F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Minimum Recoat Time			
Maximum Recoat Time			

Provide the Manufacturer's recommendations for the following: Mixing Ratio: _____

Maximum Permissible Thinning: _____

Ambient Temperature Limitations: minimum:_____maximum: ____

Surface Temperature Limitations: minimum:_____maximum: ____

Surface Profile Requirements: minimum:_____maximum: _____

END OF SECTION

SECTION 09 91 00

ARCHITECTURAL PAINTING AND COATING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide general information, products, and execution for architectural painting and coating as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. D523: Standard Test Method for Specular Gloss

B. California Air Resources Board (CARB):

1. 2007: Suggested Control Measure for Architectural Coatings

C. California Department of Public Health (CDPH)

1. Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

D. Environmental Protection Agency (EPA):

1. 40 CFR 261: Identification and Listing of Hazardous Waste

2. AP-42: Compilation of Air Pollutant Emission Factors - Volume I: Stationary Point and Area Sources, Chapter 13.2.6 – Abrasive Blasting

E. Institute for Sustainable Infrastructure (ISI):

1. Envision – v3

F. Master Painters Institute LLC (MPI)

G. National Association of Corrosion Engineers (NACE):

1. SP0188: Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

2. SP0287: Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape

H. NSF International (NSF):

1. 61 – Drinking Water System Components – Health Effects

I. Occupational Safety and Health Administration (OSHA):

1. 29 CFR 1910: Occupational Safety and Health Standards

2. 29 CFR 1926: Safety and Health Regulations for Construction

J. The Society for Protective Coatings (SSPC):

1. PA 2: Procedure for Determining Conformance to Dry Coating Thickness Requirements

2. PA 10: Guide to Safety and Health Requirements for Industrial Painting Projects

3. QP 1: Standard Procedure for Evaluating Qualifications of Industrial/Marine Painting CONTRACTOR

4. SP 1: Solvent Cleaning

5. SP 2: Hand Tool Cleaning

6. SP 3: Power Tool Cleaning

7. SP 8: Pickling

8. SP 11: Power Tool Cleaning to Bare Metal

9. SP 16: Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals

K. The Society for Protective Coatings/National Association of Corrosion Engineers (SSPC/NACE):

1. SP 6/NACE No. 3: Commercial Blast Cleaning

2. SP 7/NACE No. 4: Brush-Off Blast Cleaning

3. SP 10/NACE No. 2: Near-White Blast Cleaning

4. SP 13/NACE No. 6: Surface Preparation of Concrete

5. SP WJ-1/NACE WJ-1: Waterjet Cleaning of Metals-Clean to Bare Substrate

L. South Coast Air Quality Management District (SCAQMD):

1. Rule 1113: Architectural Coatings

1.03 DEFINITIONS:

A. Coverage: Total minimum Dry Film Thickness (DFT) in mils or sf/gallon.

B. Paint: The term paint, as used herein, means coating systems materials including primers, sealers, fillers, emulsions, enamels, epoxy, stains, lacquers, varnishes, and other applied materials, whether used in prime coats, intermediate coats, or finish coats.

C. Gloss Levels: Paint gloss levels specified herein are based on the following:

1. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, in accordance with ASTM D523.

2. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, in accordance with ASTM D523.

3. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, in accordance with ASTM D523.

4. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, in accordance with ASTM D523.

5. MPI Gloss Level 5: 35 to 70 units at 60 degrees, in accordance with ASTM D523.

6. MPI Gloss Level 6: 70 to 85 units at 60 degrees, in accordance with ASTM D523.

7. MPI Gloss Level 7: More than 85 units at 60 degrees, in accordance with ASTM D523.

1.04 SEQUENCING AND SCHEDULING:

A. Work Not Included:

1. Surfaces in concealed or inaccessible areas such as furred spaces, foundation spaces, pipe or duct chases, shafts, or utility tunnels.

2. Surfaces of anodized or prefinished aluminum, stainless steel, bronze, brass, and chromium plate.

3. Moving parts of operating equipment, mechanical or electrical moving parts, linkages, sensing devices, and motor shafts.

4. Buried concrete surfaces.

5. Nonmetallic materials such as glass and porcelain.

6. Prefinished electrical items such as motors, motor control centers, switchboards, switchgear, panelboards, transformers, and disconnect switches.

7. Prefinished architectural items such as acoustical tile, cabinets, building louvers, overhead coiling doors, sectional doors, and wall panels.

8. Fiber reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as selected.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Sustainable Design Submittals.

B. Product Data:

1. For each type of product. Include preparation requirements and application instructions.

a. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

b. Indicate Volatile Organic Compound (VOC) content.

C. Samples:

1. Initial selection: Complete fan deck, color card, or actual color chips illustrating the full range of color availability.

2. Samples for verification: For each type of paint system and in each color and gloss of topcoat.

a. Submit samples on rigid backing, 8 1/2-inches x 11-inches.

b. Label each coat of each sample.

c. Label each sample for location and application area.

D. Quality Control Submittals:

1. Contract closeout submittals: Warranty.

E. Provide the Engineer with a schedule of systems and locations requiring color selection.

F. Supplements listed in this Section.

G. Sustainable Design Submittals:

1. As specified in Section 01 84 13.

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sustainability Standards Certifications.

C. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.

D. Installer Qualifications:

1. A minimum of 5 years of documented experience in the Work of this Section.

2. Approved by the manufacturer.

E. MPI Standards:

1. Products: In accordance with MPI standards indicated and listed in "MPI Approved Products List."

2. Preparation and workmanship: In accordance with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

F. Provide finish coats compatible with substrate materials or with prime coats specified in other Sections.

G. First quality preparation, painting, and finishing is required. Dirt, grit, or dust in the paint or finish; runs, sags, or drips of paint or finish; or irregularity of finish is cause for rejection. Remove rejected finishes; repair, re-prime, and refinish as required to achieve a first quality finish.

H. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of VOCs.

2. Perform surface preparation and painting in accordance with the recommendations of the following:

a. The Paint Manufacturer’s instructions.

b. Federal, state, and local agencies having jurisdiction.

1.09 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Delivery, storage, and handling requirements as specified in Section 01 60 00. Specific requirements in addition to Section 01 60 00 shall be:

1. Container label: Include the Manufacturer's name, type of paint, brand name, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

2. Paint materials: Store at an ambient temperature from 45 degrees F to 90 degrees F in a ventilated area or as required by the Manufacturer's instructions.

1.10 PROJECT/SITE CONDITIONS:

A. Do not apply paint in temperatures or moisture conditions outside of the Manufacturer’s recommended maximum or minimum allowable.

B. Work and storage areas shall be free of dust during the application of paint finishes. Do not apply finishes in spaces with accumulated rubbish, dust, or dirt or where construction activity is present.

C. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 degrees F and 95 degrees F.

D. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above the dew point; or to damp or wet surfaces.

1.11 WARRANTY:

A. Warranty requirements as specified in Section 01 60 00. Specific requirements in addition to these sections shall be:

1. Warranty for 2 years from the substantial completion date for the satisfactory performance and installation of the painting and coating system and associated appurtenances, including correction, or at the option of the Owner, removal and replacement of Work found to be defective. The Owner will be named as the beneficiary.

2. The Contractor and the Paint Manufacturer shall jointly furnish the warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Paints:

1. AkzoNobel/Dulux

2. Benjamin Moore Paints

3. PPG Architectural Finishes, Inc.

4. Sherwin Williams

B. Products: Subject to compliance with requirements, provide product listed in the interior painting schedule for the paint category indicated.

2.02 MATERIALS:

A. Sustainable Design Product Requirements:

1. As specified in Section 01 81 13.01.

2. ISI Envision:

a. Sustainable procurement practices (RA1.2): Maximize the procurement of materials that follow sustainable procurement practices.

b. Recycled Materials (RA1.3): Maximize the procurement of materials with recycled content.

c. Locally sourced materials (RA1.4): Maximize the procurement of materials within the radius as specified in Section 01 81 13.01.

B. General:

1. Material compatibility:

a. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by Manufacturer, based on testing and field experience.

b. For each coat in a paint system, products shall be recommended in writing by the Topcoat Manufacturers for use in paint system and on substrate indicated.

C. VOC Content:

1. Products shall in accordance with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site.

D. Maintenance:

1. Extra materials: One gallon of each color and sheen for the operations building paints.

E. Colors: As selected by Engineer from Manufacturer's full range in accordance with the procedures specified in Section 01 33 00.

2.03 SPARE PARTS:

A. Shipment requirements for spare parts as specified in Section 01 60 00.

1. Extra materials: One gallon of each color and sheen.

B. Colors: Formulate paints with colorants free of lead and lead compounds.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions, with applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.

2. Gypsum board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with specified finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.02 PREPARATION:

A. In accordance with Manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Protect and cover items indicated not to be painted with suitable material.

D. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.

E. Shop Abrasive Blasting:

1. Notify the Engineer at least 7 days prior to the start of shop-blast cleaning to allow for inspection of the Work during surface preparation and shop application of paints.

2. Structural steel and similar items, as approved by the Engineer, may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternative to shop-blast cleaning.

F. Field Abrasive Blasting: Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop-blasted or field-blasted and primed or coated.

G. Metal Surface Preparation:

1. Where indicated, meet requirements of the following SSPC Specifications:

a. Solvent cleaning: SP-1.

b. Hand tool cleaning: SP-2.

c. Power tool cleaning: SP-3.

d. Commercial blast cleaning: SP-6.

2. The words solvent cleaning, hand tool cleaning, wire brushing, and blast cleaning, or similar words of equal intent in the Contract Documents or in the Paint Manufacturer's Specification, refer to the applicable SSPC Specification.

3. Where OSHA 29 CFR 1910, OSHA 29 CFR 1926, EPA 40 CFR 261, EPA AP-42, or SSPC PA 10 regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. The Paint Manufacturer's recommendations for wet-blast additives and first coat application shall apply.

4. Hand tool clean areas that cannot be cleaned by power tool cleaning.

5. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.

6. Welds and adjacent areas:

   a. Prepare such that there is the following:

      (1) No undercutting or reverse ridges on weld bead.

      (2) No weld spatter on or adjacent to weld or any area to be painted.

      (3) No sharp peaks or ridges along weld bead.

   b. Grind embedded pieces of electrode or wire flush with the adjacent surface of weld bead.

7. Pre-blast cleaning requirements:

   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.

   b. Cleaning methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing. Waterjetting in accordance with SSPC/NACE SP WJ-1/NACE WJ-1.

   c. Clean small, isolated areas as above or solvent clean with suitable solvent and a clean cloth.

8. Blast cleaning requirements:

   a. Type of equipment and speed of travel: Design to obtain a specified degree of cleanliness; minimum surface preparation is as specified herein and takes precedence over the Paint Manufacturer's recommendations.

b. Select the type and size of abrasive to produce a surface profile that meets the Paint Manufacturer's recommendations for the particular primer to be used.

c. Use only dry blast cleaning methods.

d. Do not reuse abrasive, except for designed recyclable systems.

e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.

9. Post-blast cleaning and other cleaning requirements:

a. Clean surfaces of dust and residual particles from cleaning operations by dry air blast cleaning (no oil or water vapor) or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.

b. Paint surfaces the same day they are blasted. Re-blast surfaces that have begun to rust prior to painting.

H. Gypsum Board Surface Preparation:

1. Allow joint treatment to thoroughly dry. Lightly sand joint treatments and topping compounds to produce a uniform, smooth surface. Wipe or brush free of sanding dust.

2. Fill minor defects with filler compound. Spot prime defects after repair.

I. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming in accordance with SSPC-PA 1 for touching up shop- primed surfaces.

3.03 APPLICATION:

A. General:

1. Apply paints in accordance with Manufacturer's written instructions and to recommendations in "MPI Manual."

a. Use applicators and techniques suited for paint and substrate indicated.

b. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.

c. Provide prime coats that are compatible with substrate material. Provide finish coats that are compatible with primers used.

d. Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers or grilles.

e. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.

f. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

g. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to the Topcoat Manufacturers.

h. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

i. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

B. Workmanship:

1. If surfaces are not in proper shape for coating application, repair, rebuild, or refinish before proceeding with the Work. Assume responsibility for inadequate Work caused by improper surface preparation. The application of the first coat does not relieve the responsibility for the base. Do not apply any coats on damp or wet surfaces and in no case until the preceding coat has cured. Avoid contamination or damage to prepared or intercoat surfaces. Clean and re-repair as required.

2. Application: Spread materials evenly without runs or sags and thoroughly brush out. Provide a finish that is free of abrasions, dirt, or other debris and uniform in color and appearance.

a. The number of coats specified is the minimum to be applied. Apply additional coats when undercoats, stains, or other conditions show through the final finish coat until the paint film is of uniform finish, color, and appearance.

3. Roller application: Use a fine nap roller to roll and backroll so a nearly flat or orange-peel texture is achieved. Do not use a roller application on metal or wood surfaces. Coating application shall be uniform in color, texture, and shade. Aesthetic defects shall be cause for rejection.

4. Spray application: Apply with airless or air pressure spray equipment as recommended by the Paint Manufacturer for the particular product. Apply each coat in a uniform manner to provide the equivalent thickness of brush coats. Do not double back to build up the film thickness of 2 coats in one pass.

5. Brush application: Brush paint with equipment and the technique required to achieve a flat and smooth surface without brush marks. Brush out and Work paint onto the surfaces in a uniform, even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, and other surface imperfections are not acceptable.

6. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing only after finishing has completely dried and hardened. Use workmen skilled in the installation of the items removed; install in a manner that does not void warranties.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:

a. Architectural woodwork.

b. Acoustical ceiling panels.

c. Finished mechanical and electrical equipment.

d. Light fixtures.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:

a. Foundation spaces.

b. Furred areas.

c. Ceiling plenums.

d. Duct shafts.

3. Finished metal surfaces include the following:

a. Anodized aluminum.

b. Stainless steel.

c. Chromium plate.

d. Copper and copper alloys.

e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:

a. Valve and damper operators.

b. Linkages.

c. Sensing devices.

d. Motor and fan shafts.

e. Sprinkler heads.

D. Shop-Primed and Factory-Finished Surfaces:

1. Schedule an inspection with the ENGINEER before shop priming or top coating factory-finished items are delivered to the site.

2. Prepare surfaces and spot prime using the specified primer.

3. Apply a mist coat of primer, one-mil DFT.

4. After welding, prepare and prime holdback areas as required for the paint system. Apply primer in accordance with the Manufacturer's instructions.

E. Film Thickness and Coverage:

1. Number of coats:

a. The minimum required without regard to coating thickness.

b. Additional coats may be required to obtain the minimum required paint thickness depending on method of application, differences in the Manufacturer’s products, and atmospheric conditions.

2. Application thickness:

a. Do not exceed the Manufacturer’s recommendations.

b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.

3. Visually inspect concrete, masonry, non-ferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.

4. Give particular attention to edges, angles, flanges, and other similar areas where insufficient film thicknesses are likely to be present and ensure proper DFT in these areas.

5. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

F. Factory-Applied Priming:

1. Priming or priming and finishing of certain surfaces may be specified to be factory-applied or shop-applied by fabricators.

2. Carefully examine the Contract Documents for priming or finishing Work installed by other trades to avoid duplications or omissions.

3.04 PROTECTION:

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect Work of other trades against damage from paint application. Correct damage to Work of other trades by cleaning, repairing, replacing, and refinishing, as approved by ENGINEER, and leave in an undamaged condition.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces from overspray that are adjacent to or downwind of the Work area.

F. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

G. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.05 QUALITY CONTROL:

A. Dry Film Thickness Testing: Owner will engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.

2. If test results show that dry film thickness of applied paint does not in accordance with the Paint Manufacturer's written recommendations, Contractor shall pay for

testing and apply additional coats as needed to provide dry film thickness that complies with the Paint Manufacturer's written recommendations.

B. Inspection: Leave staging and lighting in place until the Engineer has inspected the surface or coating. Replace staging removed prior to approval by the Engineer. Provide additional staging and lighting as requested by the Engineer.

C. Unsatisfactory Application:

1. If an item has an improper finish color or insufficient film thickness, clean the surface and topcoat with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the Paint Manufacturer.

2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.

3. Repair defects in accordance with the written recommendations of the Paint Manufacturer.

D. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with the recommendations of the Paint Manufacturer.

2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on the extent of repair and appearance, a finish sanding and topcoat may be required.

3. Apply finish coats, including touch up and damage-repair coats, in a manner that will present a uniform texture and color-matched appearance.

E. Manufacturer’s Services:

1. The Paint Manufacturer’s representative shall be present at the site:

a. On the first day of the application of any coating system.

b. A minimum of 2 additional site inspection visits, to provide the Manufacturer’s certificate of proper installation.

c. As required to resolve field problems attributable to or associated with the Manufacturer’s product.

d. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.06 CLEANING:

A. Brush-off Blast Cleaning:

1. The equipment, procedure, and degree of cleaning in accordance with SSPC/NACE SP 7/NACE No. 4 or SSPC SP 16.

2. Abrasive: Wet or dry blasting sand, grit, or nutshell.

3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that the surface is cleaned without pitting, chipping, or other damage.

4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.

5. The Engineer will approve the trial blast cleaned area and, if acceptable, use the area as a representative sample of surface preparation.

6. Repair or replace surface damaged by blast cleaning.

B. Acid Etching:

1. After pre-cleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by 2 parts water by volume. Adding acid to water in these proportions gives an approximate 10% solution of HCl.

2. Application:

a. Rate: 2 gallons/100 sf.

b. Work acid solution into the surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.

c. Acid will react vigorously for a few minutes during which time brushing shall be continued.

d. After bubbling subsides, in approximately 10 minutes, hose down the remaining slurry with high-pressure clean water.

e. Rinse immediately to avoid the formation of salts on the surface that are difficult to remove.

f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.

3. Ensure surface is completely dry before the application of paint.

4. Apply acid etching to obtain a grit sandpaper surface profile. If the surface is not achieved, repeat the treatment.

C. Solvent Cleaning:

1. In accordance with SSPC SP 1.

2. Consists of the removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.

D. Power Tool Cleaning: In accordance with SSPC SP 11.

E. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

F. Upon the Substantial Completion date, remove staging, scaffolding, and containers from the site or destroy in a legal manner.

G. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave the entire job clean.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 01.EW1.

3.08 SCHEDULES:

A. Paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from the Engineer before starting the Work.

B. System No. 101, Exterior Metal Surfaces, including Hollow Metal Doors and Frames, Rolling Door Angle Jambs, Miscellaneous Steel Lintels, Ferrous Steel Beams and Columns:

Surface Preparation	**Water-Based Light Industrial Coating System, MPI EXT 5.1C**	
SSPC/NACE SP 6/NACE No. 3	Prime Coat:	Primer, rust-inhibitive, alkyd MPI #79.
	Intermediate Coat:	Light industrial coating, exterior, water based, matching topcoat.
	Topcoat:	Light industrial coating, exterior, water based, acrylic semi-gloss (MPI Gloss Level 5), MPI #163.

C. System No. 102, Interior Metal Surfaces, including Hollow Metal Doors and Frames, Rolling Door Angle Jambs, Steel Columns, Miscellaneous Steel Lintels:

Surface Preparation	**Water-Based Light Industrial Coating System, MPI EXT 5.1B**	
SSPC/NACE SP 6/NACE No. 3	Prime Coat:	Primer, rust-inhibitive, water based MPI #107.
	Intermediate Coat:	Light industrial coating, interior, water based, matching topcoat.
	Topcoat:	Light industrial coating, interior, water based, acrylic semi-gloss (MPI Gloss Level 5), MPI #153.

D. System No. 103, Interior Metal Surfaces, including Steel Roof Decking, Structural Steel Roof Joists and Framing:

Surface Preparation	**Water-Based Light Industrial Coating System, MPI EXT 5.1L**	
SSPC/NACE SP 6/NACE No. 3 or SSPC SP 8	Prime Coat:	Primer, epoxy, anti-corrosive MPI #101.
	Intermediate Coat:	Epoxy coating, interior, solvent based, matching topcoat.
	Topcoat:	Epoxy coating, interior, solvent based, semi- gloss (MPI Gloss Level 5), MPI #177.

E. System No. 104, Interior Gypsum Board and Plaster (Eggshell):

Surface Preparation	**Latex over Latex Sealer System MPI INT 9.2A (Eggshell)**	
In accordance with Gypsum Board or Plaster Surface Preparation	Prime Coat:	Primer sealer, latex, interior, MPI #50.
	Intermediate Coat:	Latex, interior, matching topcoat.
	Topcoat:	Latex, interior (MPI Gloss Level 3), MPI #52.

F. System No. 105, Interior Gypsum Board and Plaster (Semi-Gloss):

Surface Preparation	**Latex over Latex Sealer System MPI INT 9.2A (Eggshell)**	
In accordance with Gypsum Board or Plaster Surface Preparation	Prime Coat:	Primer sealer, latex, interior, MPI #50.
	Intermediate Coat:	Latex, interior, matching topcoat.
	Topcoat:	Latex, interior (MPI Gloss Level 4), MPI #43.

END OF SECTION

SECTION 09 91 10

SHOP PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide shop painting as specified and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.

2. D870: Standard Practice for Testing Water Resistance of Coatings Using Water Immersion

3. D4541: Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

4. D4544: Standard Practice for Estimating Peat Deposit Thickness

5. D4585: Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation

6. G8: Standard Test Methods for Cathodic Disbonding of Pipeline Coatings

B. The Society for Protective Coatings (SSPC):

1. SP6: Commercial Blast Cleaning

2. SP10: Near-White Blast Cleaning

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Manufacturer's specifications and data on the proposed primers and detailed surface preparation, application procedures and dry mil thicknesses, including list of items and surfaces to receive shop painting.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.05 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver materials to application area in original, unbroken containers, plainly marked with name and analysis of product, manufacturer's name, and shelf lift date. Do not store or use contaminated, outdated, prematurely opened, or diluted materials.

C. Store coated items to prevent damage or dirtying of coatings. Avoid need for special cleaning, and store coated items out of contact with ground or pavement. Place suitable blocking under coated items during storage.

D. Do not expose surfaces to weather for more than six months before being topcoated, or less time if recommended by coating manufacturer.

E. Protect surfaces not to receive paint coatings during surface preparation, cleaning, and painting.

F. Protect coatings from damage during shipment and handling by padding, blocking, use canvas or nylon slings, and use care when handling.

G. At time of delivery of shop painted items to job site, ensure coatings are undamaged and in good condition.

1.06 PROJECT/SITE CONDITIONS:

A. Environmental Requirements:

1. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems can be applied.

2. Do not apply coatings when dust is being generated.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Coatings are divided into the following service types, as determined by conditions:

1. Non-Potable Water:

a. All ferrous metals not subject to potable water provide one coat with a dry film thickness of 2.5 to 3.0 mils.

b. Manufacturers:

(1) Series 1 Prime made by Tnemec Co.

(2) Carbozinc 859 by Carboline Co.

(3) Multiprime EFD Epoxy Fast Day Inhibitive Primer 94-109 made by PPG Protective & Marine Coatings (4.0 – 6.0 DFT).

c. Performance Data:

(1) ASTM- D4541- Adhesion – No less than 1250 psi pull

(2) ASTM- D4585- Humidity- no affect after 4800 hours with< 1% rust

(3) ASTM- B117 Salt Spray- No cracking , delamination or >1/64 creep after 9800 hours

2. Potable Water:

a. Ferrous metals submerged or which are subject to splash action in contact with potable water, provide one coat with a dry mil thickness of 3.0 to 3.5 mils of a certified NSF Standard 61 product.

b. Manufacturers:

(1) 94 H20 Urethane Zinc Rich Primer made by Tnemec Co.

(2) Carboguard 561 made by Carboline Co.

(3) Aquapon High Build Potable Water Epoxy 95-132 Series made by PPG Protective & Marine Coatings (4.0 – 6.0 DFT).

c. Performance Data:

(1) ASTM –D4541 Adhesion no less than 1700 psi

(2) ASTM-G8 Method A Cathodic Disbondment- No affect after 30 days

(3) ASTM D870 Immersion – No affect after 22 months

(4) ASTM B117 Salt Spray- no affect of coating film, < $1/16^{th}$ creep after 9900 hours

B. Shop prime with primers guaranteed by the manufacturer to be compatible with their corresponding primers and finish coats specified in Division 09 “Field Painting” Section for use in the field and which are recommended for use together.

PART 3 - EXECUTION

3.01 APPLICATION:

A. Surface Preparation and Priming:

1. Sandblast clean in accordance with SSPC-SP-6, Commercial Grade, immediately prior to priming non-submerged components scheduled for priming, as defined above.

2. Sandblast clean in accordance with SSPC-SP-10, Near White, immediately prior to priming submerged components scheduled for priming, as defined above.

3. Before priming, provide surfaces dry and free of dust, oil, grease and other foreign material.

4. Shop prime in accordance with accepted manufacturer's printed recommendations.

B. Non-primed Surfaces: Apply accepted coating in accordance with manufacturer's printed recommendation.

3.02 TOUCH-UP:

A. Repair or replace damaged or defective coated areas. Resultant shop painting: Paint items as specified.

B. Remove damaged or defective coatings by specified blast cleaning to meet surface cleaning requirements, just before recoating. When small areas of coating need touch up, surface preparation may be done with suitable power needle gun to match specified blast cleaning.

3.03 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 09 91 13

SPECIAL LININGS AND COATINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide special linings and coatings as indicated and in compliance with Contract Documents.

1. Section Includes:

a. Coat surfaces to include:

(1) Surfaces described in Room Finish Schedule and notes on Drawings

(2) Concrete tanks

1.02 REFERENCES:

A. ASTM International (ASTM):

1. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.

2. C413: Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings, and Polymer Concretes

3. C579: Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

4. C580: Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

5. C868: Standard Test Method for Chemical Resistance of Protective Linings

6. C882: Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear

7. D53: Specification for Rubber Belting for Power Transmission

8. D579: Standard Specification for Greige Woven Glass Fabrics

9. D638: Standard Test Method for Tensile Properties of Plastics

10. D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

11. D810: Methods of Test for Sulfated Residue, Lead, Iron and Copper in Lubricating Oils

12. D3359: Standard Test Methods for Measuring Adhesion by Tape Test

13. D4060: Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser

14. D4541: Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

15. D4585: Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation

16. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

17. E377: Standard Practice for Internal Temperature Measurements in Low-Conductivity Materials

B. The Society for Protective Coatings (SSPC):

1. SP1: Solvent Cleaning

2. SP5: White Metal Blast Cleaning

3. SP6: Commercial Blast Cleaning

4. SP7: Brush-Off Blast Cleaning

5. SP10: Near-White Blast Cleaning

6. SP12: Surface Preparation of Metals by Waterjetting Prior to Recoating

7. SP13: Surface Preparation of Concrete

1.03 DEFINITIONS:

A. Definitions.

1. Coatings: Heavy duty finishes for use on any surfaces, especially surfaces subject to submerged, high moisture, splash or chemical environment.

2. Ambient Conditions:

a. Chemical: Surface subject to corrosive chemical splash or fumes.

b. Moist: Surface subject to wet areas such as shower rooms and rooms with open tanks.

c. Normal: Surface subject to normal temperatures and humidity such as found in offices and corridors.

3. Splash: Surface subject to frequent washing and chemical splash.

4. Submerged P: Surface submerged in potable water plus 1 feet-0 inches above high liquid level.

5. Submerged NP: Surface submerged in non-potable liquid such as sewage and sludge plus 1 foot-0 inches above high liquid level.

B. First Coat: Field prime, factory prime, or shop prime. When only one coat is required, first coat is finish coat.

C. Second or Third Coats: Successive finish coats applied over first coat.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data:

1. Submit manufacturer's literature stating application recommendations and generic makeup of each type of coating scheduled.

2. Substitutions: For coatings not specified, provide substitute manufacturer's product data sheets, ASTM certified performance criteria, MSDS and other relevant data for Engineer to perform proper evaluation 10-days prior to bid date.

C. Samples:

1. Actual color samples available for each type of coating scheduled.

2. Two 4 inches by 4 inches steel panels for each method of metal preparation specified. Panel shall be representative of steel used and prevented from deterioration of surface quality. Upon acceptance by Engineer, panel shall be preserved as reference source for inspection.

D. Miscellaneous:

1. Certification:

a. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

2. Schedules:

   a. Submit schedule of proposed coating systems within 30 calendar days of Award of Contract.

   b. Schedule of proposed coating systems shall identify same information as shown in coating schedule.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Applicator Qualifications:

1. Engage an experienced applicator who has successfully completed coating system applications similar in material and extent to those indicated for Project.

2. Ensure that mixing and installation of protective coating is performed by applicators licensed by the coating manufacturer.

3. Submit four copies of a notarized statement from the manufacturer's authorized technical representative certifying the Contractor is qualified to apply the protective coating.

C. Single-Source Responsibility:

1. Provide coating material produced by same manufacturer for each system. Use only thinners recommended by manufacturer and only within recommended limits.

D. Manufacturer shall supply products that comply with local restrictions controlling use of volatile organic compounds (VOCs).

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver material in original, sealed, unopened packages and containers bearing manufacturer’s name. Each container shall have manufacturer’s printed label stating type of coating, color of coating, instructions for reducing, and spreading rate.

C. Protect and heat or cool material storage location to maintain temperature ranges recommended by coating manufacturer for most sensitive coating, but not less than 55 degrees F.

D. Keep storage area neat and clean and replace or repair damage thereto or to its surroundings.

E. Avoid danger of fire. Deposit cleaning rags and waste materials in metal containers having tight covers or remove from building each night. Provide fire extinguishers of type recommended by coating manufacturer in areas of storage and where finishing is occurring. Allow no smoking or open containers of solvents. Store solvents in safety cans. Give special attention to possible hazards in areas of existing buildings.

F. Empty containers shall have labels canceled and be clearly marked as to use.

G. Upon Substantial Completion, remaining material will become property of Owner. Seal material for storage, marked as to contents and shelf life, and store where required by Engineer.

1.07 PROJECT/SITE CONDITIONS:

A. Environmental Requirements:

1. Do not apply exterior coating in cold, foggy, damp or rainy weather.

2. Apply no finish in rooms where dust is being generated.

3. Do not apply exterior coating when temperature is lower than 50 degrees F or as required by manufacturer.

4. Maintain interior temperature and relative humidity of space, as recommended by coating manufacturer, 24 hours before applying and until coating is cured.

B. Protection:

1. Cover materials and surfaces, including floors, adjoining or below Work with clean drop cloths or canvas.

2. Remove hardware, accessories, plates, lighting fixtures, and similar items or provide protection by masking. Upon completion, replace above items or remove protection and clean.

3. Maintain manufacturer’s environmental requirements while coating dries.

1.08 MANUFACTURER'S RECOMMENDATIONS:

A. Conform to manufacturer's printed instructions for surface preparation, use, safety requirements, mixing, application, curing and intercoat precautions for protective coating. Submit to Engineer, four copies of these printed instructions and manufacturer's product data sheets, 30 days prior to application of coating.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Provide only high-grade products of nationally known manufacturer's having an established good reputation in the field. Provide products having a minimum of five years' similar, satisfactory field service and suitable for the intended service. Apply products specified except, when permitted by the Engineer, other acceptable equivalent products may be applied if the Contractor satisfactorily proves that they are equivalent to the specified item in quality, durability, performing the required function, abrasion resistance, chemical resistance, adhesion, efficiency in protecting the substrate from corrosion and deterioration, life expectancy and recoating cycles, solids content by volume, film thickness per coat, mil. feet per gallon, coverage per gallon, total cost of services, ease of application, ease of repairing damaged areas, and other pertinent criteria. In any one coating system, provide compatible coatings. Provide only products of one manufacturer in any one coating system. Touch-up with coatings as originally applied. Provide materials meeting air pollution requirements in the area where they are applied.

B. Apply materials within the manufacturer's recommended shelf life.

C. After review, submit list of coating products that will be used on the job, 30 days prior to application of coatings.

D. Deliver materials to the application area in their original, unopened containers plainly marked with the name and analysis of the product, the producer's name and the shelf life date. Do not use contaminated, outdated, prematurely opened, or diluted material. Do not modify or extend coatings and only use in accordance with the coating manufacturer's current printed instructions.

2.02 CONCRETE TANKS, MANHOLES, WET WELLS, HOLDING TANKS (PC-1):

A. Manufacturers:

1. Sherwin-Williams Company, Cleveland, Ohio.

B. The following list specifies the material requirement for surfacing system. The acceptable products are as following:

1. Sherwin-Williams Dura-Plate High Performance System:

a. Base Coat: Dura-Plate 2300, apply resurfacer coat as needed to fill bug holes and voids.

b. Topcoat: Dura-Plate, 80 to 125 mils (DFT).

2. Performance Criteria – Products shall meet the minimum as listed.

   a. Patching Compound: Cementitious Epoxy

   b. Bond Strength: ASTM C882 – No less than 1030 psi slant shear average 3 pulls

   c. Flexural Strength: ASTM C580 – No less than 1250 psi, no less than 897,000 PSI flexural modules of elasticity

   d. Compressive Strength: ASTM C579 – No less than 5100 psi average six pulls

   e. H2S Lining: Epoxy Mortar

   f. Abrasion: ASTM D4060 no less than 90 mg loss

   g. Adhesion: ASTM D4541 – Steel – 900 psi, Concrete – Type V test- no less than 700 psi

   h. Chemical Resistance: ASTM C868 Atlas Cell – 100 days in 25 percent sulfuric acid no erosion, blistering, softening or loss of adhesion

   i. Humidity: ASTM 4585 – No less than 4000 hours

   j. SWAT Test: H2S autoclave 150 degrees, 500 ppm, H2S 4000 ppm NaCl 10 percent H2So4 – No blistering cracking loss of adhesion or loss of electrical impedance after 28 days

   k. Water Absorption: ASTM C 413- No more than 0.18 water absorption

2.03 MATERIALS:

A. Coatings:

1. Color shall be formed of pigments free of lead, lead compounds or other materials which might be affected by presence of hydrogen sulfide or other gases likely to be present at Project.

2. Coatings shall meet surface burning characteristics as required by code and established by ASTM E84.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. If surfaces to be finished cannot be put into proper condition for finishing by customary cleaning, sanding, and puttying operations or if surfaces were improperly primed by others, report defects to Engineer, in writing, or assume responsibility and correct unsatisfactory finish resulting from improper surfaces. Commencement of Work indicates acceptance of surfaces.

B. Materials removed and replaced to correct defects due to Work placed on unsuitable surfaces shall be at Contractor's expense.

C. Where surface dryness is questioned, test with dampness indicating instrument. Do not apply coatings over surfaces where moisture content exceeds that permitted in manufacturer's printed instructions.

D. Provide coats compatible with the surface and prior coats.

3.02 APPICATION OF PROTECTIVE COATING SYSYEMS:

A. Hoisting, Scaffolding, Staging, And Planking: Provide, set-up, and maintain all required hoists, scaffolds, and staging and planking, and perform all access related hoisting work required to complete the work of this section as indicated and specified.

1. Scaffolds shall have solid backs and floors to prevent dropping materials from there to the floors or ground below.

B. Environmental Requirements: Comply with the Manufacturer's recommendations as to environmental conditions under which resurfacing system materials can be applied.

1. Do not apply resurfacing system materials when dust is in work site.

2. The Contractor shall provide all temporary lighting during the work.

C. Protection: Cover or otherwise protect finish work or other surfaces not being resurfaced.

1. Erect and maintain protective tarps, enclosures and/or maskings to contain debris (such as dust or airborne particles resulting from surface preparation) generated during any and all work activities. This includes, but is not limited to the use of dust/debris collection apparatus.

D. Initial Inspection of Surfaces to be Coated:

1. It is the responsibility of the Contractor to inspect and report unacceptable concrete substrate surface conditions to the Engineer prior to the commencement of surface preparation activities. Unacceptable surface conditions are defined as

the presence of cracked surfaces or concrete deteriorated to a depth of greater than 1-inch or otherwise unable to withstand surface preparation as specified herein.

E. Thinners and Solvents:

1. The Contractor shall use only solvents and thinners as recommended by the manufacturer.

3.03 SURFACE PREPARATION REQUIREMENTS:

A. General: All specified surface preparation shall be performed in accordance with the latest version of the SSPC, NACE, ICRI and other standards referenced in this section.

1. Concrete surfaces shall be abraded to produce a minimum surface profile of equal to 40 grit sandpaper with no loose concrete remaining. This preparation will be followed by vacuum cleaning to remove all dust, dirt or friable substances leaving clean, dust free surfaces for resurfacing.

2. Oil and grease shall be removed before mechanical cleaning is started via an alkaline-based emulsifying detergent as recommended by the resurfacing material manufacturer. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded and free of contaminants that might interfere with the adhesion of the resurfacing materials.

3. The air used for blast cleaning shall be free of oil and moisture to not cause contamination of the surfaces to be resurfaced.

4. Clean cloths and clean fluids shall be used in solvent cleaning.

5. Cleaning and resurfacing shall be scheduled so that dust and other contaminants from the cleaning process will not fall on wet, newly resurfaced areas.

6. Prepare concrete joint and install sealant following resurfacing material installation.

B. Initial Cleaning/Decontamination:

1. All existing areas to be resurfaced shall be pressure washed with a 2500-5000 psi containing an alkaline - based detergent to remove all loose materials, acid constituents, grease, oil, and other contaminants (use potable water only, not plant water).

2. Verify that the pH of the cleaned concrete surfaces to be coated is within the range of 9 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.

C. Abrasive Blast Cleaning:

1. Used or spent blast abrasive shall not be reused on work covered by this section.

2. The compressed air used for blast cleaning will be filtered free of condensed water or oil. Moisture traps will be cleaned at least once every four hours or more frequently as is appropriate.

3. Oil separators shall be installed just downstream of compressor discharge valves and at the discharge of the blast pot discharges. Oil separators shall be cleaned at least once every four hours or more frequently as is appropriate.

4. A paper blotter test shall be performed by the Contractor when requested by the Engineer or the Engineer's representative to determine if the air is sufficiently free of oil and moisture.

5. Regulators, gauges, filters, and separators will be in good working order for all of the compressor air lines to blasting nozzles at all times during this work.

6. An air dryer or drying unit shall be installed which dries the compressed air prior to blast connections. This dryer shall be used and maintained for the duration of surface preparation work.

7. The quality, volume, and velocity of life support and ventilation air used during surface preparation shall be in accordance with applicable safety standards and to ensure adequate visibility and proper dissipation of volatiles without impacting the prepared surface or the health of the public or personnel working for the Contractor, Subcontractors, Engineer, Engineer's Representatives, or anyone who may be affected by on-site maintenance coating work activities.

8. The abrasive blast nozzles used shall be the venturi or other high velocity type supplied with a minimum of 100 psig air pressure and the necessary volume to obtain the required blast cleaning production rates and specified degree of cleanliness.

9. The Contractor must provide adequate ventilation for airborne particulate evacuation and lighting (meeting all pertinent safety standards) to optimize visibility for both blast cleaning and observation of the substrate during surface preparation work.

10. All phases of surface preparation work specified herein must be inspected by the Engineer before the Contractor proceeds with the subsequent phase of surface preparation.

11. If, between final surface preparation work and coating application, contamination of the prepared and cleaned substrate occurs, or if the prepared steel's appearance

darkens or changes color, reblasting will be required until the specified degree of cleanliness is established.

3.04 SPECIFIC SURFACE PREPARATION REQUIREMENT:

A. In addition to the Section 3.02 requirements, the Contractor will follow the requirements of this section.

B. When the floor area is scheduled to receive a mortar application to pitch the floor, the walls above the floor shall be sawcut to a depth of 1/2-inch at a height from 0 feet-0 inches to 0 feet-6 inches above the floor. The cut shall be straight and level.

C. The Contractor shall notify the Engineer should jobsite conditions prevent the above operations and/or applications.

D. In all cases of surface Preparation the Manufacturer printed recommendations shall be adhered to for steel and concrete substrates

3.05 APPLICATION REQUIREMENTS:

A. General: Field Quality Control Inspection and Testing

B. Inspection by the Engineer or others does not limit the Contractor's responsibilities for quality control inspection and testing as specified herein or as required by the Manufacturer's instructions.

C. Perform the quality control procedures listed below in conjunction with the requirements of this Section.

1. Inspect all materials upon receipt to ensure that all are supplied by the Manufacturer.

2. Provide specified storage conditions for the resurfacing system materials, solvents, and abrasives.

3. Inspect and record findings for the degree of cleanliness of substrates using. The pH of the concrete substrate will be measured using pH indicating papers. pH testing is to be performed once every 50 square feet. Acceptable pH values shall be between 9.0 and 11.0 as measured by a full range (1-12) color indicating pH paper with readable color calibrations and a scale at whole numbers (minimum). Use Hydrion Insta-Check Jumbo 0-13 or 1-12. The paper shall be touched to the surface once using moderate gloved finger pressure. The surface shall not be wiped or moved laterally to disturb the surface during pH testing. Following the one touch, lift the paper vertically to not "wipe" the surface. Compare the color indicated with the scale provided and record the pH.

4. Inspect and record substrate profile (anchor pattern). Surfaces shall be abraded, as a minimum, equal to the roughness of 40 grit sand paper.

5. Measure and record ambient air temperature once every two hours of each shift using a thermometer and measure and record substrate temperature once every two hours using a surface thermometer.

6. Measure and record relative humidity every two hours of each shift using a sling psychrometer in accordance with ASTM E337.

7. Provide correct mixing of resurfacing materials in accordance with the Manufacturer's instructions.

8. Inspect and record that the "pot life" of resurfacing materials are not exceeded during installation.

9. Verify curing of the resurfacing materials in accordance with the Manufacturer's instructions.

10. Upon full cure of the mortar and lining material, and before the topcoat/gelcoat is applied, the installed system shall be checked by high voltage spark detection in accordance with NACE RP0188-88BN to verify a pinhole-free surface. Voltage shall be set at 11,000 volts. Areas which do not pass the spark detection test shall be corrected at no cost to the Owner and rechecked. Upon completion of the lining system installation the lined area shall be cleaned and prepared to permit close visual inspection by the Engineer or the Engineer's Representative. Any and all deficiencies or defective work (not in compliance with this section or related sections) will be marked for repair or removal/replacement by the Contractor at no additional cost to the Owner.

3.06 ACCEPTANCE CRITERIA:

A. Acceptance Criteria For Surface Preparation Work:

1. All surfaces shall be prepared in accordance with the specification and referenced standards therein.

B. Acceptance Criteria for Coating System Application Work:

1. Acceptable coating work will be based upon the following:

a. No pock-marks, trowel marks, depressions, unconsolidated areas, waviness or ridges, pinholes or holidays in either size or frequency.

b. No intercoat bond failures between lifts.

c. Proper curing of coatings.

2. Resurfaced areas shall pitch to drains.

3. There shall be no areas that puddle when flood tested.

4. The Engineer or Engineer's Representative shall, at their discretion, inspect the following:

    a. Profile and degree of cleanliness of substrate.

    b. Thickness of materials/coverage rate confirmation..

    c. Ambient temperature and humidity requirements, and substrate temperature.

    d. Curing and recoat times.

    e. Proper curing of the resurfacing materials.

5. Rework required on any holidays or any other inadequacies found by the Engineer or the Engineer's Representative in the quality of the coating work shall be marked. Such areas shall be recleaned and reworked by the Contractor according to these specifications and the manufacturer's recommendations at no additional cost to the Owner.

6. The Contractor is responsible for keeping the Engineer informed of all progress so that inspection for quality can be achieved.

7. The Contractor is ultimately responsible for the quality performance of the applied materials and workmanship. Inspections by the Engineer or the Engineer's Representative do not limit this responsibility.

3.07 FINAL INSPECTION:

A. Perform a final inspection to determine whether the resurfacing system work meets the requirements of the specifications. The Engineer and the Engineer's Representative will conduct final inspection with the Contractor.

3.08 CLEANUP:

A. Upon completion of work, the Contractor shall remove surplus materials, equipment, protective coverings, and accumulated rubbish, and thoroughly clean all surfaces and repair any work-related damage. The surrounding surface areas including roadways, and all other surfaces shall be restored to their pre-project condition. Areas not to be resurfaced shall be masked using duct tape or other protection materials to prevent these surfaces from being resurfaced.

    1. Ensure straight even termination of resurfacing/topcoat materials on wall edges and flush with embedded steel. The Contractor must follow the minimum and maximum recoat

    2. Limitation times and related temperature range restrictions between successive lifts for all products specified herein per Manufacturer's stated requirements.

3. All equipment and procedures used for resurfacing system application shall be as recommended by the Manufacturer.

4. Unless specified elsewhere herein, the Contractor shall comply with the Manufacturer's most recent written instructions with respect to the following:

    a. Mixing of All Materials

    b. Protection and Handling of All Materials

    c. Recoat Limitation and Cure Times

    d. Minimum Ambient and Substrate Temperatures, Substrate's Degree of Dryness, Relative Humidity, and Dew Point of Air

    e. Application

    f. Final Curing

    g. Use of Proper Application Equipment

5. Curing of Resurfacing System:

    a. The applied resurfacing system shall be protected from damage during curing and shall be cured as recommended by the Manufacturer. Ambient conditions shall be controlled by the Contractor during curing to ensure the minimum air temperature and minimum relative humidity as required by the Manufacturer are maintained.

B. Patching And Surfacing The Concrete: Pre-dampen concrete surfaces prior to applying mortar and surfacer).Trowel apply mortar Series 218 or 217 on all ceilings, walls and floors to fill all large spalls, deep voids and rebuild concrete at joints, etc.

1. Apply mortar in maximum 1-1/2 inch lifts (layers) filling deepest areas first.

2. Trowel apply surfacer on all ceilings, walls and floors to fill bug holes, and surface uneven concrete with exposed aggregate

3. Apply surfacer at minimum 1/16-inch and maximum 1/4-inch as a surfacer and maximum 1/2-inch as hole filler.

4. Do not apply successive lifts until previous lift has cured for 12 hours minimum but not longer than 24 hours at 75 degrees F. If 24 hours has elapsed re-scarify surfaces to receive additional resurfacing materials

C. Chemical Resistant Lining:

1. General Note: The Contractor is advised that with all thick-film, quick curing materials applied to concrete surfaces, outgassing of the concrete can occur. Possible remedies include applying materials when the temperature of the concrete surfaces are descending, or applying a thin 1/8-inch layer of the specified surfacing material. Other remedies may exist, and may be submitted for the Engineer's approval.

3.09 NONSKID SURFACE AT CONTAINMENT AREAS:

A. Evenly and uniformly broadcast a sufficient quantity of 50 to 90 sieve size silica blasting sand on top of the last top coat before it cures, in order to create a nonskid surface.

B. Sand floor areas for the nonskid surface. After surfaces have cured, vacuum clean excess sand from the areas.

3.10 FIELD QUALITY CONTROL:

A. Sampling of Materials:

1. Engineer reserves right to select unopened containers of materials furnished for project and have materials tested at an independent testing laboratory. Owner will pay for first tests.

2. Retests of rejected materials and tests of replacement materials shall be paid for by Contractor.

3. Remainder of contents of containers not required for testing will be returned to Contractor.

B. Coverage:

1. Before beginning Work, finish one complete room, space surface, or item of each color scheme required, showing selected colors, finished texture, material, and workmanship. After approval, sample rooms or items shall serve as standard for similar Work throughout building.

2. If coverage is not acceptable to Engineer, Engineer reserves right to require extra application of paint at no extra cost to Owner.

3. Work at site where coat of material is applied will be inspected by Engineer before application of succeeding specified coat, otherwise no credit for coat applied will be given and Contractor automatically assumes responsibility to recoat Work in question. Furnish Engineer report of particular coat applied and when completed for inspection to comply with above.

3.11 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

DIVISION 10

SPECIALTIES

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SECTION 10 14 00

SIGNAGE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide general information, products, and execution for signage as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. A117.1: Accessible and Usable Buildings and Facilities.

B. American Architectural Manufacturers Association (AAMA):

1. 611: Voluntary Specification for Anodized Architectural Aluminum

C. ASTM International (ASTM):

1. B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

2. B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

3. D1187: Type II – Specification for Asphalt-Base Emulsions (For Metal Surfaces).

4. D4802: Standard Specification for Poly (Methyl Methacrylate) Acrylic Plastic Sheet

D. California Air Resources Board (CARB):

1. 2007: Suggested Control Measure for Architectural Coatings

2. ATCM: Airborne Toxic Control Measures to Reduce Formaldehyde Emissions from Composite Wood Products

E. California Department of Public Health (CDPH):

1. Standard Method v1.1: Standard Method for the Testing & Evaluation of VOC Emissions

F. Federal Regulations:

1. 40 CFR 59, Subpart D: National Volatile Organic Compound Emission Standards for Architectural Coatings

G. Institute for Sustainable Infrastructure (ISI):

1. Envision – v2

H. National Electrical Manufacturers Association (NEMA):

1. LD 3: High-Pressure Decorative Laminates.

I. South Coast Air Quality Management District (SCAQMD):

1. Rule 1113 – Architectural Coatings

2. Rule 1168 – Adhesive and Sealant Applications

J. U.S. Department of Transportation:

1. Manual on Uniform Traffic Control Devices (MUTCD), current edition.

1.03 DEFINITIONS:

A. Accessible: In accordance with the ICC/ANSI A117.1-2009 American.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Warranty documentation as specified in Section 01 61 00.

C. Submit the following as specified in Section 01 33 00.

1. Product Data: For each type of product.

2. Shop Drawings:

a. Include fabrication and installation details and attachments to other Work.

b. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.

c. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

3. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in Manufacturer's standard size unless otherwise indicated and as follows:

   a. Interior signs: Full-size sample

   b. Dimensional letters: Full-size sample.

4. Sign Schedule: Use same designations specified or as shown on the Drawings in a sign schedule.

5. Qualification Data: For installer and Manufacturer.

6. Sample Warranty: For special warranty.

7. Maintenance Data: For signs to include in maintenance manuals.

D. Sustainable Design Submittals:

1. As specified in Section 01 81 13.01.

E. O&M data requirements as specified in Section 01 78 23.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by Manufacturer.

C. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.

D. Temperature Change: 180 degrees F, material surfaces.

E. Accessibility Standard: In accordance with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for signs.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1. Package signs, labeled in name groups.

2. Store adhesive attachment tape at ambient room temperatures.

1.09 PROJECT/SITE CONDITIONS:

A. Field Measurements: Verify locations of anchorage devices and electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on shop Drawings.

B. Do not install signs when ambient temperature is lower than recommended by Manufacturer.

C. Maintain this minimum during and after installation of signs.

1.10 COORDINATION:

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

B. Furnish templates for placement of electrical service embedded in permanent construction by other installers

1.11 WARRANTY:

A. Warranty requirements as specified in Section 01 78 36. Specific requirements in addition to Section 01 78 36 shall be:

1. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

a. Failures include, but are not limited to, the following:

(1) Deterioration of finishes beyond normal weathering.

(2) Deterioration of embedded graphic image.

(3) Separation or delamination of sheet materials and components.

b. Warranty Period: Five years from date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Exterior and Interior Signs:

1. ASI Sign Systems, Inc.

2. Mohawk Sign Systems

B. Dimensional Letters and Numbers:

1. A.R.K. Ramos

2. ASI Sign Systems, Inc.

3. Metal Arts; Div of L&H Mfg

4. Signature Sign Signs, Inc.

C. Hazardous Material Signs:

1. Brady Signmark

2. Emedco

D. Fire Extinguisher Signs:

1. Accuform

2. Brady Corporation

3. Emedco

2.02 MATERIALS:

A. Sustainable Design Product Requirements:

1. As specified in Section 01 81 13.01.

2. ISI Envision:

a. Sustainable procurement practices (RA1.2): Maximize the procurement of materials that follow sustainable procurement practices.

b. Recycled materials (RA1.3): Maximize the procurement of materials with recycled content.

c. Locally sourced materials (RA1.4): Maximize the procurement of materials within the radius as specified in Section 01 81 13.01.

B. Panel-Sign Materials:

1. Aluminum sheet and plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish required

2. Aluminum extrusions: ASTM B221, alloy and temper recommended by aluminum producer and finisher for type of use and finish required.

3. Acrylic sheet: ASTM D4802, category as standard with Manufacturer for each sign, Type UVF (UV filtering).

4. Plastic-laminate sheet: NEMA LD 3, general-purpose HGS Grade, 0.048-inches nominal thickness.

5. Vinyl film: UV-resistant vinyl film of nominal thickness required, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as required and suitable for exterior applications.

2.03 COMPONENTS:

A. Interior Signs:

1. Type: One-piece melamine plastic laminate with contrasting color core, non-static, fire retardant, self-extinguishing, matte finish.

2. Thickness: 1/8-inches.

3. Tactile characters/symbols raised 1/32-inches from the sign plate face.

4. Braille: Text shall be accompanied by Grade 2 Braille.

5. Character color: To be selected from Manufacturer's full color range.

6. Background color: To be selected from the Manufacturer's full color range.

7. Characters – Restroom Signs:

a. Height: 5/8-inches

b. Style: As shown on Drawings

c. Width to height ratio: As shown on Drawings

d. Stroke width to height ratio: As shown on Drawings

8. Characters – Room Signs:

    a. Height: 5/8-inches

    b. Style: As shown on Drawings

    c. Width to height ratio: As shown on Drawings

    d. Stroke width to height ratio: As shown on Drawings

9. Character placement: Centered.

10. Corners: Square.

11. Edges: Square.

12. Border: 3/8-inches wide.

13. Use: In accordance with the Contract Documents.

B. Hazardous Material Signals:

1. In accordance with NFPA 704.

2. Material: Reflective sheeting applied to 0.040-inches thick aluminum.

3. Background, letters, and numbers: Die cut vinyl with pressure-sensitive adhesive.

4. Use: In accordance with the Contract Documents.

C. Emergency Eye Wash and Shower Signs:

1. Material: Reflective sheeting applied to 0.060-inches thick aluminum plate.

2. Reflective sheeting: Type 1, tested in accordance with ASTM D4956.

3. Character color: To be selected from the Manufacturer's full color range.

4. Background color: To be selected from the Manufacturer's full color range. Profile: Rounded corners with 3/16-inches mounting holes.

5. Use: In accordance with the Contract Documents.

6. Size: As shown on the Drawings.

D. Confine Space Signs:

1. Material: Reflective sheeting applied to 0.060-inches thick aluminum plate.

2. Reflective sheeting: Type 1, tested in accordance with ASTM D4956.

3. Character color: To be selected from the Manufacturer's full color range.

4. Background color: To be selected from the Manufacturer's full color range. Profile: Rounded corners with 3/16-inches mounting holes.

5. Use: In accordance with the Contract Documents.

6. Size: As shown on the Drawings.

E. Dimensional Numbers:

1. Waterjet cut characters with smooth flat faces, sharp corners, and formed lines and profiles, free from pits, scale, holes or other defects. Construct to receive mounting studs.

2. Material: Aluminum 5052 Alloy, 1/2-inches thick.

3. Finish: Painted face and returns, letters sprayed with acrylic polyurethane baked semi-gloss finish, 1.75 mils nominal thickness.

   a. Color: Custom color to match sample provided by Engineer.

4. Letter style: Letters to be twentieth century font, 18 inches high on exterior building identification numbers.

5. Text: As shown on the Drawings.

F. Exterior Signs:

1. Material: Reflective sheeting applied to 0.060-inches thick aluminum plate.

2. Reflective sheeting: Type 1, tested in accordance with ASTM D4956.

3. Character color: To be selected from the Manufacturer's full color range.

4. Background color: To be selected from the Manufacturer's full color range. Profile: Rounded corners with 3/16-inches mounting holes.

5. Use: In accordance with the Contract Documents.

6. Size: As shown on the Drawings.

7. Text: As shown on the Drawings. To be approved by Engineer.

8. Transportation control and regulation signs: In accordance with MUTCD, latest edition.

G. Fire Extinguisher Signs:

1. Material: 0.040-inches thick aluminum plate

2. Size: As shown on Drawings

3. Character color: White

4. Background color: Red

5. Text: FIRE EXTINGUISHER

6. Use: In accordance with the Contract Documents

2.04 FABRICATION:

A. Regional Materials: Panel signs shall be manufactured within 500 miles of Project site.

B. General: Provide Manufacturer's standard sign assemblies in accordance with requirements specified in this Section.

1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.

2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.

3. In accordance with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.

4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.

5. Internally brace signs for stability and for securing fasteners.

6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing Work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

C. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into panel surface as shown on the Drawings to produce precisely formed copy, incised to uniform depth.

1. Engraved metal: Fill engraved graphics with Manufacturer's standard baked enamel.

2. Engraved opaque acrylic sheet: Fill engraved graphics with Manufacturer's standard enamel.

3. Face-engraved clear acrylic sheet: Fill engraved copy with Manufacturer's standard enamel. Apply Manufacturer's standard opaque background color coating to back face of acrylic sheet.

D. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

E. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions as shown on the Drawings. Modify Manufacturer's standard brackets as required.

1. Aluminum brackets: Factory finish brackets with baked-enamel or powder-coat finish to match sign-background color unless otherwise indicated.

F. Dimensional Letters and Numbers:

1. Fabricated characters: Fabricate letters and numbers to required sizes and styles, using metals and thicknesses as shown on the Drawings. Form exposed faces and sides of characters to produce surfaces free from warp and distortion. Include internal bracing for stability and attachment of mounting accessories in accordance with requirements specified for finish, style, and size.

2.05 ACCESSORIES:

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and in accordance with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.

2. For exterior exposure, furnish nonferrous-metal devices unless otherwise indicated.

3. Exposed metal-fastener components, general:

a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.

b. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant Allen-head spanner-head or one-way-head slots unless otherwise indicated.

4. Sign Mounting Fasteners:

a. Concealed studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.

5. Inserts: Furnish inserts to be set by other trades into concrete or masonry Work.

2.06 FINISHES:

A. General Finish Requirements:

1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2. Appearance of finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of accepted Samples and are assembled or installed to minimize contrast.

3. Directional finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

4. Organic, anodic, and chemically produced finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage Work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Verify that anchor inserts are correctly sized and located to accommodate signs.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. General: Install signs using mounting methods as shown on the Drawings and in accordance with Manufacturer's written instructions.

1. Notify Engineer in writing of sign installation at least 21 days in advance. Engineer will assign exact location for each sign.

2. Install signs level, plumb, true to line, and at locations and heights as shown on the Drawings, with sign surfaces free of distortion and other defects in appearance.

3. Install signs so they do not protrude or obstruct in accordance with the accessibility standard.

4. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

5. Corrosion protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Room-Identification Signs and Other Accessible Signage: Install in locations on walls as shown on the Drawings.

C. Mounting Methods:

1. Concealed studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.

b. Thin or hollow surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Through fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.

3. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.

4. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep

adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.

D. Field-Applied, Vinyl-Character Signs: Clean and dry substrate. Align sign characters in final position before removing release liner. Remove release liner in stages, and apply and firmly press characters into final position. Press from the middle outward to obtain good bond without blisters or fishmouths. Remove carrier film without disturbing applied vinyl film.

E. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

3.03 REPAIR/RESTORATION:

A. Remove and replace damaged or deformed signs and signs that do not in accordance with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

3.04 CLEANING:

A. Remove temporary protective coverings and strippable films as signs are installed.

B. On completion of installation, clean exposed surfaces of signs in accordance with Manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 10 28 13

TOILET ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide toilet accessories as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A666: Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

2. A1008: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

3. B456: Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium

4. C1503: Standard Specification for Silvered Flat Glass Mirror

5. F446: Standard Practice for Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials

B. Business + Institutional Furniture Manufacturers Association (BIFMA)

1. M7.1: Standard Test Method for Determining VOC Emissions

2. e3: Furniture Sustainability Standard

C. California Air Resources Board (CARB):

1. 2007: Suggested Control Measure for Architectural Coatings

D. California Department of Public Health (CDPH):

1. Standard Method v1.1: Standard Method for the Testing & Evaluation of VOC Emissions

E. Institute for Sustainable Infrastructure (ISI):

1. Envision – v3

F. National Fire Protection Association (NFPA):

1. 70: National Electrical Code

G. South Coast Air Quality Management District (SCAQMD):

1. Rule 1113: Architectural Coatings

2. Rule 1168: Adhesive and Sealant Applications

1.03 COORDINATION:

A. Coordinate accessory locations with other Work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Warranty documentation as specified in Section 01 61 00.

C. O&M documentation as specified in Section 01 78 23.

D. Submittals:

1. Product data – For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes

b. Include anchoring and mounting requirements, including requirements for cutouts in other Work and substrate preparation

c. Include electrical characteristics

2. Samples: Full size, for each exposed product and for each finish specified

a. Approved full-size Samples will be returned and may be used in the Work.

b. Product schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

(1) Identify locations using room designations as shown on the Drawings.

(2) Identify accessories using designations as shown on the Drawings.

E. Informational Submittals:

1. Sample warranty: For manufacturer's special warranty

F. Closeout Submittals:

1. Maintenance data: For accessories to include in maintenance manuals

G. Sustainable Design Submittals:

1. As specified in Section 01 81 13.01.

H. O&M Special Requirements:

1. O&M data requirements as specified in Section 01 78 23.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Provide electrical components, devices, and accessories listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.09 WARRANTY:

A. Warranty requirements as specified in Section 01 78 36. Specific requirements in addition to these sections shall be:

1. Manufacturer's special warranty for mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

a. Failures include, but are not limited to, visible silver spoilage defects

b. Warranty period: 15 years from date of substantial completion

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturers:

1. A & J Washroom Accessories, Inc.

2. American Specialties, Inc.

3. Bobrick Washroom Equipment, Inc.

4. Bradley Corporation

5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.

B. Source Limitations: Obtain public-use washroom accessories from single manufacturer.

2.02 MATERIALS:

A. Sustainable Design Product Requirements:

1. As specified in Section 01 81 13.01.

2. ISI Envision:

a. Support sustainable procurement practices (RA1.1): Maximize the procurement of materials that follow sustainable procurement practices.

b. Use recycled materials (RA1.2): Maximize the procurement of materials with recycled content.

B. Stainless Steel: ASTM A666, Type 304, 0.031-inches minimum nominal thickness unless otherwise indicated.

C. Steel Sheet: ASTM A1008, Designation CS (cold rolled, commercial steel), 0.036-inches minimum nominal thickness.

D. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

E. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).

F. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.03 COMPONENTS:

A. Washroom Accessories:

1. Toilet Tissue (Roll) Dispenser:

a. Basis of Design Product: Bobrick B-2892

b. Mounting: Surface mounted

c. Operation: Holder accommodates two standard-core toilet tissue rolls for non-controlled delivery. Tumbler lock secures spindles in place; spindles can only be removed after unlocking with furnished key.

d. Capacity: Designed for two standard 6-inches diameter tissue rolls.

e. Material and finish: Satin-finish cast aluminum bracket with molded high impact plastic spindles.

2. Paper Towel Dispenser and Trash Receptacle:

a. Basis of Design Product: Bobrick B-3699

b. Mounting: Surface mounted

c. Minimum towel-dispenser capacity: 350 C-fold or 475 multifold towels

d. Material and finish: Stainless steel, No. 4 finish (satin)

e. Lockset: Tumbler type

f. Waste receptacle: Removable stainless steel container with hemmed top edges

g. Minimum waste-receptacle capacity: 2 gallons

3. Soap Dispenser (wall mounted):

a. Basis of Design Product: Bobrick B-2112

b. Description: Body to be 0.0312-inches thick stainless steel of drawn one-piece seamless construction, with a locked, hinged stainless steel lid for refilling, satin finish.

c. Mounting: Vertically oriented, surface mounted with concealed mounting bracket and wall plate.

d. Capacity: 40 fluid ounces

e. Valve: Black molded plastic push button and spout

f. Operation: Piston pressed down to dispense soap, refill accomplished by removal of piston, spout, and supply assembly from top, or removing container from bottom of assembly.

g. Locking; escutcheon locks to body with concealed locking mechanism opened with key provided.

4. Grab Bar:

a. Basis of Design Product: Bobrick B-5800 Series

b. Mounting: Flanges with concealed fasteners

c. Materials:

(1) Grab bars: Stainless steel, 0.05-inches thick tubing

(2) Concealed mounting flanges: Stainless steel, 0.125-inches thick plate.

(3) Snap flange covers: Stainless steel, 0.031-inches thick plate.

d. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.

e. Outside diameter: 1 1/2-inches

f. Configuration and length: As shown on Drawings

(1) Water closet types: Provide one of each at each accessible water closet stall.

(a) 42-inches horizontal at side wall

(b) 36-inches horizontal at back wall

(c) 18-inches vertical bar at side wall

5. Sanitary Napkin and Tampon Dispenser:

a. Basis of Design Product: Bobrick B-2706 25

b. Mounting: Surface mounted

c. Capacity: 30 tampons and 20 napkins

d. Operation: Single coin (25 cents)

e. Exposed Material and Finish: Stainless steel, No. 4 finish (satin)

f. Lockset: Tumbler type with separate lock and key for coin box

6. Sanitary Napkin Disposal:

a. Basis of Design Product: Bobrick B-245

b. Mounting: Surface mounted

c. Door or cover: Self-closing, top disposal-opening cover and container with integral finger depression for opening cover

d. Material and finish: Stainless steel, No. 4 finish (satin) with all welded construction with radiused face and corners.

(1) Container: Stainless steel, 0.0312-inches thick plate

(2) Cover: Stainless steel, 0.031-inches thick plate. Drawn seamless construction and secured to container with full length stainless steel piano hinge.

7. Glass Mirror:

a. Basis of Design Product: Bobrick B-292 2436

b. Frame: Stainless-steel angle, 0.05-inches thick with galvanized steel back

c. Corners: Manufacturer's standard

d. Integral shelf: Stainless-steel, 0.05-inches thick, 4-inches deep

e. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.

(1) One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.

(2) Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.

8. Toilet Seat Cover Dispenser

a. Basis of Design Product: Bobrick B-4221

b. Satin-finish stainless steel

c. Dispenses 250 single or half fold toilet seat covers or one box

d. Fills from bottom

B. Custodial Accessories:

1. Mop and Broom Holder with Utility Shelf:

a. Basis of Design Product: Bobrick B-239 x 34

b. Description: Unit with shelf, hooks, holders, suspended beneath shelf. Stainless steel shelf with exposed edges turned down not less than 1/2-inches and supported by two triangular brackets welded to shelf underside.

c. Length: 34-inches

d. Hooks: Four

e. Mop/Broom holders: Three, spring-loaded, rubber hat, cam type

f. Material and finish: Stainless steel, No. 4 finish (satin)

(1) Shelf: Not less than nominal 0.05-inches thick stainless steel

2.04 FABRICATION:

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full- length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION:

A. Install accessories in accordance with Manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by the Unit Manufacturer. Install units level, plumb, and firmly anchored in locations and at heights as shown on the Drawings.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested in accordance with ASTM F446.

3.02 CLEANING:

A. Remove temporary labels and protective coatings.

B. Clean and polish exposed surfaces in accordance with Manufacturer's written instructions.

3.03 ADJUSTING:

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 10 40 00

FIREFIGHTING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide firefighting equipment as indicated and in compliance with Contract Documents.

1. Section includes:

a. Firefighting Equipment

(1) Portable hand-carried fire extinguishers

(2) Fire extinguisher mounting brackets

1.02 REFERENCES:

A. Aluminum Association (AA):

1. M12C22A31: Mechanical Finish

2. M12C22A32/A34: Mechanical Finish

3. M12C22A41: Anodized Plus Finish

4. M12C22A42/A44: Mechanical Finish

B. American Architectural Manufacturers Association (AAMA):

1. 611: Voluntary Specification for Anodized Architectural Aluminum

2. 2603: Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

C. American National Standards Institute (ANSI):

1. S3.19: Measurement of Real-Ear Protection of Hearing Protectors and Physical Attenuation of Ear Muffs

D. ASTM International (ASTM):

1. A666: Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

2. A1008: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

3. B36: Standard Specification for Brass Plate, Sheet, Strip, And Rolled Bar

4. B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

5. B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

6. C1036: Standard Specification for Flat Glass

7. C1048: Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass

8. D4802: Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet

9. E814: Standard Test Method for Fire Tests of Penetration Firestop Systems

E. National Association of Architectural Metal Manufacturers (NAAMM):

1. Metal Finishes Manual for Architectural and Metal Products.

F. National Fire Protection Association (NFPA):

1. 10: Portable Fire Extinguishers

G. The Society for Protective Coatings (SSPC):

1. SP5: White Metal Blast Cleaning

2. SP8: Pickling

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Submit manufacturer's product data, shop drawings, catalogs and brochures for all items specified.

2. Fire Extinguishers: Include rating and classification.

3. Submit manufacturer's installation instructions.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Regulatory Requirements: Provide equipment in accordance with federal, state, and local safety codes. Provide revisions or additions to equipment necessitated by such codes at no additional cost.

C. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.

D. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10 "Portable Fire extinguishers."

E. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver equipment in manufacturer's original unopened and undamaged packages.

C. Clearly identify manufacturer, brand name, contents, stock number and order number on each package. Damaged packages that may affect conditions of contents are not acceptable.

D. Store in original packaging under protective cover and protect from damage. Stack containers in accordance with manufacturer's recommendations.

E. Handle equipment in manner to prevent damage to products and finishes.

1.07 WARRANTY:

A. Comply with general requirements specified in Section 01 78 36.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, following:

a. Failure of hydrostatic test according to NFPA 10.

b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Use of manufacturer’s name and model or catalog number for purpose of establishing standard of quality and general configuration only. Model numbers listed reference to first manufacturer listed.

B. Fabricate, assemble, erect, and place in operating condition in conformance with drawings, specifications, engineering data, instructions, approved submittals, and recommendations of equipment manufacturer.

2.02 FIREFIGHTING EQUIPMENT:

A. Portable Hand-Carried Fire Extinguishers:

1. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.

a. Manufacturers:

(1) Badger Fire Protection; a Kidde company

(2) Buckeye Fire Equipment Company

(3) J. L. Industries, Inc.; a division of Activar Construction Products Group

b. Valves: Manufacturer's standard.

c. Handles and Levers: Stainless steel.

d. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

2. Multipurpose Dry-Chemical Type in Aluminum Container: 4-A:60-B:C, 10-lb with monoammonium phosphate-based dry chemical in enameled-aluminum container.

B. Fire Extinguisher Mounting Brackets:

1. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

2. Manufacturers:

a. Badger Fire Protection; a Kidde company

b. Buckeye Fire Equipment Company

c. J. L. Industries, Inc.; a Division of Activar Construction Products Group

3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Engineer.

a. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

(1) Orientation: Vertical

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine firefighting equipment for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FIRE EXTINGUISHER INSTALLATION:

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets:

1. 54 inches above finished floor to top of fire extinguisher.

2. Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

DIVISION 13

SPECIAL CONSTRUCTION

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SECTION 13 12 41

EQUIPMENT ENCLOSURES

PART 1 GENERAL

1.01 DESCRIPTION:

A. Section Includes:

1. Fiberglass reinforced plastic (FRP) custom equipment enclosures.

1.02 QUALITY ASSURANCE

A. Except as modified or supplemented herein, materials and construction methods shall comply with applicable provisions of ASTM C582.

B. Manufacturer Qualifications: Equipment enclosures shall be manufactured and erected by firm with minimum of 3 yrs experience in structures of size and character specified.

C. Equipment enclosures shall be end products of a single manufacturer to achieve standardization for appearance.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. Equipment enclosure shall be clear span, designed to be self-supporting from periphery structure.

2. Design Loads: See Section 01 41 20 Seismic and Wind Requirements

3. Dimensions: As shown on Drawings.

1.04 SUBMITTALS

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Shop Drawings:

1. Include plans and elevations, design loads, fabrication details indicating laminate thicknesses and panel depths and widths, location of openings, hardware, doors, hinges, door seals, and size and location of anchor bolts.

C. Stamped by Professional Engineer registered in State of Utah.

D. Samples:

1. Color charts and samples of colors available from manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store on manufacturer's site and job site, and protect during shipment to prevent panel warping and fracturing.

1.06 WARRANTY:

A. Provide manufacturer’s standard warranty form in which manufacturer agrees to repair finish or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 EQUIPMENT ENCLOSURES

1. Manufacturers:

a. Basis of Design: Customized version of 200-095 Enclosure by Tracom.

b. RM Products Ltd.

2. Chemical-resistant polyester resins containing UV inhibitors capable of withstanding continuous exposure to environment at Project site and during plant operation.

3. Suitable for service in temperature range of -30°F to +120°F.

B. Glass Reinforcing:

1. Combination of chopped strand mat and woven roving, treated with finish compatible to resin being used.

C. Insulation: R 7 insulation minimum.

2.02 ACCESSORIES

A. Concrete Anchors:

1. Stainless steel wedge anchors.

2. Manufacturers:

a. Stud Anchor by Hilti, Inc.

b. Redhead Wedge Anchor by ITT Phillips Drill Division.

c. Rawl Stud by Rawl Plug Company, Inc.

d. Or approved equal.

B. Fasteners: Stainless steel hex bolts, flat washers, and hex nuts of size as determined by manufacturer.

C. Front Doors:

1. Double door with active and inactive leaf constructed of fiberglass over insulation core. Provide surface-mounted bolts at top and bottom of inactive leaf for stainless steel hinges, latch without lock on active leaf. Provide tubular hydraulic closure and safety chain on active leaf.

D. Top Access Door.

1. Leaf constructed of fiberglass over insulation core. Provide surface-mounted bolts at continuous stainless steel piano hinge with latch with lock. Provide tubular hydraulic closure and safety chain.

E. Louvers

1. (4) Fixed, passive screened ventilation louvers

F. Neoprene Gasket:

1. Soft, closed cell, neoprene gasket material.

2. Suitable for exposure to sewage and sewage gases.

3. Thickness shall be as indicated, but in no case less than 1/4 in.

2.03 FABRICATION

A. Construct walls and roof panels from structural system utilizing double fiberglass reinforced polyester skins over insulation; bond to skins to prevent separation.

B. Color: As selected by ENGINEER.

C. Provide fiberglass blocking encased in FRP to anchor doors and windows, and to make panel joints.

D. Provide fiberglass mounting flange around the exterior of the enclosure for drilling and anchoring to concrete.

E. Resin seal cut or drilled laminate edges.

2.04 SOURCE QUALITY CONTROL

A. Loss of bond between insulation and laminate may cause reduction in panel strength and, therefore is cause for rejection.

PART 3 EXECUTION

3.01 EXAMINATION

A. Check slab where equipment enclosure is to be erected to determine if support surface is level and free of depressions or humps exceeding 1/4 in. in 10 ft, which may prevent sealing of base to curb or slab or produce deformation in anchor flange.

B. Do not proceed with erection until deficiencies are corrected.

3.02 INSTALLATION

A. Install buildings at locations indicated on Drawings.

B. Gasket field joints and where building rests on supporting structures. Space bolts at distance to compress gasket between bolts.

C. Use washers against fiberglass surfaces to minimize local stresses.

D. Adjust doors, and hardware to provide free, smooth operation.

END OF SECTION

SECTION 13 34 19

METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide design, materials and erection of metal building(s) on concrete foundations as indicated and in compliance with Contract Documents.

B. Make minor dimensional modifications to the foundations as may be required for the specific building provided. All modifications are subject to the acceptance of the Engineer.

C. The building manufacturer to provide a delegated design submittal for the design of the entire building system including the parts that are specified in other sections.

1.02 REFERENCES:

A. American Architectural Manufacturers Association (AAMA):

1. 2605: Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

B. American Institute of Steel Construction (AISC):

1. Manual of Steel Construction.

2. AISC 360 - Specification for Structural Steel Buildings.

3. AISC 341 - AISC Seismic Provisions for Structural Steel Buildings.

4. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges.

C. American Iron and Steel Institute (AISI):

1. D100: Cold Formed Steel Design Manual.

D. American Society of Civil Engineers (ASCE):

1. 7: Minimum Design Loads for Buildings and Other Structures - Includes Supplement No. 1

E. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):

1. ASHRAE 90.1-2007 - Energy Standard for Buildings Except Low-Rise Residential Buildings (I-P Edition).

F. ASTM International (ASTM):

1. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

3. A325: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

4. A563: Standard Specification for Carbons and Alloy Steel Nuts.

5. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

6. A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

7. B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

8. D2244: Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

9. D4214: Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

G. American Welding Society (AWS):

1. Code for Welding in Building Construction

H. International Building Code of the International Code Council

I. Metal Building Manufacturers' Association:

1. Recommended Design Practices Manual.

J. The Society of Protective Coatings (SSPC):

1. SP6: Commercial Blast Cleaning

2. SP10: Near-White Blast Cleaning

K. The appropriate criteria from the following sources shall also be applicable to the design:

1. See Section 01 41 20 Seismic and Wind Requirements

2. See drawing 0100-S001

3. Society for Protective Coatings Standards

4. Federal, Military, and Commercial Standards

5. ASTM Standards

1.03 ADMINISTRATIVE REQUIREMENTS:

A. Pre-installation Meeting: Prior to erection of framing, conduct pre-installation meeting at site attended by Owner, Engineer, manufacturer's technical representative, inspection agency and related trade contractors.

B. Coordinate work of Division 08 Sections "Plastic Doors and Frames" and "Door Hardware" and openings and penetrations and manufacturer's accessories with installation of metal panels.

1.04 DEFINITIONS:

A. Traditional Metal Building System: Building system using either continuous or simple span "Z" purlins for support of roof covering material.

B. Gable Symmetrical: Continuous frame building with ridge in center of building, consisting of tapered or straight columns and tapered or straight rafters. Sidewall girts may be continuous (by-passing columns) or simple span (flush in column line). Rafters may or may not have interior columns.

C. Roof Slope: Pitch expressed as inches of rise for each 12 inches (305 mm) of horizontal run.

D. Building Eave Height: Nominal dimension measured from finished floor to top flange of eave strut.

E. Building Width: Measured from outside to outside of side wall secondary structural member.

F. Building Length: Measured from outside to outside of end wall secondary structural member.

G. Auxiliary Loads: Dynamic loads induced by cranes, conveyors, or material handling systems.

H. Collateral Loads: Weight of any non-moving equipment or material, such as ceilings, electrical or mechanical equipment, sprinkler systems, plumbing, or ceilings.

I. Dead Load: Actual weight of building system as supplied by manufacturer supported by given member.

J. Floor Live Loads: Loads induced on floor system by building occupants and possessions including but not limited to furniture and equipment.

K. Roof Live Loads: Loads produced by maintenance activities, rain, erection activities, and or movable or moving loads but not including wind, snow, seismic, crane, or dead loads.

L. Roof Snow Loads: Gravity load induced by weight of snow or ice on roof, assumed to act on horizontal projection of roof.

M. Seismic Loads: Loads acting in any direction on structural system due to action of an earthquake.

N. Structural Engineer: Structural Engineer licensed in the State of Utah.

O. Wind Loads: Loads on structure induced by forces of wind blowing from any horizontal direction.

1.05 SYSTEM DESCRIPTION:

A. General: Provide a complete, integrated set of metal building system manufacturer's standard mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include primary and secondary framing, metal roof panels, metal wall panels, and accessories complying with requirements indicated.

1. Provide metal building system of size and with spacings, slopes, and spans indicated.

B. Primary Frame Type: Solid-member, structural-framing system without interior columns. Clear Span rigid frame with straight depth column and rafter sections of shop welded steel plates.

C. End-Wall and Side-Wall Framing: Manufacturer's standard, for buildings not required to be expandable, consisting of primary frames, x-braced capable of supporting one-half of a bay design load, and end-wall and side-wall columns.

D. Secondary Frame Type: Manufacturer's standard purlins and exterior-framed girts.

E. Exterior Metal Wall System: Field-assembled, exposed fastener, metal wall panels with continuous rigid foam insulation board, and faced fiberglass insulation.

F. Roof System: Mechanically seamed (double folded), concealed fastener, trapezoidal seam metal roof panels with two layers of fiberglass insulation.

G. Snow guards where indicated on drawings.

1.06 SYSTEM PERFORMANCE REQUIREMENTS

A. Design pre-engineered building in accordance with the specified building code, ASCE 7, the minimum loads shown on the Drawings and these specifications. Where requirements conflict, the more stringent requirement shall apply. Design of structures using MBMA loading combinations alone is unacceptable and will be cause for rejection. Failure to provide a complete listing of support reactions as specified will be cause for rejection. Partial or incomplete submittals will not be reviewed.

B. Design rigid frames as pinned base frames. Provide cross-bracing to resist lateral loads only where indicated on the drawings. Provide pinned base portal frames to resist lateral loads where indicated on the drawings or where cross-bracing is not indicated. Cantilever columns shall not be used.

C. Structural Performance: Provide metal building systems capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Design Loads: As required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures" and the International Building Code, 2009 Edition, but not less than the minimum design loads shown on the drawings. Where requirements conflict, the more stringent requirement shall apply.

2. Dead Loads: Dead load shall include weight of building frames, girts, purlins, wall and ceiling panels, insulation, ceilings, liner panels and other building components.

3. Roof Live Loads: Design roof areas for a minimum of 25 psf live load in addition to calculated dead loads. Design roof areas for the appropriate wind and snow loads. Determine ponding effects due to roof deck and framing deflections by rational analysis to assure stability under ponding conditions. Include an additional 10 psf collateral dead load minimum.

4. Roof Snow Loads:

   a. Include vertical loads induced by the weight of snow, but not less than 25 psf. Allow for unbalanced and drift loads.

   b. Consider roof loads resulting from unbalanced snow, drifting and the impact of adjacent structures or obstructions. Consider the additional loading due to rainfall on snow where appropriate.

5. Wind Loads:

   a. Include horizontal loads induced by a basic wind speed (3 second gust) corresponding to 90 mph wind speed.

b. Wall and roof pressures and pressures for the design of components and cladding shall be obtained from ASCE 7-10, but the design wind load shall not be less than that determined by the International Building Code, 2009 Edition.

6. Piping, Equipment and Collateral Loads. Design pre-engineered building and components for the actual piping, duct, conduit and equipment loads to be supported by the member. As a minimum, use a uniform piping load of 10 pounds per square foot of tributary area or a concentrated load of 2000 pounds located at any point along the length of the member, whichever produces the most severe condition.

7. The Pre-engineered Building Manufacturer shall obtain from the Contractor and coordinate information for all additional loads required for the design.

8. Load Combinations: Design metal building systems to withstand the most critical effects of load factors and load combinations as required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures" and the International Building Code, 2009 Edition.

9. Deflection Limits: Engineer assemblies to withstand design loads with total load deflections no greater than the following:

   (1) Purlins and Rafters: Vertical deflection of 1/360 of the span.

   (2) Rigid Frames: Vertical deflection of 1/360 of the span.

   (3) Girts: Horizontal deflection of 1/240 of the span.

   (4) Metal Roof Panels: Vertical deflection of 1/240 of the span.

   (5) Metal Wall Panels: Horizontal deflection of 1/240 of the span.

   (6) Building Lateral drift: Horizontal deflection of 1/60 of the building height.

10. Design secondary framing system to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances at openings.

11. Design wall girts for support of liner panels and attached piping.

12. Provide metal panel assemblies capable of withstanding the effects of loads and stresses indicated, based on testing according to ASTM E 1592.

13. The Pre-engineered Building Manufacturer shall design the roof purlins for lateral loads for the lateral support of the interior masonry partition at the roof and provide any supplemental framing required for this lateral support. Design purlins for a reaction at the top of the partition due to a lateral load of 5 psf acting on the wall.

D. Seismic Performance: Design and engineer metal building systems capable of withstanding the effects of earthquake motions determined in accordance with ASCE 7, "Minimum Design Loads for Buildings and Other Structures", the International Building Code, 2009 Edition, but not less than the minimum earthquake design data shown on the drawings. Where requirements conflict, the more stringent requirement shall apply.

E. Make dimensional modifications to the foundations as may be required for the specific building provided. All modifications are subject to the acceptance of the Engineer. Modifications to building pier and footing sizes based on the column and base plate sizes, anchor bolt locations and design loads submitted by the building manufacturer shall be made at no additional cost to the Owner.

F. The building manufacturer is responsible for the design of the entire building system including the parts that are specified in other sections.

G. The building manufacturer is responsible for designing and providing supplemental supports for support of equipment, mechanical ducts, electrical conduits and process piping from roof and walls.

H. Thermal Movements: Provide metal panel systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.

2. Thermal Performance: Provide metal panel assemblies with the following minimum R-values for opaque elements when tested according to ASTM C 1363 or ASTM C 518. Alternatively, U value methodology in accordance with 2018 IECC Energy Code chapter 4 Table C402.1.4 (U-Factor Method) shall be acceptable in lieu of using the prescriptive value below for R Value. Metal Roof Panel Assemblies:

    a. R-Value: R-19+ R-11 liner system

3. Metal Wall Panel Assemblies:

    a. R-Value: R-13 + R-13ci

I. Air Infiltration for Metal Roof Panels: Air leakage through assembly of not more than 0.07 cfm/sq. ft. (0.36 L/s per sq. m) when tested according to ASTM E 1680 at static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).

J. Air Infiltration for Metal Wall Panels: Air leakage through assembly of not more than 0.006 cfm/sq. ft. (0.03 L/s per sq. m) of wall area when tested according to ASTM E 1680 at static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).

K. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E 1646 at a static pressure of 12 lbf/sq. ft. (575 Pa).

L. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E 1646 at a static pressure of 20 lbf/sq. ft. (958 Pa).

M. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for Class 90.

1.07 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Delegated-Design Submittal: For metal building system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

2. Qualifications Statement: For engineer performing delegated design: Licensed in Utah and with a minimum of 2 years engineering metal building systems.

3. Completely detailed shop drawings for all members. Indicate all dimensions, architectural details, connections, openings and lifting devices. Mark each member for identification. Show mark on erection plan and place legibly on member at time of manufacture. Do not fabricate members before shop drawings are accepted by the Engineer.

4. Manufacturer's specifications and product data for all items specified including anchor bolt plans and sizes, locations of primary and secondary framing members and bracing.

5. Drawings of modifications or changes in architectural features or details which are necessitated by design requirements. Make all such modifications without additional compensation.

6. Shop drawings shall include as minimum information:

a. Drawings shall bear the seal and signature of a structural engineer licensed in Utah.

b. Codes to which the design conforms.

c. Span, depth, camber, weight and spacing of building elements.

d. All lateral bracing elements and connections.

e. Building component interface connection bolts and welds.

f. Gravity, wind and seismic design loadings, including concentrated loads and their points of application.

g. Tabulated vertical and horizontal support reactions for each basic load case and for each of the various loading combinations used in the design of the building frame at each support location for use in design verification of foundations. Submittals containing tabulations of only the basic load cases that do not include load combinations will be rejected.

h. Member material specifications, sizes and gages.

i. Bridging member sizes, connections and locations.

j. Roof and wall panel layouts.

k. Door, window, louver and finish hardware schedules.

l. Roof openings, and railings and snow retention system.

m. Show welding in conformance with AISC Detailing Manual, AISC Manual and AWS Structural Welding Code.

n. Submit the welding procedure for each type of weld prior to welding.

o. Qualification test reports bearing witness certification by an independent testing laboratory for each welder, welding operator and tacker to be employed in the work.

p. Mill certificates and copy of reports for all analyses and tests required by referenced ASTM Standard Specifications and AWS Structural Welding Code.

q. Show all piping, electrical and communications penetrations on walls and roof.

7. Manufacturers Qualifications: MBMA Member and AISC Certified Manufacturer.

8. Certificate stating that the surface preparation and shop painting conforms to specifications.

   a. Provide specified shop coatings with type, brand and manufacturer.

   b. Provide paint manufacturer's current printed recommendations and product data sheets for each product used.

c. Provide shop painting applicator's correspondence for determining compatibility of shop coatings with field applied paint coatings and for selecting manufacturer producing field paint coatings.

9. Certificate stating that the zinc coating conforms to the ASTM specified requirements.

10. Manufacturer’s product data, material descriptions, dimensions of individual components and profiles, and finishes for the following:

    a. Roof panels

    b. Wall panels

    c. Wall liner panels

    d. Trim and closures

    e. Doors and frames

    f. Thermal insulation and vapor-retarder facings

    g. Windows

    h. Storefront

    i. Louvers

    j. Skylights

    k. Gutters and downspouts

    l. Roof curbs and flashing

    m. Snow retention system

11. For the following products, in manufacturer’s standard sizes, submit range of color, texture, and pattern variations expected, in the profile and style indicated. Prepare samples from the same material to be used for the Work.

    a. Roof Panels: 12 inches x 12 inches

    b. Wall Panels: 12 inches x 12 inches

B. Submit a comprehensive calculation package for all framing, bracing, and covering components. Calculations shall present codes and standards used, member stress values and associated deflections. Calculations shall be signed and sealed by a professional engineer registered in Utah.

C. Submit a comprehensive loading report package including all foundation reactions as specified in sufficient time to allow 60 calendar days for the Engineer to review the submittal and redesign the foundations, as required, based upon the reactions submitted with the shop drawings. The 60 day period for review and redesign of foundation will not commence until a complete submittal with all of the specified loading combinations and reactions is received. The review and redesign period shall not be a basis for a delay claim, nor shall the delay of the start of the review due to receipt of an incomplete submittal.

D. Provide dimensions of members at all critical points and changes in section.

E. Provide dead loads of all building components (panels, insulation, ceilings, skylights, frames, etc.) used in the design.

F. Provide size, spacing locations and design loads of all anchor bolt groups referenced to the building lines shown on the contract drawings.

G. Provide magnitudes and locations of all piping and equipment loads based upon the actual piping and equipment sizes, content and locations to be installed. Provide this information to the building designer for incorporation into the design of the pre-engineered building.

H. Provide pressure diagrams for all wind loadings considered in the design of the structure.

I. Provide calculated maximum vertical deflections of all primary and secondary members under the various live and wind loads and the maximum deflections under total load. Provide maximum lateral deflections at eaves of all frames in both primary directions.

J. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:

1. Flashing and trim

2. Gutters

3. Downspouts

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Professional Structural Engineer Qualifications: Structural engineer who is legally qualified to practice in the State of Illinois and who is experienced in providing engineering services of kind indicated.

C. Erector Qualifications: An experienced erector who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

D. Manufacturer Qualifications: A qualified manufacturer and member of MBMA.

1. AISC Certification for Category MB: An AISC-Certified Manufacturer that designs and produces metal building systems and components in an AISC-Certified Facility.

2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

E. Source Limitations: Obtain primary metal building system components, including structural framing and metal panel assemblies, through one source from a single manufacturer.

F. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

G. Regulatory Requirements: Fabricate and label structural framing to comply with special inspection requirements at point of fabrication for welding and other connections required by authorities having jurisdiction.

H. Structural Steel: Comply with AISC's "Specification for Structural Steel Buildings--Allowable Stress Design, Plastic Design," or AISC's "Load and Resistance Factor Design Specification for Structural Steel Buildings," for design requirements and allowable stresses.

I. Cold-Formed Steel: Comply with AISI's "Specification for the Design of Cold-Formed Steel Structural Members," or AISI's "Load and Resistance Factor Design Specification for Steel Structural Members," for design requirements and allowable stresses.

J. Surface-Burning Characteristics: Provide field-insulated metal panels having thermal insulation and vapor-retarder-facing materials with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Flame-Spread Index: 25 or less, unless otherwise indicated.

2. Smoke-Developed Index: 450 or less, unless otherwise indicated.

1.09 DELIVERY, STORAGE, AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling. Transport, handle and store materials to protect from weather, rusting, corrosion or other damage.

C. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage. Store building components off the ground on supports.

D. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness and with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage. Cover and protect from snow, rain and ground splatter.

E. Use nylon slings or padded cables for handling material. Do not drop or drag material.

1.10 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements:

1. Established Dimensions for Foundations: Comply with established dimensions on approved anchor-bolt plans, establishing foundation dimensions and proceeding with fabricating structural framing without field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.

2. Established Dimensions for Metal Panels: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements or allow for field trimming metal panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.11 COORDINATION

A. Coordinate size and location of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate installation of floor, roof, and wall penetrations.

C. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

D. Coordinate installation of all openings per approved shop drawings and requirements specified in Division 08.

1.12 WARRANTY:

A. Special Warranty on Metal Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.

b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.

c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam, metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Basis of Design Manufacturer: Ceco Building Systems (www.cecobuildings.com). Other acceptable manufacturers include:

1. A&S Building Systems.

a. Mesco Building Solutions.

b. Metallic Building Systems.

2. Star Building Systems.

3. Varco-Pruden Buildings; a division of Blue Scope Buildings, North America, Inc.

4. Butler Manufacturing company; a division of Blue Scope Buildings, North America, Inc.

5. American Building Systems.

6. Or Approved Equal.

2.02 PERFORMANCE/DESIGN CRITERIA:

A. Design pre-engineered building in accordance with the specified building code, ASCE 7 and these specifications. Design of structures using MBMA loading combinations alone is unacceptable and will be cause for rejection. Failure to provide a complete listing of support reactions as specified will be cause for rejection. Partial or incomplete submittals will not be reviewed.

B. Design Loads:

1. Loading Combinations: Proportion structures and components for loading combinations and load factors as prescribed in the applicable building code and in the code governing the particular material. As a minimum, the most severe effects of the following load factors and combinations from ASCE 7 shall be considered.

2. The design of the structural system shall be sufficient to resist the following loads in addition to equipment and structure dead load:

a. Dead Loads: Dead load shall include weight of building frames, girts, purlins, wall and ceiling panels, insulation, ceilings, skylights and other building components.

b. Roof Live Loads: Design roof areas for a minimum live load as stated in Structural drawings in addition to calculated dead loads. Design roof areas for the appropriate wind and snow loads. Determine ponding effects due to roof deck and framing deflections by rational analysis to assure stability under ponding conditions.

c. Snow Loads: Design structures for the appropriate snow loads based on location, use, type of structure and roof slope. Unless more severe conditions are warranted, the snow load shall be calculated from the snow criteria stated on Structural Drawings.

d. Consider roof loads resulting from unbalanced snow, drifting and the impact of adjacent structures or obstructions. Consider the additional loading due to rainfall on snow where appropriate.

e. Wind Loads: Determine the design wind pressures by using the appropriate design equations of ASCE 7. See Section 01 41 20 for Wind design criteria.

f. Seismic Loads: Base seismic loads on ASCE 7. Seismic analysis shall be by the Equivalent Lateral Force Analysis Method. Do not use The Simplified Analysis Method. See Section 01 41 20 for Seismic design criteria.

g. Piping and Equipment Loads: Design pre-engineered building and components for the actual piping and equipment loads to be supported by the member. As a minimum, use a uniform collateral load of 10 pounds per square

foot of tributary area or a concentrated load of 1000 pounds located at any point along the length of a primary member and 500 pounds located at any point along the length of a secondary member, whichever produces the most severe condition.

h. Transporting and Handling: Design roof frames for loads resulting from transporting and installation.

C. Reference pre-engineered building columns, anchor bolts and components to the building lines indicated on the contract drawings. Alternate building or reference lines shall not be used and will be cause for rejection.

D. Limit vertical deflections of all elements to 1/240th of the span individually and collectively.

E. Lateral drift of the building (sidesway) shall be limited to H/60 where H is the height of the building.

F. Design rigid frames as pinned base frames. Provide cross-bracing to resist lateral loads only where indicated on the drawings. Provide pinned base portal frames to resist lateral loads only where indicated on the drawings. Cantilever columns shall not be used.

G. The roof coverings shall be designed for the specified live load and the wind load, and shall carry an Underwriters' Laboratories wind uplift Class 90 rating. Deflection of the roof panels shall not exceed 1/180th of its span when supporting these loads.

H. Roof bracing of the IPS building: Bracing cannot occur within the plan extents of the roof skylights so that the skylights can be used for removal of equipment within the building. The building designer shall design all applicable bracing elements to satisfy all loading and deflection requirements stated.

I. The Pre-engineered Building Manufacturer shall obtain from the Contractor and coordinate information for all additional loads required for the design. The contractor shall not construct the foundation until all building load reactions are reviewed and accepted by the Engineer.

2.03 STRUCTURAL FRAMING:

A. Primary and endwall framing, bracing and secondary structural framing shall be the standard of the building manufacturer except as specified herein and indicated on the drawings. Provide bracing system as required at the roof. Provide diagonal rods, single strut, or chevron bracing in walls. Bracing shall not interfere with windows, doors, louvers, or furnishings.

1. Hot-rolled shapes: ASTM A 36 or ASTM A 992, minimum yield of 36 ksi (248 MPa) or 50 ksi (345 MPa).

2. Built-up sections:

    a. Webs:

        (1) ASTM A 1011 or ASTM A1018, SS or HSLAS, Grade 55 (380) for webs 3/16 inch (4.76 mm) thick and thinner.

        (2) ASTM A 572 Grade 50 (340) or ASTM A572 Grade 55 (380) or ASTM A 529 Grade 55 for webs thicker than 3/16 inch (4.76 mm).

    b. Flanges: ASTM A 529 Grade 55 (380) or ASTM A 572 Grade 50 (340) or 55 (380).

3. Round tube: ASTM A 500, Grade B or C with minimum yield strength of 42 ksi (290 MPa).

4. Square and rectangular tube: ASTM A 500, Grade B or C, minimum yield strength of 42 ksi (290 MPa).

5. Cold-formed C sections: ASTM A 1011, Grade 55 (380), or ASTM A 653, Grade 55 (380).

6. X-bracing: ASTM A 529 or A 572 for rod bracing 36 ksi (248 MPa) or 50 ksi (345 MPa), ASTM A 36 for angle bracing or ASTM A 475 for cable bracing.

B. Secondary structural framing: consisting of purlins, girts, braces, supports and accessories shall be rolled formed sections.

1. Purlins, girts, and eave struts: ASTM A 1011 Grade 55 (380), or ASTM A 653, Grade 55 (380).

2. Thickness as required by design. Minimum Uncoated Thickness:

    a. 16 gauge: 0.056 inch (1.421 mm) minimum uncoated thickness.

3. Finish: Gray Shop Coat. Shop coat only intended to provide temporary protection during transportation and erection.

C. Bolts:

1. Rigid Frame Connections: Provide High Strength Bolts, Nuts and Washers:

    a. Bolts: ASTM F 3125 Grade A325 Heavy Hex Structural Type I.

    b. Washers: ASTM F 436 Type 1 Hardened Steel.

c. Nuts: ASTM A 563 Grade C Heavy Hex. Nuts shall be wax coated by emulsion such that the torque required to complete a Rotational Capacity (RC) test shall be reduced by 40% from the un-waxed state.

d. Coating: ASTM F 1941 Electrodeposited Yellow Zinc.

2. Other Connections: Provide High Strength or Machine Bolts as required by manufacturer design:

a. High Strength Bolts and Nuts:

b. Bolts: ASTM F 3125 Grade A325 Heavy Hex Structural Type I.

c. Nuts: ASTM A 563 Grade C Heavy Hex.

d. Coating: ASTM F 1941 Electrodeposited Yellow Zinc.

3. Machine Bolts:

a. Bolts: ASTM A 307 Grade Carbon Steel.

b. Nuts: ASTM A 563 Grade A Hex Nut.

c. Coating: ASTM F 1941 Electrodeposited Clear Zinc.

D. Hot dip galvanize primary and end wall framing in accordance with ASTM A123 and A153. Hot dip galvanize secondary structural framing consisting of purlins, girts, braces and supports in accordance with ASTM A653 with G90 (Z275) coating designation; mill phosphatized.

E. After galvanizing, Shop paint primary and end wall framing, secondary structural framing consisting of purlins, girts braces and supports with system No. 102 per Section 09 91 00 Architectural Painting and Coating.

2.04 METAL WALL PANELS:

A. Material: Aluminum-Zinc-Alloy-Coated Steel Sheet: ASTM A792, structural quality, Grade 50, Coating Class AZ50, prepainted by the coil-coating process per ASTM A755.

B. Large Tapered-Rib-Profile, Exposed Fastener Metal Panels: Structural metal panel consisting of formed metal sheet with trapezoidal major ribs with intermediate stiffening ribs symmetrically placed between major ribs, installed by lapping edges of adjacent panels.

1. Basis of Design: Ceco, PBR Panel.

a. Coverage Width: 36 inches.

b. Major Rib Spacing: 12 inches.

c. Rib Height: 1-1/4 inch.

d. Nominal Coated Thickness: 26 gauge.

e. Panel Surface: Smooth.

2. Exterior Finish: Fluoropolymer Two-Coat System (PVDF): 0.2 – 0.3 mil primer with 0.7 - 0.8 mil 70 percent PVDF fluoropolymer color coat.

a. Signature 300.

3. Color: As selected from manufacturer's standard colors.

2.05 METAL ROOF PANELS

A. Material: Aluminum-Zinc-Alloy-Coated Steel Sheet: ASTM A792, structural quality, Grade 50, Coating Class AZ50, prepainted by the coil-coating process per ASTM A755.

B. Mechanically Seamed, Concealed Fastener, Trapezoidal Seam Metal Roof Panels: Structural metal roof panel consisting of formed metal sheet with raised trapezoidal ribs at panel edges, installed by lapping and mechanically interconnecting edges of adjacent panels, and attaching panels to supports using concealed clips and fasteners in a weathertight installation.

1. Basis of Design: Ceco, Double-Lok.

a. Panel width: 18 inches wide x 3 inches high.

b. Joint Type: Double folded.

c. Thickness: 24 gauge.

d. Roof Slope: 1:12.

2. Exterior Finish: Fluoropolymer Two-Coat System (PVDF): 0.2 – 0.3 mil primer with 0.7 - 0.8 mil 70 percent PVDF fluoropolymer color coat.

a. Signature 300.

3. Color: As selected from manufacturer's standard colors.

2.06 METAL ROOF PANEL ACCESSORIES

A. General: Provide complete metal roof panel assembly incorporating trim, copings, fasciae, gutters and downspouts, and miscellaneous flashings, in manufacturer's standard profiles.

Provide required fasteners, closure strips, splice plates, support plates, and sealants as indicated in manufacturer's written instructions.

B. Flashing and Trim: Match material, thickness, and finish of metal panel face sheet.

C. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where necessary to ensure weathertight construction.

D. Two Piece Floating Clips: ASTM C645, with ASTM A653, G90 hot-dip galvanized zinc coating, configured for concealment in panel joints, and identical to clips utilized in tests demonstrating compliance with performance requirements.

E. Panel Fasteners: Fasteners as recommended by metal panel manufacturer for corrosive environments.

F. Joint Sealers: Manufacturer's standard or recommended liquid and preformed sealers and tapes and as follows:

1. Factory-Applied Seam Sealant: Manufacturer's standard type.

2. Tape Sealers: Manufacturer's standard non-curing butyl tape, AAMA 809.2.

G. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1 inch standoff; fabricated from extruded polystyrene

1. Thermal requirements: R-5 minimum.

H. Pipe Penetration Flashing: Approved by metal roof panel manufacturer.

1. Pipe flashing: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated on Drawings. Provide stainless-steel snaplock swivel clamps.

I. Snow Guards: Approved by metal roof panel manufacturer.

1. Retention Type: Fence-style snow retention system installed perpendicular to the roofing ribs.

a. Manufacturer: S-5! ColorGard or equal.

b. Color: Finish to match roof system.

J. Eave trim conditions

1. Gutters: Formed from minimum 0.0159-inch- (0.40-mm-) thick, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2438-mm-) long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

2. Gutter Supports: Fabricated from same material and finish as gutters; spaced 36 inches (900 mm) o.c.

3. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

4. Downspouts: Formed from 0.0159-inch- (0.4-mm-) thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- long sections, complete with formed elbows and offsets.

2.07 PANEL SEALANTS:

A. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch wide and 1/8 inch thick.

B. Joint Sealant: ASTM C920; one-part elastomeric polyurethane, polysulfide, or silicone-rubber sealant; of type, grade, class, and use classifications required to seal joints in panels and remain weathertight; and as recommended by metal building system manufacturer.

2.08 INSULATION:

A. Glass-Fiber Blanket: ASTM C991 for flexible fibrous glass insulation for metal buildings, Type I.

1. Manufacturer: Owens Corning; EcoTouch or equal.

a. Roof First Layer: Laminated; Draped over roof purlins.

b. Roof Second Layer: Unfaced; Installed parallel to roof purlins.

c. Wall: Laminated

B. Polyisocyanurate Board: ASTM C1289, Type 1, Class 1.

1. Wall: continuous insulation barrier on exterior face of girts.

C. Polyisocyanurate Board: ASTM C1289, Type 1, Class 1.

1. Wall: continuous insulation barrier on exterior face of girts.

2.09 METAL WALL LINER PANEL:

A. Flush-Profile, Metal Liner Panels Solid panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges; with flush or overlapping joint between panels; designed for interior side of metal wall panel assemblies and installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps.

B. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet 0.030-inchnominal uncoated steel thickness.

C. Exterior Finish: Fluoropolymer Two-Coat System (PVDF): 0.2 – 0.3 mil primer with 0.7 - 0.8 mil 70 percent PVDF fluoropolymer color coat.

1. Signature 300.

D. Color: As selected from manufacturer's standard colors.

E. Panel Coverage: 12 inches

F. Panel Height: 1.5 inches

2.10 DOORS, WINDOWS, STOREFRONT, SKYLIGHTS AND LOUVERS:

A. Provide as specified and as shown on the drawings.

2.11 FRAMING FOR OPENINGS:

A. Provide structural steel framing members for doors, windows, storefront, skylights, and louvers. Fabricate the members of structural steel and of sufficient size to support the weight and resulting loads of each item.

B. Provide finish for framing the same as primary and secondary framing.

2.12 ROOF CURBS:

A. Fabricated from minimum 0.0428-inch thick, aluminum-zinc alloy-coated steel sheet pre-painted with coil coating; finished to match metal roof panels; with welded top box and bottom skirt, wood nailer, and integral full-length cricket; capable of withstanding loads of specified skylights and fall protection system of size and height indicated.

1. Curb Sub-framing: Minimum 0.0528-inch thick, angle- C-, or Z-shaped steel sheet.

2. Insulation: 1-inch thick, rigid type.

B. Provide design of, furnish and install roof curbs for roof hatches indicated on drawings. Coordinate to ensure curbs meet requirements to suit the roof hatches to be installed.

2.13 SNOW RETENTION SYSTEM:

A. Manufacturers:

1. S-5 Color Gard manufactured by Metal Roof Innovations, Ltd., Colorado Springs, Co.

B. Description:

1. Aluminum standing seam roof clamps shall be 6061-T6 extruded aluminum conforming to ASTM B221. Carbon steel or plastic parts not acceptable. Clamps attach to standing seams using a minimum of two (2) stainless steel set screws. Clamp spacing shall be at every second seam.

2. Cross member shall be continuous and shall be 6061-T6 extruded aluminum conforming to ASTM B221. Provide cross member with receptacle in face for insertion of color strip. Color strip shall be same material, finish and color as roof panels specified.

3. Fasteners and clamp hardware shall be 300 series stainless steel.

4. Provide continuous finished roof panel strips for insertion into crossmember receptacle.

5. Finish and color to match roof panels.

2.14 PRECAST CONCRETE SPLASH BLOCKS

A. Normal weight, air entrained concrete achieving 5,000 psi compressive strength in 28 days. Manufacturer’s standard method of reinforcement for size as indicated on drawings.

1. Height: 3” nominal

2. Finish: smooth, as-cast surface; natural concrete color.

2.15 SHOP PAINTING:

A. Paint primary and end wall framing, secondary structural framing consisting of purlins, girts, braces and support as specified herein.

B. Surface Preparation:

1. Protect all structural steel as specified herein and followed by field painting as specified. Do not paint steel to be completely encased in concrete.

2. Complete all welding before beginning surface preparation and shop painting except when size of members, field erection procedures or other approved necessity requires welding after shop priming.

3. Prepare surfaces of steel by removing all weld spatter, flux, residue, burrs and metal surface defects before cleaning.

   a. Grind sharp edges and corners smooth and eliminate pinholes and unevenness adversely affecting coating thickness and longevity.

   b. Level rough, uneven surfaces and fill depressions to produce a base satisfactory for specified primers and finishes with even transitions which permit consistent film thickness at inside and outside corners.

   c. Do no cleaning or priming until surface preparation is acceptable.

4. Clean structural steel surfaces in conformance with SSPC-SP6 - Commercial Blast Cleaning. Clean structural steel surfaces to be immersed to near white metal in conformance with SSPC-SP10.

5. Prime clean dry surfaces before rusting, contamination or deterioration starts. Prime within eight hours of cleaning under ideal conditions or sooner if conditions are not ideal. Protect cleaned surfaces to prevent deterioration before coating. Re-clean as specified herein just before priming if blast cleaned area is not primed within eight hours of cleaning.

6. Clean and paint surfaces inaccessible after assembly before assembly unless such areas are seal welded.

7. Apply coating to prepared, clean, dry surfaces in conformance with paint manufacturer's current printed recommendations and as specified herein.

8. Hold back coatings which would be damaged by field welding and welding heat from areas to be welded until welding is completed. Re-clean and recoat substrate as specified herein for original coats for areas of held back coatings when coated areas have had coating damaged by welding.

9. Perform coating operations only during suitable ambient and surface conditions, moderate temperatures, low humidity and low air movement. Protect from precipitation and intense sunlight.

10. Immediately after surface preparation, mix and apply coatings to produce a complete, tenacious, continuous bonded film, uniform in thickness and without

defects. Provide a coating with film thickness not less than specified and with no runs, sags, skips, holidays, pinholes or blisters.

11. Remove damaged or defective coatings by specified cleaning to meet surface cleaning requirements immediately before recoating.

C. Finish Coating

1. Roof panels, wall panels, liner panels, gutters, canopy framing, downspouts, snow retention system, trim, flashing and accessories shall receive the following shop applied finishes:

a. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: conversion coatings; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight), with a minimum total dry film thickness of 1.0 mil. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions, except as modified below:

(1) Humidity Resistance: 2000 hours

(2) Salt-Spray Resistance: 2000 hours

b. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored backer finish, consisting of prime coat and wash coat with a total minimum dry film thickness of 0.5 mil.

2. Surface preparation, mixing, application and safety requirements shall be in accordance with the paint manufacturer's printed instructions and as specified.

2.16 GALVANIZING:

A. Provide hot-dip galvanizing in conformance with ASTM A123, Grade 100 to all steel indicated or specified to be galvanize coated.

B. Provide hot-dip galvanizing, in conformance with ASTM A153, to all bolts, nuts and washers that will be used with galvanized steel.

C. Complete all fabrication and prepare surfaces of steel by removing all weld spatter, flux, residue, burrs and metal surface defects before galvanizing. Clean weldments with power wire brush prior to galvanizing.

D. Provide steel dipped into solution of zinc chloride plus ammonium chloride immediately prior to galvanizing. Do not use galvanizing process utilizing flux blanket overlaying molten zinc.

E. SSPC–SP16 treat all pieces that will be in contact with or encased in concrete or masonry after galvanizing.

1. Two coats of one of the following coating systems shall be applied :

a. Series 161 HS Tneme-Fascure by Tnemec Co. Inc., Kansas City, MD

b. Kop-Coat Super Hi-Gard by Kop-Coat Inc., Pittsburgh, PA

c. Valspar-Series 89 by Valspar Corp., Baltimore, MD

2. Prepare the steel surface in conformance with the manufacturer's printed instructions for the preparation of all non-ferrous metals before applying the initial coat of the two coat system.

F. Tap bolt nuts after hot-dip galvanizing in conformance with ASTM A563.

G. Inspect galvanized material for compliance with these specifications. Mark the material with a clearly visible stamp indicating the name of the galvanizer, the ASTM number and the weight of zinc coating in ounces per square foot.

2.17 GALVANIZE TOUCH-UP:

A. Touch-up abraded hot-dip galvanized areas by the brush applied method with zinc-rich coatings having dry film thickness of not less than 6 mils. Repair galvanize using paints containing zinc dust in conformance with ASTM A780.

B. Touch-up all damaged galvanized surfaces with one of the following zinc rich coatings:

1. Endupor, zinc-rich coating by Dampney Manufacturing Co., Everett, MA

2. ZiRP, zinc-rich coating by Duncan Galvanizing Corp., Everett, MA

3. ZRC Cold Galvanizing Compound by ZRC Chemical Products Co., Division of Norfolk Corp., Quincy, MA

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedment’s to

receive structural framing, with Erector present, for compliance with requirements and metal building system manufacturer's tolerances.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and prepare surfaces to be coated according to manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place, unless otherwise indicated.

3.03 FABRICATION:

A. Fabricate each element and connection as indicated on the shop drawings accepted by the Engineer.

B. General:

1. Shop-fabricate framing members for field bolted assembly.

2. Surfaces of bolted connections: Smooth and free from burrs and distortions.

3. Shop connections to conform to manufacturer's standard design practices.

4. Mark framing members with identifying mark.

5. Welding to conform to AWS D1.1 and AWS D1.3 as applicable.

6. Tolerances: Comply with MBMA's "Metal Building Systems Manual": Chapter IV, Section 9, "Fabrication and Erection Tolerances."

C. Primary Framing:

1. Plates, stiffeners, and related members: Factory welded base plates, splice plates, cap plates, and stiffeners into place on structural members.

2. Bolt holes and related machining: Shop fabricate base plates, splices and flanges to include bolt connection holes. Shop-fabricate webs to include bracing holes.

3. Secondary structural connections (purlins and girts): Ordinary (not pretensioned) bolted connections with welded clips.

4. Welding inspection: Per IAS AC472 Part A.

D. Zee Purlins:

1. Fabricate purlins from cold-formed Z-shaped sections with stiffened flanges.

2. Size flange stiffeners to comply with requirements of AISI S100.

3. Purlin flanges unequal in width for easier nesting during erection.

4. Purlins pre-punched at factory to provide for field bolting to rigid frame clips.

5. Eave Struts:

6. Fabricate eave struts from cold-formed unsymmetrical C-shaped sections with stiffened flanges.

7. Size flange stiffeners to comply with requirements of AISI S100.

8. No welded splices permitted.

9. Eave Struts pre-punched at factory to provide for field bolting to rigid frame clips.

E. Girts: Simple or continuous span as required by design. Connection bolts will install through webs, not flanges.

F. Bracing:

1. Diagonal Bracing:

a. Diagonal bracing in roof and sidewalls shall be used to resist lateral loads in structure.

b. Furnish to length and equipped with hillside washers and nuts at each end.

c. Bracing may consist of rods threaded at each end or galvanized cable with suitable threaded end anchors.

d. If load requirements dictate, bracing may be of structural angle or pipe, bolted in place.

2. Flange Braces: Brace compression flange of primary framing laterally with angles connecting to purlin or girt webs so that flange compressive stress is within allowable limits for any combination of loading.

3. Bridging:

a. Laterally brace top chord of long bay purlins with horizontal bridging if roof system being used will not supply adequate lateral support to top chord.

G. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

H. Standing Seam Panels:

1. Provide factory fabricated and finished metal panels and accessories meeting performance requirements, indicated profiles and structural requirements.

2. Fabricate metal joints configured to accept applied sealant providing weathertight seal and preventing metal to metal contact and minimizing noise resulting from thermal movement.

3. Fabricate panels in continuous lengths for full length of detailed runs, except where otherwise indicated on drawings.

4. Sheet Metal Flashing and Trim: Fabricate or install flashing and trim to comply with manufacturer’s written instructions and construction drawings.

5. Configure Double-Lok panels with interlocking edges with factory applied hot-melt mastic inside female seam. Female side snaps over male side and when seamed creates continuous lock, forming 360 degree Pittsburgh seam.

6. Notch Double-Lok panels at factory at both ends so that field installation can commence or terminate from either end of building.

7. Maximum panel length: 45 feet (13 716 mm) unless otherwise indicated.

I. End Laps:

1. Fabricate with 16 gauge backup plates and eight end lap joint fasteners installed in six pre-punched holes in flat and in dimples in trapezoidal legs.

2. Apply mastic between panels and secure with self-drilling fasteners through panels and backup plate.

3. Through roof fasteners may be used only at end laps and eaves.

3.04 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written erection instructions and erection drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base Plates: Clean concrete bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.

2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing true to line, level, plumb, rigid, and secure. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

a. Joint Type: Snug tightened or pretensioned.

G. Secondary Framing: Erect framing true to line, level, plumb, rigid, and secure. Fasten secondary framing to primary framing using clips with field connections using non-high-strength bolts.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.

2. Locate and space wall girts to suit openings such as doors and windows.

3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, and other penetrations of roof and walls.

H. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.

2. Locate interior end-bay bracing only where indicated.

I. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

J. Erection Tolerances: Maintain erection tolerances of structural framing within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.05 METAL PANEL INSTALLATION, GENERAL

A. Examination: Examine primary and secondary framing to verify that structural panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before metal panel installation.

B. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, louvers, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports, unless otherwise indicated.

3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.

4. Locate and space fastenings in uniform vertical and horizontal alignment.

5. Locate metal panel splices over, but not attached to, structural supports with end laps in alignment. Stagger panel splices and end laps to avoid a four-panel lap splice condition.

6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal panel manufacturer.

2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

3.06 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.

2. Shim or otherwise plumb substrates receiving metal wall panels.

3. When two rows of metal panels are required, lap panels 4 inches minimum.

4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.

5. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Predrill panels.

6. Flash and seal metal wall panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.

7. Install screw fasteners in predrilled holes.

8. Install flashing and trim as metal wall panel work proceeds.

9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated, or if not indicated, as necessary for waterproofing.

10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws.

11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Field-Assembled, Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.

1. Field-Insulated Assemblies: Install thermal insulation as specified. Fasten with exposed fasteners as recommended by manufacturer.

2. Install full height liner panels on all wall at interior side of girts.

3.07 METAL ROOF PANEL INSTALLATION:

A. General: Provide metal roof panels of full length from eave to ridge, unless otherwise indicated or restricted by shipping limitations.

1. Install ridge caps as metal roof panel work proceeds.

2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Mechanically-Seamed, Trapezoidal Standing Seam Metal Roof Panels: Install weathertight metal panel system in accordance with manufacturer's written instructions, approved shop drawings, and project drawings. Install metal roof panels in orientation, sizes and locations indicated, free of waves, warps, buckles, fastening stresses and distortions. Anchor panels and other components securely in place. Provide for thermal and structural movement.

C. Attach panels to supports using clips, screws, fasteners and sealants recommended by manufacturer and indicated on approved shop drawings.

1. Fasten metal panels to supports with concealed clips at each location indicated on approved shop drawings, with spacing and fasteners recommended by manufacturer.

2. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

3. Provide weatherproof jacks for pipe and conduit penetrating metal panels of types recommended by manufacturer.

4. Dissimilar Materials: Where elements of metal panel system will come into contract with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.

3.08 THERMAL INSULATION INSTALLATION FOR FIELD-ASSEMBLED METAL PANELS

A. General: Install insulation concurrently with metal wall panel installation, in thickness indicated to cover entire wall, according to manufacturer's written instructions.

1. Set vapor-retarder-faced units with vapor retarder to warm side of construction, unless otherwise indicated. Do not obstruct ventilation spaces, except for firestopping.

2. Tape joints and ruptures in vapor retarder and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths with both sets of facing tabs sealed to provide a complete vapor retarder.

4. Install blankets straight and true in one-piece lengths. Install vapor retarder over insulation with both sets of facing tabs sealed to provide a complete vapor retarder.

B. Blanket Roof Insulation: Comply with the following installation method:

1. Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing members. Install layer of filler insulation over first layer to fill space formed by metal roof panel standoffs. Hold in place by panels fastened to standoffs.

2. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

C. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing members. Hold in place by metal wall panels fastened to secondary framing.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

D. Board Wall Insulation: Extend board insulation in field-assembled metal wall panel assembly in thickness indicated to cover entire wall.

3.09 DOOR AND FRAME INSTALLATION

A. General: Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with wall

flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.

1. Reference Division 08 Section “Doors and Frames” for erection tolerances and touch-up requirements.

3.10 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

2. Install components for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

3. Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.

E. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.11 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, and accessories.

1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or SSPC-SP 3, "Power Tool Cleaning."

2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

C. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

3.12 WELDING:

A. Conform to requirements of AWS Structural Welding Code and as indicated or specified.

B. No field welding permitted unless indicated on Engineer accepted fabrication shop drawings.

C. No field welding permitted on galvanized steel.

3.13 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

DIVISION 22

PLUMBING

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SECTION 22 05 00

PLUMBING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide new and modify existing plumbing systems as indicated and in compliance with Contract Documents.

B. The Work of this Section shall include all labor, materials, tools, equipment and appurtenances, and performing all operations necessary to furnish and install complete and operable systems in accordance with this Section of these Specifications, the Drawings, and the codes and standards listed herein.

C. Coordinate with the Local Water Utility as to any Local restrictions or requirements relative to backflow prevention devices and metering.

D. Limits of Work shall be as indicated on the Drawings. Items of Work shall consist of the following:

1. All plumbing removals indicated.

2. Domestic hot and cold-water piping to plumbing fixtures.

3. Domestic tempered water piping to emergency eyewash/showers.

4. Provide backflow preventers where indicated in domestic water piping for connection by other Sections to process equipment and hydronic heating systems

5. Drain-waste-vent sanitary piping from plumbing fixtures and floor drains.

6. Special waste and vent system for laboratory.

7. Domestic water heaters, electric water heaters, potable water well tanks, plumbing fixtures, roof drains, floor drains. Furnish roof drains to roofing trade for all roofs.

E. Compliance Requirements of Plumbing Systems:

1. American Iron and Steel (AIS) Requirements for WIFIA Projects:

a. Consolidated Appropriations Act of 2014 P.L. 113-76 – Iron and Steel products made primarily of iron or steel that are permanently incorporated into the project shall use iron and steel that are produced in the United States.

b. Listed Plumbing Products include:

(1) Lined or unlined pipes and fittings (includes pipe used as wall and floor sleeves)

(2) Tanks

(3) Flanges

(4) Pipe Clamps and Restraints (includes hangars and supports)

(5) Valves

(6) Sinks

c. Throughout this Division, AIS Compliance will be noted for materials and components that align with the products indicated.

d. Mechanical equipment, components, and systems are not considered construction materials. This excludes plumbing itmes from AIS compliance, including:

(1) Pumps (including strainers)

(2) Water Heaters

(3) Controls and Switches (including sensors)

(4) VFD Drives

(5) Emergency Fixtures (including showers and eyewashes)

(6) Water Meters

(7) Filters and Aerators

F. Section Includes:

1. Piping materials and installation instructions common to most piping systems

2. Joining Materials

3. Transition fittings

4. Dielectric fittings

5. Mechanical sleeve seals

6. Sleeves

7. Escutcheons

8. Grout

9. Trap Primer Piping

10. Strainers

11. Valve Boxes

12. Freeze Protection Enclosures

13. Expansion Tanks

14. Electric Trap Primers

15. Hoses

16. Drip Pans

17. Access Panels

18. Potable Water Well Tanks and Accessories

1.02 DEFINITIONS:

A. Architect: Where used in this section and other subsequent sections, Architect is intended to refer to the lead design consulting firm, as well as its associated consulting engineers. On projects where the lead design consulting firm is an engineer, rather than an architect, Architect shall refer to the lead consulting engineer.

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

F. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

G. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic

2. PE: Polyethylene plastic.

3. PVC: Polyvinyl chloride plastic.

H. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.03 REFERENCES:

A. Except as specified herein, the latest edition of the standards listed below form a part of this Specification to the extent referenced in this Section. Where earlier editions of standards are adopted as referenced in applicable codes, those shall govern. The publications are referred to within the text by the basic designation only.

B. In each of the standards referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. American National Standards Institute (ANSI):

1. Z358.1: Emergency Eyewash and Shower Equipment

D. American Society of Mechanical Engineers (ASME):

1. A112.18.1M: Plumbing Fixture Fittings

2. A112.21.1M: Floor Drains

3. A112.21.2M: Roof Drains

4. A112.36.2M: Cleanouts

5. B16.1: Cast Iron Pipe Flanges and Flanged Fittings

6. B16.3: Malleable Iron Threaded Fittings

7. B16.12: Cast Iron Threaded Drainage Fittings

8. B16.18: Cast Copper Alloy Solder Joint Pressure Fittings

9. B16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

10. B16.23: Cast Copper Alloy Solder Joint Draining Fittings - DWV

11. B16.24: Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500, and 2500

12. B16.26: Cast Copper Alloy Fittings for Flared Copper Tubes

13. B16.29: Wrought Copper and Wrought Copper Alloy Solder Joint Draining Fittings - DWV

14. B16.32: Cast Copper Alloy Joint Fittings for Solvent Draining Systems

15. B16.50: Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings

16. B40.1: Pressure Gauges and Gauge Attachments

E. American Society of Sanitary Engineering (ASSE):

1. 1003: Water Pressure Reducing Valves

2. 1013: Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers

3. 1015: Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies

4. 1017: Temperature Actuated Mixing Valves for Hot Water Distribution Systems

5. 1018: Trap Seal Primer Valves - Potable, Water Supplied

6. 1019: Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type

7. 1071: Temperature Actuated Mixing Valves for Plumbed Emergency Equipment

F. ASTM International (ASTM):

1. A47: Ferritic Malleable Iron Castings

2. A53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

3. A74: Cast Iron Soil Pipe and Fittings

4. A126: Gray Iron Castings for Valves, Flanges and Pipe Fittings

5. A183: Carbon Steel Track Bolts and Nuts

6. A518: Corrosion-Resistant High-Silicon Iron Castings

7. A536: Ductile Iron Castings

8. B32: Solder Metal

9. B42: Seamless Copper Pipe, Standard Sizes

10. B88: Seamless Copper Water Tube

11. B306: Copper Drainage Tube (DWV)

12. B584: Copper Alloy Sand Castings for General Applications

13. C564: Rubber Gaskets for Cast Iron Soil Pipe and Fittings

14. D2000: Rubber Products in Automotive Applications

15. D2665: Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

16. D2846: Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot - and Cold-Water Distribution Systems

17. F441: Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

G. American Water Works Association (AWWA):

1. C104: Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

2. C105: Polyethylene Encasement for Ductile-Iron Pipe Systems

3. C110: Ductile-Iron and Gray-Iron Fittings, 3 In. through 48 In., for Water

4. C111: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

5. C115: Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

6. C151: Ductile-Iron Pipe, Centrifugally Cast, for Water

7. C500: Metal-Seated Gate Valves for Water Supply Service

8. C509: Resilient-Seated Gate Valves for Water Supply Service

9. C651: Disinfecting Water Mains

10. C700: Cold-Water meters – Displacement Type, Bronze Main Case

11. C701: Cold-Water Meters-Turbine Type, for Customer Service

12. C702: Cold-Water meters – Compound Type

13. C707: Encoder Type, Remote Registration Systems for Cold-Water Meters

14. D100: Welded Steel Tanks for Water Storage

H. American Welding Society (AWS):

1. A5.8: Filler Metals for Brazing and Braze Welding

2. BRH: Brazing Handbook

I. Cast Iron Soil Pipe Institute (CISPI):

1. 301: Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications

2. 310: Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

3. HSN-85: Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

J. Foundation for Cross-Connection Control And Hydraulic Research (FCCCHR):

1. FCCCHR List: List of Approved Backflow Prevention Assemblies

K. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

1. SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation

2. SP-70: Cast Iron Gate Valves, Flanged and Threaded Ends

3. SP-71: Gray Iron Swing Check Valves, Flanged and Threaded Ends

4. SP-80: Bronze Gate, Globe, Angle and Check Valves

5. SP-85: Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

6. SP-110: Ball Valves Threaded, Socket Welding, Solder Joints, Grooved and Flared Ends

L. Plumbing and Drainage Institute (PDI):

1. WH 201: Water Hammer Arresters

M. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

1. SMACNA Seismic Restraint Unit: Seismic Restraint Manual: Guidelines for Mechanical Systems

N. Underwriters Laboratories (UL):

1. 1453: Electric Booster and Commercial Storage Tank Water Heaters

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Shop Drawings:

a. Coordination Drawings: Prepare as specified in Paragraph "Cooperation and Coordination with Other Trades" of this Section.

2. Product Data: For each product, provide descriptive data to show the specific manufacturer, model, type, size, capacity, curves, wiring diagrams, options, etc. of each item. Where products are available with Energy Star labeling, they shall be provided.

3. Certification: Submit documentation certifying completion of the following items in compliance with this Section.

a. Tests

b. Flushing

c. Manufacturers' services

d. Disinfection

4. Test Reports: Prepare as specified in Part 3 of this section.

a. Pressure tests

b. Backflow preventer tests

c. Functional testing

5. Certificates and Licenses: Prepare as specified in Part 1 of this section.

a. Qualifications of Installer

b. Qualifications of Construction Supervisor

6. Operation and Maintenance Manuals: Prepare manuals in accordance with Section 01 78 23.

7. Closeout Submittals:

a. Record Drawings: Prepare as specified in Part 1 of this section.

B. Welding certificates.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00.

B. Provisions:

1. Drawings and specification direct attention to certain features of equipment, but do not purport to cover all details entering into design and construction of the equipment, controls, or appurtenances.

2. Consideration shall be given only to products of manufacturers who demonstrate successful experience in manufacture, operation, and servicing equipment of type, size, performance, and reliability equal to that specified. Equipment and components shall be the product of a single manufacturer insofar as possible.

3. Equipment furnished to fit within the space allocated with adequate clearance for proper operation and maintenance.

C. Workmanship and Design:

1. Provide equipment such that all parts are designed for continuous and uninterrupted service, and such that lubrication, adjustment, or replacement of parts is possible without manufacturer's assistance. Corresponding parts of multiple units shall be interchangeable.

2. Install equipment that complies with state, local and federal codes and regulations.

D. Alternate Equipment and Arrangement:

1. If any equipment submitted for acceptance requires arrangement differing from that indicated or specified, Contractor to prepare and submit for review, detailed structural, mechanical and electrical drawings, and equipment lists showing all necessary changes and all special features of equipment proposed. Changes are at no additional compensation to the Contractor.

E. Qualifications of Installer:

1. Prior to installation, submit data showing the name and license of the installing contractor and that he has successfully installed systems of the same type and design as specified herein. Data shall include names and locations of at least two installations of such systems. Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18 months. The installing contractor shall be licensed to perform applicable plumbing systems installation in the state in which the project is located.

F. Qualifications of Construction Supervisor:

1. Provide a Construction Supervisor with a minimum of 5 years of experience in plumbing construction supervision who shall be responsible for the installation of the Work of this Section of the Specifications. The Construction Supervisor shall be licensed to perform applicable plumbing systems supervision in the state in which the project is located. Prior to installation, submit data for acceptance showing the name and license of the Construction Supervisor.

G. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

H. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

I. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

J. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

K. The Contractor shall be responsible for the field verification of existing conditions prior to submitting bids.

L. The Contractor shall be responsible for reporting any existing damaged equipment or systems to the Owner prior to any work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with APWA Section 01 66 00 and as specified.

B. Shipping:

1. Equipment, material and spare parts are to be shipped completely assembled except where partial disassembly is required by transportation regulations or for protection of components.

C. Receiving:

1. Inspect and inventory items upon delivery to site.

2. Store and safeguard equipment, material and spare parts in accordance with manufacturer's recommendations.

D. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

E. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.07 COORDINATION:

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.

D. The Contractor shall coordinate with Owner for all new to existing connections, system shutdowns and restart-up.

E. For work in existing occupied facilities, coordinate all service shut-downs with Owner. Contractor shall request service interruptions a minimum of 72 hours prior to desired time of interruption. The Owner reserves the right to reject or change requested time of service interruption.

1.08 COOPERATION AND COORDINATION WITH OTHER TRADES:

A. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow efficient completion of the project. Materials and equipment shall be installed as fast as conditions will permit, and installed properly.

B. Furnish to all other trades advance information on location and size of all concrete pads, chases, frames, boxes, pits, sleeves, and openings needed for the Work, and also furnish layout information and shop drawings necessary to permit other trades affected by the Work to install their work properly coordinated and without delay.

C. Where there is evidence that Work installed interferes with the work of other Sections, assist in working out space conditions to make satisfactory adjustments.

D. With the acceptance of the Engineer and without extra cost to the Owner, make reasonable modifications in Work specified under this Section required to coordinate with normal structural interference's, or for proper execution of specified work.

E. If work is installed before coordinating with other trades so as to cause interference with the work of such trades, make all necessary changes in Work under this Section of the at no additional cost to the Owner.

F. Protect all materials and work of other trades from damage that may be caused by the Work required under this Section and be responsible for repairing any damages caused by such work without any additional cost to the Owner.

G. Follow Drawings in layout work. Check drawings of, and coordinate with, other trades to verify special provisions, installation requirements and spaces in which Work provided under this Section will be installed. Maintain maximum headroom or space conditions at all points. Where headroom or space conditions appear inadequate, notify the Engineer before proceeding.

H. Attend regular coordination and job progress meetings required.

1.09 PERFORMANCE REQUIREMENTS – GENERAL:

A. Plumbing Demolition:

1. Where indicated on plans, disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

a. Piping to be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

b. Piping to be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

c. Equipment to be Removed: Disconnect and cap services and remove equipment.

d. Equipment to be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

e. Equipment to be Removed and Salvaged: Disconnect and cap services and remove equipment, tag and deliver to Owner.

2. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, notify Architect before proceeding.

B. Piping Systems – Common Requirements:

1. Install piping according to the following requirements and Division 22 sections specifying piping systems.

2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, equipment sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

3. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

6. Install piping to permit valve servicing.

7. Install piping at indicated slopes.

8. Install piping free of sags and bends.

9. Install fittings for changes in direction and branch connections.

10. Install piping to allow application of insulation.

11. Select system components with pressure rating equal to or greater than system operating pressure.

12. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

13. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type with polished chrome-plated finish.

    b. Chrome-Plated Piping: One-piece, cast-brass or stamped steel type with polished chrome-plated finish.

    c. Insulated Piping at Wall and Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or stamped-steel type with polished chrome-plated finish.

    d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or stamped steel type with polished chrome-plated finish.

    e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or stamped steel type with polished chrome-plated finish.

    f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or stamped steel type with polished chrome-plated finish.

14. Sleeves are not required for core-drilled holes.

15. Permanent sleeves are not required for holes formed by removable PE sleeves.

16. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, concrete floors, and roof slabs.

17. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

18. Install sleeves in new walls and slabs as new walls and slabs are constructed.

19. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

    b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

    c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

        (1) Seal space outside of sleeve fittings with grout.

20. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Section 07 92 00 for materials and installation.

21. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

    a. Install steel pipe for sleeves smaller than 6 inches in diameter.

    b. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

    c. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

22. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to

allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

23. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Section 07 84 00 for materials.

24. Verify final equipment locations for roughing-in.

25. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

C. Piping Joint Construction:

1. Join pipe and fittings according to the following requirements and Division 22 sections specifying piping systems.

2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

4. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

    a. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.

    b. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendixes.

    c. CPVC Piping: Join according to ASTM D2846 appendix.

    d. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.

    e. PVC Non-pressure Piping: Join according to ASTM D2855.

    f. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D3138 appendix.

10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.

11. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D3212.

12. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.

    a. Plain-End Pipe and Fittings: Use butt fusion

    b. Plain-End Pipe and Socket Fittings: Use socket fusion

13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

D. Piping Connections:

1. Make connections according to the following, unless otherwise indicated:

    a. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

b. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

c. Dry Piping Systems: Install dielectric coupling and flanges to connect piping materials of dissimilar metals.

d. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

E. Equipment Installation – Common Requirements:

1. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

3. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

4. Install equipment to allow right of way for piping installed at required slope.

F. Painting:

1. Painting of plumbing systems, equipment, and components is specified in Division 09.

2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

G. Concrete Bases:

1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

a. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

e. Install anchor bolts to elevations required for proper attachment to supported equipment.

f. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

g. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03.

H. Supports and Anchorages:

1. Erection of Metal Supports and Anchorages:

a. Refer to Division 05 for structural steel.

b. Refer to painting requirements as specified in Division 09 sections.

c. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

d. Field Welding: Comply with AWS D1.1.

2. Erection of Wood Supports and Anchorages:

a. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

b. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

c. Attach to substrates as required to support applied loads.

d. All wood products shall be treated to be fire resistant.

I. Grouting:

1. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

2. Clean surfaces that will come into contact with grout.

3. Provide forms as required for placement of grout.

4. Avoid air entrapment during placement of grout.

5. Place grout, completely filling equipment bases.

6. Place grout on concrete bases and provide smooth bearing surface for equipment.

7. Place grout around anchors.

8. Cure placed grout.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS:

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

C. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS:

A. Refer to individual Division 22 piping sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, non-metallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B32, lead-free 95-5 tin-antimony alloy. Include water-flushable flux according to ASTM B813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for copper tubing, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D2235.

2. CPVC Piping: ASTM F493.

3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.

4. PVC to ABS Piping Transition: ASTM D3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.04 TRANSITION FITTINGS:

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Dresser Industries, Inc.; DMD Division

c. Ford Meter Box Company, Incorporated (The); Pipe Products Division

d. JCM Industries

e. Smith-Blair, Inc.

f. Viking Johnson

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.

3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Eslon Thermoplastics

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:

a. NIBCO, Inc.

b. NIBCO, Inc.; Chemtrol Division

E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Fernco, Inc.

c. Mission Rubber Company

d. Plastic Oddities, Inc.

2.05 DIELECTRIC FITTINGS:

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Epco Sales, Inc.

b. Watts Industries, Inc.; Water Products Division

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

2. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company

d. Pipeline Seal and Insulator, Inc.

3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Waterway Fittings: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 degrees F.

1. Manufacturers:

a. Perfection Corp.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Co., Inc.

d. Victaulic

2.06 MECHANICAL SLEEVE SEALS:

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Metraflex Co

b. Pipeline Seal and Insulator, Inc.

c. Garlock Sealing Technologies

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Carbon steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.07 SLEEVES:

A. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

B. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

E. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

F. Underdeck Clamp: Clamping ring with set screws.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.08 ESCUTCHEONS:

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw and polished chrome-plated finish.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw and polished chrome-plated finish.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and polished chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed or exposed-rivet hinge, set screw or spring clips, and polished chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.09 GROUT:

A. Description: ASTM C1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.10 TRAP PRIMER PIPING:

A. ASTM F876/877, NSF 14 and 61, cross-linked polyethylene tubing minimum 150 psig and minimum 75 degree F rated, compression fitting or mechanical insert fitting joints. Provide minimum number of joints in embedded tubing.

B. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

2.11 STRAINERS:

A. Strainers shall have blow-off outlet with pipe nipple and gate valve or ball valve with discharge pipe nipple. Copper alloy or cast-iron body. Provide stainless steel strainer element with perforations of 0.047 inch.

2.12 VALVE BOXES:

A. For each buried valve provide cast-iron, ductile-iron, or plastic box of a suitable size. Provide cast-iron, ductile-iron, or plastic cover respectively for the box with the word "WATER" cast on the cover. Plastic boxes shall be constructed of ABS plastic or inorganic fiber-reinforced black polyolefin plastic. Coat cast-iron and ductile-iron boxes with bituminous paint.

2.13 FREEZE PROTECTION ENCLOSURE:

A. Provide factory-fabricated freeze-proof, weatherproof enclosure with ASSE 1060 certification for protecting water service equipment. The enclosure shall be constructed fiberglass reinforced plastic or minimum 0.05-inch thick reinforced aluminum sheeting with factory-applied fluropolymer coating. Enclosures shall have series 300 stainless steel fasteners and hardware, and have EPDM elastomer gasketing. Wood construction shall not be acceptable. Provide with minimum 1-1/2-inches thick unicellular, non-wicking, polyisocyanurate insulation. Enclosure shall be of modular design, have access doors with locking handles and shall be fully accessible for maintenance. Enclosure shall be provided with unidirectional drain ports that shall be designed to discharge full flow from enclosed piping and equipment and prevent intrusion of debris and/or vermin. Enclosure shall be shop manufactured; field construction is not acceptable. Enclosure shall be of dimensions indicated and anchored to a concrete slab sized in accordance with enclosure manufacturer’s requirements.

B. Enclosure manufacturer shall factory-furnish and install electric heaters (where scheduled on drawings)of capacity, quantity as indicated on the drawings, designed to maintain a minimum internal temperature of 40 degrees F. Heaters shall be UL certified and shall be NEC approved for submersion.

C. Enclosure shall have minimum internal dimensions of 26 inches wide x 70 inches long x 45 inches high, with larger sizes as specified on the drawings.

2.14 EXPANSION TANKS:

A. NSF 61; diaphragm type expansion tanks designed for use in potable water systems; butyl diaphragm, polypropylene liner, welded steel shell; constructed, tested hydrostatically and certified in accordance with ASME BPVC SEC VIII D1. Tank shall be equipped with all necessary fittings including stainless steel system connection and welded air charge fitting with plastic cap. Tank and fittings shall have 125 psig minimum working pressure and 180 degrees F minimum operating temperature.

B. Tanks shall be factory pre-charged and field-adjusted to match incoming water pressure.

C. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

2.15 ELECTRIC TRAP PRIMER:

A. Trap primer valve and control all housed in moisture proof enclosure complete with UL listed electrical assembly consisting of circuit breaker, switch, and timer solenoid valve designed to operate on 120 VAC, single phase power. Unit shall be rated for minimum range of 32 to 120 degrees F and 20 to 125 psig, minimum 2 ounces water at 20 psig per trap served. Inlet and outlet piping connections shall be 1/2-inch NPT.

1. Provide distribution unit to serve up to four (4) traps where required.

2.16 HOSE:

A. Kink resistant reinforced rubber hose, corrosion resistant metal couplings, minimum 5 year warranty; size and length as indicated.

B. Provide pipe escutcheons in finished spaces. Pipe escutcheons shall be of stainless steel, anodized aluminum or chrome-plated brass, solid or split hinged.

2.17 DRIP PANS:

A. Examine all Drawings and in cooperation with the Electrical Trade confirm the final location of all new electrical equipment to be installed in the vicinity of new and existing piping. All overhead piping containing liquid or vapor shall be no closer than 3 feet from a vertical line to electrical equipment including, but not limited to, electric motors, controllers, switchboards, panelboards, and similar equipment. Piping is not permitted in Electrical Rooms and stairwells unless specifically serving that room.

B. Where the installation of new and existing plumbing systems piping does not comply with the requirements of the foregoing paragraph, where feasible the piping shall be relocated. Where not feasible, provide drip pans as specified below, except as otherwise indicated on the Drawings.

C. Provide drip pans fabricated from 14-gauge steel sheet and with edges turned up 2-1/2-inches. Reinforce top edge, either by structural angles or by rolling top over 1/4-inch rod made of same material as drip pan sheet metal. Provide hole and 1 inch threaded half coupling for low point drain. Provide hanging brackets of sufficient quantity made of same material as drip pan sheet metal for connecting threaded rods used for suspended drip pans. All joints shall be welded watertight and entire and welded assembly sandblasted, degreased and hot dipped galvanized after fabrication.

D. Locate drip pans under piping passing over or within 3 feet horizontally of material and equipment defined above, and elsewhere as indicated. Hang from structure with rods and

building attachments, fasten rods to brackets on sides of drip pan. Carefully pitch to the drip pan low point for drainage. Brace to prevent sagging or swaying. Drip pans shall be installed within 12 inches below piping.

E. Provide 1-inch schedule 40 hot dipped galvanized steel drain line from each drip pan and terminate 6 inches above the floor at nearest floor drain.

2.18 ACCESS PANELS:

A. Access panels shall give access to each valve and cleanout in concealed spaces above non removable (hard) suspended ceilings, and to all other concealed parts of the system. Access panels shall be located where indicated on the Drawings, or where otherwise require accessibility for the proper inspection, operation and maintenance of the system.

B. Access panels shall be Milcor Type M, 16 inch by 16 inch minimum, as manufactured by Inryco, Inc. Door shall be constructed of 18 gage galvanized steel with frame constructed of 16 gage galvanized steel. Casing bead shall be galvanized steel. Hinges shall be steel concealed spring type with steel pin. Locks shall be flush, screwdriver operated, with metal cam. Prime coat shall be factory applied rust-inhibitive light grey paint. Provide masonry anchors where required.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Installation, workmanship, inspection, and testing shall be in accordance with the specified Plumbing Code, Energy Conservation Code, and Building Code with the additions specified herein. Install piping straight and true to bear evenly on hangers and supports. Keep the interior and ends of new piping and existing piping affected by the Work thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs or other acceptable methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter. Inspect piping before placing into position. When fixtures require both hot water and cold water supplies, provide the hot water supply to the left of the cold water supply. Plastic piping shall not penetrate fire walls or fire floors and shall be used on one side of fire walls and fire floors not closer than 6 inches to the penetration. Plastic DWV piping shall not be permitted in more than two-story buildings. Cast-iron DWV piping only shall be provided in more than two-story buildings. Copper tube extracted joints shall not be permitted.

B. Piping shall not be permitted in Electrical Rooms and stairwells unless specifically serving that room.

C. Piping and other apparatus shall not be installed in such a manner so as to interfere with the full swing of doors, movement of personnel and equipment, and access to other equipment.

D. Install aboveground pressurized piping to permit draining of all sections of each piping systems without traps. Pitch piping back to system low points. Provide drain valves at all piping low points.

E. Make provisions for pipe expansion and contraction with suitable anchors and offsets, expansion joints, or expansion loops. Install piping to allow freedom of movement in all planes without imposing undue stress on any section of the main piping, branch piping, equipment and structure.

F. Buried Piping:

1. Pipe bedding and compacted backfill to a point 12 inches above crown of buried pipe shall be provided under this Section of the Specifications in accordance with the requirements of Section 31 23 33.

2. Pipe bedding shall be 6 inches deep. Bedding and compacted backfill shall be non-corrosive material such as cleaned washed sand, and contain no stones, metal, rubbish of any kind, frozen material, organic matter, or any other material capable of damaging piping or coating, and/or of settling.

3. Where feasible, install buried lines in a single trench. Trenches shall be wide enough to permit at least 6 inches spacing between lines and the sides and floor of the trench.

4. Terminate buried piping not more than 6 inches above finished ground surface or floor slab-on-grade, or from foundation wall inside surface.

5. Make provisions in buried piping for differential settlement.

6. Completely encase buried copper tubing, ductile-iron piping, and cast-iron piping with polyethylene tube or sheet in accordance with AWWA C105.

G. Threaded Connections:

1. Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread paste, pipe cement and oil, or PTFE powder and oil; apply only on male threads. Provide exposed ferrous pipe threads with one coat of primer applied to a minimum dry film thickness of 1.0 mil. Do not thread metal pipe into plastic piping.

H. Soldered Connections:

1. Soldering shall be performed in accordance with best soldering practice. Before soldering copper tubing joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Provide suitable flux for use with solder. Surplus soldering material shall be removed at all joints. Piping shall be supported prior to soldering and not be sprung or forced.

2. For solder end valves, remove stems and washers and other items subject to damage by heat during installation. Reassemble valve after soldering is complete. Valves without heat sensitive parts do not require disassembly but shall be fully opened during soldering.

I. Brazed Connections:

1. Brazing of copper tubing joints shall be performed in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be continuously purged with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Piping shall be supported prior to brazing and not be sprung or forced.

J. Flanged Connections:

1. Flanges shall be faced true, and made square and tight.

K. Seismic Bracing Requirements:

1. Piping and equipment shall be supported and braced to resist seismic loads where required by the specified Building Code. Provide seismic restraints in accordance with the SMACNA Seismic Restraint Unit.

L. Pipe Through-Penetrations:

1. Furnish pipe sleeves where piping passes through walls, floors, ceilings, roofs, and partitions. Sleeves will be installed and secured in proper position and location during construction by the trade whose element will be penetrated. Such trades include concrete, masonry, steel siding in the case of a steel building, and dry wall in the case of framed construction. Core drilling of masonry and concrete may be provided by this Section in lieu of pipe sleeves when cavities in the core-drilled holes are completely grouted smooth. Furnish sleeves of sufficient length to pass through entire thickness of walls, floors, ceilings, roofs, and partitions.

2. Pipe Penetrations Through Building Interior Construction: Provide not less than 1/4-inch space between exterior of piping or pipe insulation and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. For non-fire rated assemblies, seal at both ends of the sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass or silicone. Seal both ends of penetrations through fire rated assemblies to maintain fire resistive integrity with UL listed fill, void, or cavity material.

3. Pipe Penetrations Through Building Exterior Construction: Provide a mechanically adjustable segmented elastomeric seal, with sleeve sized as recommended by seal manufacturer.

4. Extend sleeves in floor slabs 2 inches above the finished floor, except sleeves are not required where drain, waste and vent piping passes through concrete floor slabs located on grade. Sleeves through walls shall terminate flush with the finished surface on either side of the wall.

M. Cross Connection and Interconnections:

1. No equipment, devices or piping shall be installed which will provide a cross or interconnection between a domestic water supply and a drainage, soil or waste pipe which will permit or make possible the backflow of sewage, polluted water or waste into the domestic water supply system.

N. Connections to Existing Water Supply Systems:

1. Use tapping or drilling machine valve and mechanical joint type sleeves for connections to be made under pressure. Bolt sleeves around the main piping; bolt valve conforming to AWWA C500 to the branch connection. Open valve, attach drilling machine, make tap, close valve, and remove drilling machine, without interruption of service. Notify the Engineer in writing at least 7 days prior to connection date and receive acceptance before any service is interrupted. Furnish materials required to make connections into the existing water supply systems and perform excavating, backfilling, surface restoration and other incidental labor. Furnish the labor and the tapping or drilling machine for making the actual connections to the existing systems.

3.02 DISINFECTION:

A. Disinfect the new water piping and existing water piping affected by the Work in accordance with the specified Plumbing Code with the additions specified herein or AWWA C651 whichever is more stringent. Fill piping systems with chlorine solution and allow solution to stand. Following the required standing time, flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 to 0.5 ppm, or the residual chlorine content of domestic water supply. Obtain at least two consecutive satisfactory bacteriological samples from new and existing water piping, analyzed by a certified laboratory, and submit results prior to the new and existing water piping being placed into service. Disinfection of systems supplied by non-potable water (service water) is not required.

B. Where it is not possible to disinfect a potable water storage tank as specified above, the entire interior of the tank shall be swabbed with a solution which contains 200 parts per million of available chlorine; and the solution shall than be allowed to stand 3 hours before the tank is flushed and returned to service.

C. For a potable water filter or similar device, the dosage shall be determined by the State Department of Environmental Protection.

3.03 PAINTING:

A. Field painting of above ground plumbing piping shall be provided under this Section in accordance with Section 09 90 00.

B. Field touch up all damaged factory or shop applied coatings for material and equipment furnished under this Section in accordance with the manufacturer's recommendation.

C. Do not apply field painting and touch-up until after installation and testing is completed and system accepted.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 05 13

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. National Electrical Manufacturers Association (NEMA):

1. MG1: Motors and Generators

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.08 COORDINATION:

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.

3. Ratings and characteristics of supply circuit and required control sequence.

4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS:

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.02 MOTOR CHARACTERISTICS:

A. Duty: Continuous duty at ambient temperature of 104 degrees F and at altitude of 4200 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS:

A. Description: NEMA MG 1, Design B, medium induction motor

B. Efficiency: Premium efficient, as defined in NEMA MG 1

C. Service Factor: 1.15

D. Multispeed Motors: Variable torque

1. For motors with 2:1 speed ratio, consequent pole, single winding

2. For motors with other than 2:1 speed ratio, separate winding for each speed

E. Multispeed Motors: Separate winding for each speed

F. Rotor: Random-wound, squirrel cage

G. Bearings: Redressable, shielded, antifriction ball bearings suitable for radial and thrust loading

H. Temperature Rise: Match insulation rating

I. Insulation: Class F

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS:

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.

2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.05 SINGLE-PHASE MOTORS:

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor

2. Split phase

3. Capacitor start, inductor run

4. Capacitor start, capacitor run

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.01 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 22 05 19

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide meters and gages for plumbing piping as indicated and in compliance with Contract Documents.

1. Thermometers

2. Pressure Gages

3. Test Plugs

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B1.1: Unified Inch Screw Threads (UN and UNR Thread Form)

2. B1.20.1: Pipe Threads, General Purpose (Inch)

3. B40.100: Pressure Gauges and Gauge Attachments

4. B40.200: Thermometers, Direct Reading and Remote Reading

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product. Submit manufacturer's technical product data, including installation instructions for each type of meter and gage. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.

C. Product Certificates: For each type of meter and gage.

D. Operation and Maintenance Data: For each type of meters and gages to include in operation and maintenance manuals.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of meters and gages, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

C. Codes and Standards:

1. UL Compliance: Comply with applicable UL standards pertaining to meters and gages.

2. ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

D. Certification: Provide meters and gages whose accuracies, under specified operating conditions, are certified by manufacturer.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS:

A. Manufacturers:

1. Palmer - Wahl Instruments Inc.

2. Miljoco Co.

3. Trerice, H. O. Co.

4. Weiss Instruments, Inc.

5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Division.

B. Case: Die-cast aluminum or brass, 7 inches to 9 inches long.

C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 scale division.

2.02 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS:

A. Manufacturers:

1. Miljoco Co

2. Trerice, H. O. Co.

3. Weiss Instruments, Inc.

4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Division

B. Type: Vapor Tension, Universal Angle Brass.

C. Case: Liquid-filled type, metal, 4-1/2-inch diameter.

D. Element: Bourdon tube.

E. Movement: Brass precision geared.

F. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

G. Pointer: Red or other dark-color metal.

H. Window: Glass.

I. Ring: Brass or Stainless steel.

J. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

K. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

L. Accuracy: Plus or minus 1 scale division.

2.03 BIMETALLIC-ACTUATED DIAL THERMOMETERS:

A. Manufacturers:

1. Ernst Gage Co.

2. Eugene Ernst Products Co.

3. Miljoco Co.

4. Trerice, H. O. Co.

5. Weiss Instruments, Inc.

6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Division

B. Type: Bi-metal stainless steel case and stem.

C. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.

D. Case: Liquid-filled type, stainless steel with 3-inch to 5-inch diameter

E. Element: Bimetal coil

F. Dial: 1 inch diameter, dust and leak proof

G. Pointer: Red or other dark-color metal

H. Window: Glass

I. Ring: Stainless steel

J. Connector: Adjustable angle type

K. Stem: 1/8 inch diameter with nominal length of 5 inches

L. Accuracy: 0.5 percent of dial range

2.04 DIGITAL THERMOMETERS:

A. Manufacturers:

1. Weksler Glass Thermometer Corporation

2. Weiss Instruments, Inc.

B. Case: High Impact ABS, black plastic

C. Range: -40 degrees to 300 degrees F

D. Display: LCD, 3/8 inches

E. Accuracy: 1 percent of reading

F. Lux Rating: 10 Lux (1 foot candle)

2.05 THERMOWELLS:

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Provide thermowells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2: extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

2.06 PRESSURE GAGES:

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Division

2. Miljoco Co

3. Trerice, H. O. Co.

4. Weiss Instruments, Inc.

5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Division

B. General use type complying with ANSI B40, Grade A.

C. Case: Liquid-filled type, drawn steel or Brass, 4-1/2-inch diameter.

D. Pressure-Element Assembly: Phosphor bronze Bourdon tube.

E. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.

F. Movement: Mechanical, with link to pressure element and connection to pointer.

G. Dial: White coated aluminum with permanently etched scale markings.

H. Pointer: Red or other dark-color metal.

I. Window: Glass.

J. Ring: Brass or Stainless steel.

K. Accuracy: Grade A, 1 percent scale.

L. Pressure Range:

1. Vacuum: 30-in. Hg of vacuum to 15 psig of pressure

2. Water: 0-100 psi

M. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.

2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.07 TEST PLUGS:

A. Manufacturers:

1. MG Piping Products Co.

2. Miljoco Co.

3. Peterson Equipment Co., Inc.

4. Trerice, H. O. Co.

5. Watts Industries, Inc.; Water Products Division

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 degrees F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for water service at 20 to 200 degrees F shall be CR.

2. Insert material for water service at minus 30 to plus 275 degrees F shall be EPDM.

2.08 SIGHT FLOW INDICATORS:

A. Description: Piping inline-installation device for visual verification of flow.

B. Construction: Bronze or stainless-steel body, with sight glass and paddle wheel indicator, and threaded or flanged ends.

C. Minimum Pressure Rating: 150 psig

D. Minimum Temperature Rating: 200 degrees F

E. End Connections for NPS 2 and Smaller: Threaded

F. End Connections for NPS 2-1/2 and Larger: Flanged

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.

2. Inlets and outlets of each domestic water heat exchanger.

3. Inlet and outlet of each domestic hot-water storage tank.

L. Install pressure gages in the following locations:

1. Building water service entrance into building.

2. Inlet and outlet of each pressure-reducing valve.

3. Suction and discharge of each domestic water pump.

3.02 CONNECTIONS:

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING:

A. Adjust faces of meters and gages to proper angle for best visibility.

3.04 APPLICATIONS:

A. Thermometer Applications:

1. Install thermometers in the outlet of each domestic water heater and each domestic, hot-water storage tank.

2. Install liquid-filled-case-type, bimetallic-actuated dial thermometers at suction and discharge of each pump.

3. Thermometer stems shall be of length to match thermowell insertion length.

4. Provide the following temperature ranges for thermometers:

a. Domestic Hot Water: 30 to 180 degrees F, with 2-degree scale divisions

b. Domestic Cold Water: 0 to 100 degrees F, with 2-degree scale divisions

B. Gage Applications:

1. Install pressure gages at discharge of each water service into building.

2. Install pressure gages for discharge of each pressure-reducing valve.

3. Install pressure gages at suction and discharge of each pump.

4. Install pressure gages at suction and discharge of each domestic water pump shall.

5. Provide the following pressure ranges for thermometers:

a. Scale Range for Water Service Piping: 0 to 100 psi

b. Scale Range for Domestic Water Piping: 0 to 100 psi

3.05 INSTALLATIONS:

1. Install direct-mounting thermometers and adjust vertical and tilted positions.

2. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

3. Install thermowells with socket extending a minimum of 2 inches into fluid to center of pipe and in vertical position in piping tees where thermometers are indicated.

4. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

5. Install remote-mounting pressure gages on panel.

6. Install needle-valve and snubber fitting in piping for each pressure gage.

7. Install test plugs in tees in piping.

8. Install permanent indicators on walls or brackets in accessible and readable positions.

9. Install connection fittings for attachment to portable indicators in accessible locations.

10. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.

11. Adjust faces of thermometers and gages to proper angle for best visibility.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 05 23

VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide valves for plumbing piping as indicated and in compliance with Contract Documents.

1. Ball Valves:

a. Brass ball valves

b. Bronze ball valves

c. Steel ball valves

d. Iron ball valves

e. CPVC ball valves

f. PVC ball valves

2. Butterfly Valves:

a. Iron, grooved-end butterfly valves

b. CPVC butterfly valves

c. PVC butterfly valves

d. Chainwheels

3. Check Valves:

a. Bronze lift check valves

b. Bronze swing check valves

c. Iron swing check valves

d. Iron swing check valves with closure control

e. Iron, grooved-end swing check valves

f. Iron, center-guided check valves

g. Iron, plate-type check valves

h. CPVC ball check valves

i. PVC ball check valves

4. Gate Valves:

a. Bronze gate valves

b. Iron gate valves

c. CPVC gate valves

d. PVC gate valves

e. Chainwheels

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B1.20.1: Pipe, Threads, General Purpose (Inch)

2. B16.1: Pipe Flanges and Fittings

3. B16.5: Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

4. B16.10: Face-to-Face and End-to-End Dimensions of Valves

5. B16.18: Cast Copper Alloy Solder Joint Pressure Fittings

6. B16.34: Valves – Flanged, Threaded, and Welding End

7. B31.9: Building Services Piping.

B. ASTM International (ASTM):

1. A126: Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

2. A216: Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

3. A395: Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

4. A536: Standard Specification for Ductile Iron Castings

5. B61: Standard Specification for Steam or Valve Bronze Castings

6. B62: Standard Specification for Composition Bronze or Ounce Metal Castings

7. B584: Standard Specification for Copper Alloy Sand Castings for General Applications

C. American Water Works Association (AWWA):

1. C606: Grooved and Shouldered Joints

D. Manufacturers' Standardization Society (MSS):

1. SP-45: Bypass and Drain Connections

2. SP-67: Butterfly Valves

3. SP-71: Gray Iron Swing Check Valves, Flanged and Threaded Ends

4. SP-72: Ball Valves with Flanged or Butt-welding Ends for General Service

5. SP-80: Bronze Gate, Globe, Angle, and Check Valves

6. SP-110: Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

7. SP-122: Plastic Industrial Ball Valves

8. SP-125: Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided

9. SP-139: Copper alloy gate, Globe, Angle, and Check Valves for Low Pressure/Low Temperature Plumbing Applications

10. SP-145: Metal Ball Valves for Low Pressure/Low Temperature Plumbing Applications

E. NSF International (NSF):

1. 61: Drinking Water System Components – Health Effects

2. 372: Drinking water System Components – Lead Content

1.03 DEFINITIONS:

A. CWP: Cold working pressure

B. EPDM: Ethylene propylene-diene terpolymer rubber

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber

D. NRS: Non-rising stem

E. OS&Y: Outside screw and yoke

F. RS: Rising stem

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 and NSF 372.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, and soldered ends.

3. Set ball valves open to minimize exposure of functional surfaces.

C. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

D. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES:

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

C. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves

2. ASME B16.1 for flanges on iron valves

3. ASME B16.5 for flanges on steel valves

4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria

5. ASME B16.18 for solder-joint connections

6. ASME B31.9 for building services piping valves

D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

E. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

F. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

G. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 and larger.

2. Handlever: For quarter-turn valves smaller than NPS 4.

3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Valve Installation" Article

K. Valves in Insulated Piping:

1. Include 2-inch stem extensions.

2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.

3. Memory stops that are fully adjustable after insulation is applied.

2.02 BRASS BALL VALVES:

A. Brass Ball Valves, One-Piece:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Dezurik

b. Apollo Flow Controls

c. American Valve, Inc.

d. Kitz Corporation

3. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 400 psig.

c. Body Design: One piece.

d. Body Material: Forged brass or bronze.

e. Ends: Threaded and soldered.

f. Seats: PTFE.

g. Stem: Brass or stainless steel.

h. Ball: Chrome-plated brass or stainless steel.

i. Port: Reduced.

B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Threaded or Soldered Ends:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. American Valve, Inc.

b. Apollo Flow Controls

c. Crane

d. Milwaukee Valve Company

e. NIBCO Inc.

f. WATTS

3. Description:

a. Standard: MSS SP-110 or MSS SP-145.

b. CWP Rating: 600 psig.

c. Body Design: Two piece.

d. Body Material: Forged brass.

e. Ends: Threaded and soldered.

f. Seats: PTFE.

g. Stem: Brass.

h. Ball: Chrome-plated brass.

i. Port: Full.

C. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Threaded or Soldered Ends:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

    a. Apollo Flow Controls

    b. Hammond Valve

    c. Kitz Corporation

    d. Milwaukee Valve Company

    e. NIBCO Inc.

3. Description:

    a. Standard: MSS SP-110 or MSS SP-145.

    b. CWP Rating: 600 psig.

    c. Body Design: Two piece.

    d. Body Material: Forged brass.

    e. Ends: Threaded and soldered.

    f. Seats: PTFE.

    g. Stem: Stainless steel.

    h. Ball: Stainless steel, vented.

    i. Port: Full.

D. Brass Ball Valves, Two-Piece with Regular Port and Brass Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

    a. Apollo Flow Controls

    b. Hammond Valve

    c. Milwaukee Valve Company

    d. NIBCO Inc.

    e. WATTS

3. Description:

    a. Standard: MSS SP-110.

    b. CWP Rating: 600 psig.

    c. Body Design: Two piece.

    d. Body Material: Forged brass.

    e. Ends: Threaded and soldered.

    f. Seats: PTFE.

    g. Stem: Brass.

    h. Ball: Chrome-plated brass.

    i. Port: Regular.

E. Brass Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

    a. Jamesbury; Metso

3. Description:

    a. Standard: MSS SP-110.

    b. CWP Rating: 600 psig.

    c. Body Design: Two piece.

    d. Body Material: Brass or bronze.

    e. Ends: Threaded and soldered.

    f. Seats: PTFE.

    g. Stem: Stainless steel.

    h. Ball: Stainless steel, vented.

    i. Port: Regular.

F. Brass Ball Valves, Three-Piece with Full Port and Brass Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. Jomar Valve

   b. Kitz Corporation

   c. WATTS

3. Description:

   a. Standard: MSS SP-110.

   b. CWP Rating: 600 psig.

   c. Body Design: Three piece.

   d. Body Material: Forged brass.

   e. Ends: Threaded and soldered.

   f. Seats: PTFE.

   g. Stem: Brass.

   h. Ball: Chrome-plated brass.

   i. Port: Full.

G. Brass Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. Marwin Valve; Richards Industries

3. Description:

   a. Standard: MSS SP-110.

   b. CWP Rating: 600 psig.

c. Body Design: Three piece.

d. Body Material: Forged brass.

e. Ends: Threaded and soldered.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel, vented.

i. Port: Full.

2.03 BRONZE BALL VALVES:

A. Bronze Ball Valves, One-Piece with Bronze Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. FNW; Ferguson Enterprises

c. NIBCO Inc.

d. WATTS

3. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 400 psig.

c. Body Design: One piece.

d. Body Material: Bronze.

e. Ends: Threaded.

f. Seats: PTFE.

g. Stem: Bronze.

h. Ball: Chrome-plated brass.

i. Port: Reduced.

B. Bronze Ball Valves, One-Piece with Stainless-Steel Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. NIBCO Inc.

c. WATTS

3. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 600 psig.

c. Body Design: One piece.

d. Body Material: Bronze.

e. Ends: Threaded.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel, vented.

i. Port: Reduced.

C. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Crane

c. Hammond Valve

d. Milwaukee Valve Company

e. NIBCO Inc.

f. WATTS

g. Zurn Industries

3. Description:

a. Standard: MSS SP-110 or MSS-145.

b. CWP Rating: 600 psig.

c. Body Design: Two piece.

d. Body Material: Bronze.

e. Ends: Threaded and soldered.

f. Seats: PTFE.

g. Stem: Bronze or brass.

h. Ball: Chrome-plated brass.

i. Port: Full.

D. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

1. Manufacturers:

a. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

b. Apollo Flow Controls

c. Crane

d. Hammond Valve

e. Milwaukee Valve Company

f. NIBCO Inc.

g. WATTS

2. Description:

a. Standard: MSS SP-110 or MSS-145.

b. CWP Rating: 600 psig.

c. Body Design: Two piece.

d. Body Material: Bronze.

e. Ends: Threaded or soldered.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel, vented.

i. Port: Full.

E. Bronze Ball Valves, Two-Piece with Regular Port and Bronze or Brass Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Hammond Valve

c. Milwaukee Valve Company

d. NIBCO Inc.

e. WATTS

3. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 600 psig.

c. Body Design: Two piece.

d. Body Material: Bronze.

e. Ends: Threaded.

f. Seats: PTFE.

g. Stem: Bronze or brass.

h. Ball: Chrome-plated brass.

i. Port: Regular.

F. Bronze Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Hammond Valve

c. NIBCO Inc.

d. WATTS

3. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 600 psig.

c. Body Design: Two piece.

d. Body Material: Bronze.

e. Ends: Threaded.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel, vented.

i. Port: Regular.

G. Bronze Ball Valves, Three-Piece with Full Port and Bronze or Brass Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

    a. Apollo Flow Controls

    b. Crane

    c. Hammond Valve

    d. Milwaukee Valve Company

    e. NIBCO Inc.

    f. WATTS

3. Description:

    a. Standard: MSS SP-110.

    b. CWP Rating: 600 psig.

    c. Body Design: Three piece.

    d. Body Material: Bronze.

    e. Ends: Threaded.

    f. Seats: PTFE.

    g. Stem: Bronze or brass.

    h. Ball: Chrome-plated brass.

    i. Port: Full.

H. Bronze Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

    a. Apollo Flow Controls

    b. Hammond Valve

    c. Milwaukee Valve Company

    d. NIBCO Inc.

e. WATTS

3. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 600 psig.

c. Body Design: Three piece.

d. Body Material: Bronze.

e. Ends: Threaded.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel, vented.

i. Port: Full.

I. Bronze Ball Valves, Three-Piece with Regular Port and Bronze Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Jamesbury; Metso

c. NIBCO Inc.

3. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 600 psig.

c. Body Design: Three piece

d. Body Material: Bronze

e. Ends: Threaded or soldered.

f. Seats: PTFE.

g. Stem: Bronze.

h. Ball: Chrome-plated brass.

i. Port: Regular.

J. Bronze Ball Valves, Three-Piece with Regular Port and Stainless-Steel Trim:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Jamesbury; Metso

c. NIBCO Inc.

3. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 600 psig.

c. Body Design: Three piece.

d. Body Material: Bronze.

e. Ends: Threaded or soldered.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel, vented.

i. Port: Regular.

K. Bronze Ball Valves, Two-Piece, Safety-Exhaust:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Jamesbury; Metso

c. NIBCO Inc.

3. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 600 psig.

c. Body Design: Two piece.

d. Body Material: Bronze, ASTM B584, Alloy C844.

e. Ends: Threaded.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Chrome-plated brass, with exhaust vent opening for pneumatic applications.

i. Port: Full.

2.04 STEEL BALL VALVES:

A. Steel Ball Valves with Full Port, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Jamesbury; Metso

c. NIBCO Inc.

3. Description:

a. Standard: MSS SP-72.

b. CWP Rating: 285 psig.

c. Body Design: Split body.

d. Body Material: Carbon steel, ASTM A216, Type WCB.

e. Ends: Flanged or threaded.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel, vented.

i. Port: Full.

B. Steel Ball Valves with Regular Port, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Jamesbury; Metso

c. NIBCO Inc.

3. Description:

a. Standard: MSS SP-72.

b. CWP Rating: 285 psig.

c. Body Design: Uni-body.

d. Body Material: Carbon steel, ASTM A216, Type WCB.

e. Ends: Flanged or threaded.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel, vented.

i. Port: Regular.

2.05 IRON BALL VALVES:

A. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

B. Iron Ball Valves, Class 125:

1. Manufacturers:

a. American Valve, Inc.

b. Apollo Flow Controls

c. Kitz Corporation

d. WATTS

e. Zurn Industries

2. Description:

a. Standard: MSS SP-72.

b. CWP Rating: 200 psig.

c. Body Design: Split body.

d. Body Material: ASTM A126, gray iron.

e. Ends: Flanged or threaded.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel.

i. Port: Full.

2.06 CPVC BALL VALVES:

A. CPVC Union Ball Valves:

1. Manufacturers:

a. American Valve, Inc.

b. Georg Fischer Inc.

c. Hayward Flow Control

d. IPEX USA

e. NIBCO Inc.

f. Spears Manufacturing Company

g. Thermoplastic Valves, Inc

2. Description:

a. Standard: MSS SP-122.

b. Pressure Rating and Temperature: 125 psig at 73 degrees F.

c. Body Material: CPVC.

d. Body Design: Union type.

e. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.

f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded.

g. Ball: CPVC; full port.

h. Seals: PTFE or EPDM-rubber O-rings.

i. Handle: Tee shaped.

B. CPVC Non-Union Ball Valves:

1. Manufacturers:

a. American Valve, Inc.

b. Legend Valve & Fitting Inc.

c. NIBCO Inc.

d. Spears Manufacturing Company

e. Thermoplastic Valves, Inc.

2. Description:

a. Standard: MSS SP-122.

b. Pressure Rating and Temperature: 125 psig at 73 degrees F.

c. Body Material: CPVC.

d. Body Design: Non-union type.

e. End Connections: Socket or threaded.

f. Ball: CPVC; full or reduced port.

g. Seals: PTFE or EPDM-rubber O-rings.

h. Handle: Tee shaped.

2.07 PVC BALL VALVES:

A. PVC Union Ball Valves:

1. Manufacturers:

a. American Valve, Inc.

b. Georg Fischer Inc.

c. Hayward Flow Control

d. Legend Valve & Fitting Inc.

e. IPEX USA

f. NIBCO Inc.

g. Spears Manufacturing Company

h. Thermoplastic Valves, Inc.

2. Description:

a. Standard: MSS SP-122.

b. Pressure Rating and Temperature: 125 psig at 73 degrees F.

c. Body Material: PVC.

d. Body Design: Union type.

e. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.

f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded.

g. Ball: PVC; full port.

h. Seals: PTFE or EPDM-rubber O-rings.

i. Handle: Tee shaped.

B. PVC Non-Union Ball Valves:

1. Manufacturers:

a. American Valve, Inc.

b. Georg Fischer Inc.

c. Hayward Flow Control

d. Legend Valve & Fitting Inc.

e. IPEX USA

f. NIBCO Inc.

g. Spears Manufacturing Company

h. Thermoplastic Valves, Inc.

2. Description:

a. Standard: MSS SP-122.

b. Pressure Rating and Temperature: 125 psig at 73 degrees F.

c. Body Material: PVC.

d. Body Design: Non-union type.

e. End Connections: Socket or threaded.

f. Ball: PVC; full or reduced port.

g. Seals: PTFE or EPDM-rubber O-rings.

h. Handle: Tee shaped.

2.08 IRON, SINGLE-FLANGE BUTTERFLY VALVES:

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. DeZURIK

c. Hammond Valve

d. Jenkins Valves

e. Kitz Corporation

f. Legend Valve & Fitting Inc.

g. Milwaukee Valve Company

h. NIBCO Inc.

i. Red-White Valve Corp.

j. Stockham

k. WATTS

3. Description:

a. Standard: MSS SP-67, Type I.

b. CWP Rating: 200 psig.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.

e. Seat: EPDM.

f. Stem: One- or two-piece stainless steel.

g. Disc: Aluminum bronze.

B. Iron, Single-Flange Butterfly Valves with Ductile-Iron Disc:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. American Valve, Inc.

   b. Apollo Flow Controls

   c. DeZURIK

   d. Hammond Valve

   e. Jenkins Valves

   f. Kitz Corporation

   g. Legend Valve & Fitting Inc.

   h. Milwaukee Valve Company

   i. NIBCO Inc.

   j. Red-White Valve Corp.

   k. Stockham

   l. WATTS

3. Description:

   a. Standard: MSS SP-67, Type I.

   b. CWP Rating: 200 psig.

   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

   d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.

   e. Seat: EPDM.

   f. Stem: One- or two-piece stainless steel.

   g. Disc: Nickel-plated or nickel-coated ductile iron.

C. Iron, Single-Flange Butterfly Valves with Stainless-Steel Disc:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. American Valve, Inc.

   b. Apollo Flow Controls

   c. DeZURIK

   d. Hammond Valve

   e. Jenkins Valves

   f. Kitz Corporation

   g. Legend Valve & Fitting Inc.

   h. Milwaukee Valve Company

   i. NIBCO Inc.

   j. Red-White Valve Corp.

   k. Stockham

   l. WATTS

3. Description:

   a. Standard: MSS SP-67, Type I.

   b. CWP Rating, NPS 12 and Smaller: 200 psig.

   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

   d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.

   e. Seat: EPDM.

   f. Stem: One- or two-piece stainless steel.

   g. Disc: Stainless steel.

2.09 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES:

A. Ductile Iron, Grooved-End Butterfly Valves, 175 CWP:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Kennedy Valve Company

b. Tyco by Johnson Controls Company

c. Victaulic Company

d. Zurn Industries

3. Description:

a. Standard: MSS SP-67, Type I.

b. CWP Rating: 175 psig.

c. Body Material: Coated, ductile iron.

d. Stem: Two-piece stainless steel.

e. Disc: Coated, ductile iron.

f. Seal: EPDM.

B. Ductile Iron, Grooved-End Butterfly Valves, 300 CWP:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Kennedy Valve Company

b. NIBCO Inc.

c. Tyco by Johnson Controls Company

d. Victaulic Company

3. Description:

a. Standard: MSS SP-67, Type I.

b. CWP Rating, NPS 8 and Smaller: 300 psig.

c. CWP Rating, NPS 10 and Larger: 200 psig.

d. Body Material: Coated, ductile iron.

e. Stem: Two-piece stainless steel.

f. Disc: Coated, ductile iron.

g. Seal: EPDM.

2.10 CPVC BUTTERFLY VALVES:

1. Manufacturers:

a. Georg Fischer Inc.

b. Hayward Flow Control

c. NIBCO Inc.

d. Spears Manufacturing Company

e. Thermoplastic Valves, Inc.

B. Description:

1. Pressure Rating and Temperature: 125 psig at 73 degrees F.

2. Body Material: CPVC.

3. Body Design: Lug or wafer type.

4. Seat: EPDM rubber.

5. Seals: PTFE or EPDM-rubber O-rings.

6. Disc: CPVC.

7. Stem: Stainless steel.

8. Handle: Lever.

2.11 PVC BUTTERFLY VALVES:

A. Manufacturers:

1. American Valve, Inc
2. Georg Fischer Inc.
3. Hayward Flow Control
4. Legend Valve & Fitting Inc.
5. IPEX USA
6. NIBCO Inc.
7. Spears Manufacturing Company
8. Thermoplastic Valves, Inc.

B. Description:

1. Pressure Rating and Temperature: 125 psig at 73 degrees F.
2. Body Material: PVC.
3. Body Design: Lug or wafer type.
4. Seat: EPDM rubber.
5. Seals: PTFE or EPDM-rubber O-rings.
6. Disc: PVC.
7. Stem: Stainless steel.
8. Handle: Lever.

2.12 BRONZE LIFT CHECK VALVES:

A. Bronze Lift Check Valves with Bronze Disc, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.
2. Manufacturers:
   a. Crane
   b. Jenkins Valves
   c. Stockham

3. Description:

    a. Standard: MSS SP-80, Type 1.

    b. CWP Rating: 200 psig.

    c. Body Design: Vertical flow.

    d. Body Material: ASTM B61 or ASTM B62, bronze.

    e. Ends: Threaded or soldered. See valve schedule articles.

    f. Disc: Bronze.

B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

    a. Hammond Valve

    b. Jenkins Valves

    c. Kitz Corporation

    d. Milwaukee Valve Company

    e. NIBCO Inc.

    f. Red-White Valve Corp.

    g. WATTS

3. Description:

    a. Standard: MSS SP-80, Type 2.

    b. CWP Rating: 200 psig.

    c. Body Design: Vertical flow.

    d. Body Material: ASTM B61 or ASTM B62, bronze.

    e. Ends: Threaded or soldered. See valve schedule articles.

    f. Disc: NBR, PTFE.

2.13 BRONZE SWING CHECK VALVES:

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. American Valve, Inc.

b. Apollo Flow Controls

c. Crane

d. Hammond Valve

e. Jenkins Valves

f. Kitz Corporation

g. Milwaukee Valve Company

h. NIBCO Inc.

i. Red-White Valve Corp.

j. Stockham

k. WATTS

3. Description:

a. Standard: MSS SP-80, Type 3.

b. CWP Rating: 200 psig.

c. Body Design: Horizontal flow.

d. Body Material: ASTM B62, bronze.

e. Ends: Threaded or soldered. See valve schedule articles.

f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

    a. Apollo Flow Controls

    b. Crane

    c. Hammond Valve

    d. Jenkins Valves

    e. Kitz Corporation

    f. Milwaukee Valve Company

    g. NIBCO Inc.

    h. Red-White Valve Corp.

    i. Stockham

    j. WATTS

3. Description:

    a. Standard: MSS SP-80, Type 4.

    b. CWP Rating: 200 psig.

    c. Body Design: Horizontal flow.

    d. Body Material: ASTM B62, bronze.

    e. Ends: Threaded or soldered. See valve schedule articles.

    f. Disc: PTFE.

C. Bronze Swing Check Valves with Bronze Disc, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

    a. American Valve, Inc.

b. Apollo Flow Controls

c. Crane

d. Jenkins Valves

e. Kitz Corporation

f. Milwaukee Valve Company

g. NIBCO Inc.

h. Red-White Valve Corp.

i. Stockham

3. Description:

a. Standard: MSS SP-80, Type 3.

b. CWP Rating: 300 psig.

c. Body Design: Horizontal flow.

d. Body Material: ASTM B62, bronze.

e. Ends: Threaded or soldered. See valve schedule articles.

f. Disc: Bronze.

D. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Crane

b. Hammond Valve

c. Jenkins Valves

d. Milwaukee Valve Company

e. NIBCO Inc.

f. WATTS

3. Description:

a. Standard: MSS SP-80, Type 4.

b. CWP Rating: 300 psig.

c. Body Design: Horizontal flow.

d. Body Material: ASTM B62, bronze.

e. Ends: Threaded or soldered. See valve schedule articles.

f. Disc: PTFE.

2.14 IRON SWING CHECK VALVES:

A. Iron Swing Check Valves with Metal Seats, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Crane

c. Hammond Valve

d. Jenkins Valves

e. Kitz Corporation

f. Legend Valve & Fitting Inc.

g. Milwaukee Valve Company

h. NIBCO Inc.

i. Red-White Valve Corp.

j. Stockham

k. WATTS

3. Description:

a. Standard: MSS SP-71, Type I.

b. CWP Rating: 200 psig.

c. Body Design: Clear or full waterway.

d. Body Material: ASTM A126, gray iron with bolted bonnet.

e. Ends: Flanged or threaded. See valve schedule articles.

f. Trim: Bronze.

g. Gasket: Asbestos free.

B. Iron Swing Check Valves with Nonmetallic-to-Metal Seats, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Crane

b. Stockham

3. Description:

a. Standard: MSS SP-71, Type I.

b. CWP Rating: 200 psig.

c. Body Design: Clear or full waterway.

d. Body Material: ASTM A126, gray iron with bolted bonnet.

e. Ends: Flanged or threaded. See valve schedule articles.

f. Trim: Composition.

g. Seat Ring: Bronze.

h. Disc Holder: Bronze.

i. Disc: PTFE.

j. Gasket: Asbestos free.

C. Iron Swing Check Valves with Metal Seats, Class 250:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. Apollo Flow Controls

   b. Crane

   c. Hammond Valve

   d. Jenkins Valves

   e. Milwaukee Valve Company

   f. NIBCO Inc.

   g. Stockham

   h. WATTS

3. Description:

   a. Standard: MSS SP-71, Type I.

   b. CWP Rating: 500 psig.

   c. Body Design: Clear or full waterway.

   d. Body Material: ASTM A126, gray iron with bolted bonnet.

   e. Ends: Flanged or threaded. See valve schedule articles.

   f. Trim: Bronze.

   g. Gasket: Asbestos free.

2.15 IRON SWING CHECK VALVES WITH CLOSURE CONTROL:

A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Crane

b. Hammond Valve

c. Jenkins Valves

d. Milwaukee Valve Company

e. NIBCO Inc.

f. Stockham

g. WATTS

3. Description:

a. Standard: MSS SP-71, Type I.

b. CWP Rating: 200 psig.

c. Body Design: Clear or full waterway.

d. Body Material: ASTM A126, gray iron with bolted bonnet.

e. Ends: Flanged or threaded. See valve schedule articles.

f. Trim: Bronze.

g. Gasket: Asbestos free.

h. Closure Control: Factory-installed exterior lever and weight.

B. Iron Swing Check Valves with Lever and Weight-Closure Control, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. Apollo Flow Controls

   b. Crane

   c. Hammond Valve

   d. Jenkins Valves

   e. Milwaukee Valve Company

   f. NIBCO Inc.

   g. Stockham

   h. WATTS

3. Description:

   a. Standard: MSS SP-71, Type I.

   b. CWP Rating: 200 psig.

   c. Body Design: Clear or full waterway.

   d. Body Material: ASTM A126, gray iron with bolted bonnet.

   e. Ends: Flanged or threaded. See valve schedule articles.

   f. Trim: Bronze.

   g. Gasket: Asbestos free.

   h. Closure Control: Factory-installed exterior lever and weight.

2.16 IRON, GROOVED-END SWING CHECK VALVES:

A. Iron, Grooved-End Swing Check Valves, 300 CWP:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Anvil International

b. Tyco by Johnson Controls Company

c. Victaulic Company

3. Description:

a. CWP Rating: 300 psig.

b. Body Material: ASTM A536, ductile iron.

c. Seal: EPDM.

d. Disc: Spring operated, ductile iron or stainless steel.

2.17 IRON, CENTER-GUIDED, SPRING-LOADED CHECK VALVES:

A. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Anvil International

b. APCO Willamette Valve and Primer Corporation

c. Hammond Valve

d. Jenkins Valves

e. Milwaukee Valve Company

f. NIBCO Inc.

g. WATTS

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 200 psig.

c. Body Material: ASTM A126, gray iron.

d. Style: Compact wafer, spring loaded.

e. Seat: Bronze.

B. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Hammond Valve

c. Milwaukee Valve Company

d. NIBCO Inc.

e. WATTS.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 200 psig.

c. Body Material: ASTM A126, gray iron.

d. Style: Globe, spring loaded.

e. Ends: Flanged.

f. Seat: Bronze.

C. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. APCO Willamette Valve and Primer Corporation

   b. Crispin Valve

   c. Val-Matic Valve & Manufacturing Corp.

3. Description:

   a. Standard: MSS SP-125.

   b. CWP Rating: 300 psig.

   c. Body Material: ASTM A395 or ASTM A536, ductile iron.

   d. Style: Compact wafer, spring loaded.

   e. Seat: Bronze.

D. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. APCO Willamette Valve and Primer Corporation

   b. Crispin Valve

   c. Val-Matic Valve & Manufacturing Corp.

3. Description:

   a. Standard: MSS SP-125.

   b. CWP Rating: 300 psig.

   c. Body Material: ASTM A395 or ASTM A536, ductile iron.

   d. Style: Globe, spring loaded.

e. Ends: Flanged.

f. Seat: Bronze.

E. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 250:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crispin Valve

c. Hammond Valve

d. Milwaukee Valve Company

e. NIBCO Inc.

f. Val-Matic Valve & Manufacturing Corp.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 400 psig.

c. Body Material: ASTM A126, gray iron.

d. Style: Compact wafer, spring loaded.

e. Seat: Bronze.

F. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 250:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crispin Valve

c. Hammond Valve

d. Milwaukee Valve Company

e. NIBCO Inc.

f. Val-Matic Valve & Manufacturing Corp.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 400 psig.

c. Body Material: ASTM A126, gray iron.

d. Style: Globe, spring loaded.

e. Ends: Flanged.

f. Seat: Bronze.

G. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 300:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crispin Valve

c. Val-Matic Valve & Manufacturing Corp.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 500 psig.

c. Body Material: ASTM A395 or ASTM A536, ductile iron.

d. Style: Compact wafer, spring loaded.

e. Seat: Bronze.

H. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 300:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. APCO Willamette Valve and Primer Corporation

   b. Crispin Valve

   c. Val-Matic Valve & Manufacturing Corp.

3. Description:

   a. Standard: MSS SP-125.

   b. CWP Rating: 500 psig.

   c. Body Material: ASTM A395 or ASTM A536, ductile iron.

   d. Style: Globe, spring loaded.

   e. Ends: Flanged.

   f. Seat: Bronze.

I. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. APCO Willamette Valve and Primer Corporation

   b. Crispin Valve

   c. Hammond Valve

   d. Milwaukee Valve Company

   e. NIBCO Inc.

   f. Val-Matic Valve & Manufacturing Corp.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 200 psig.

c. Body Material: ASTM A126, gray iron.

d. Style: Compact wafer, spring loaded.

e. Seat: EPDM or NBR.

J. Iron Globe, Center-Guided Check Valves with Resilient Seat, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Anvil International

b. APCO Willamette Valve and Primer Corporation

c. Apollo Flow Controls

d. Crispin Valve

e. Hammond Valve

f. Milwaukee Valve Company

g. NIBCO Inc.

h. Val-Matic Valve & Manufacturing Corp.

i. Zurn Industries

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 200 psig.

c. Body Material: ASTM A126, gray iron.

d. Style: Globe, spring loaded.

e. Ends: Flanged.

f. Seat: EPDM or NBR.

K. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crispin Valve

c. Val-Matic Valve & Manufacturing Corp.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 300 psig.

c. Body Material: ASTM A395 or ASTM A536, ductile iron.

d. Style: Compact wafer, spring loaded.

e. Seat: EPDM or NBR.

L. Iron, Globe, Center-Guided Check Valves with Resilient Seat, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crispin Valve

c. Val-Matic Valve & Manufacturing Corp.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 300 psig.

c. Body Material: ASTM A395 or ASTM A536, ductile iron.

d. Style: Globe, spring loaded.

e. Ends: Flanged.

f. Seat: EPDM or NBR.

M. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 250:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crispin Valve

c. Hammond Valve

d. Milwaukee Valve Company

e. NIBCO Inc.

f. Val-Matic Valve & Manufacturing Corp.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 400 psig.

c. Body Material: ASTM A126, gray iron.

d. Style: Compact wafer, spring loaded.

e. Seat: EPDM or NBR.

N. Iron Globe, Center-Guided Check Valves with Resilient Seat, Class 250:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crispin Valve

c. Hammond Valve

d. Milwaukee Valve Company

e. NIBCO Inc.

f. Val-Matic Valve & Manufacturing Corp.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 400 psig.

c. Body Material: ASTM A126, gray iron.

d. Style: Globe, spring loaded.

e. Ends: Flanged.

f. Seat: EPDM or NBR.

O. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 300:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crispin Valve

c. Val-Matic Valve & Manufacturing Corp.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 500 psig.

c. Body Material: ASTM A395 or ASTM A536, ductile iron.

d. Style: Compact wafer, spring loaded.

e. Seat: EPDM or NBR.

P. Iron Globe, Center-Guided Check Valves with Resilient Seat, Class 300:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crispin Valve

c. Val-Matic Valve & Manufacturing Corp.

3. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 500 psig.

c. Body Material: ASTM A395 or ASTM A536, ductile iron.

d. Style: Globe, spring loaded.

e. Ends: Flanged.

f. Seat: EPDM or NBR.

2.18 IRON, PLATE-TYPE CHECK VALVES:

A. Iron, Dual-Plate Check Valves with Metal Seat, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crane

c. Keckley Company

3. Standard: API 594.

4. CWP Rating: 200 psig.

5. Body Design: Wafer, spring-loaded plates.

6. Body Material: ASTM A126, gray iron.

7. Seat: Bronze.

B. Iron, Dual-Plate Check Valves with Metal Seat, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crane

c. Val-Matic Valve & Manufacturing Corp.

3. Standard: API 594.

4. CWP Rating: 300 psig.

5. Body Design: Wafer, spring-loaded plates.

6. Body Material: ASTM A395 or ASTM A536, ductile iron.

7. Seat: Bronze.

C. Iron, Dual-Plate Check Valves with Metal Seat, Class 250:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crane

3. Standard: API 594.

4. CWP Rating: 400 psig.

5. Body Design: Wafer, spring-loaded plates.

6. Body Material: ASTM A126, gray iron.

7. Seat: Bronze.

D. Iron, Dual-Plate Check Valves with Metal Seat, Class 300:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. APCO Willamette Valve and Primer Corporation

   b. Crane

   c. Val-Matic Valve & Manufacturing Corp.

3. Standard: API 594.

4. CWP Rating: 500 psig.

5. Body Design: Wafer, spring-loaded plates.

6. Body Material: ASTM A395 or ASTM A536, ductile iron.

7. Seat: Bronze.

E. Iron, Single-Plate Check Valves with Resilient Seat, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. Flo Fab Inc.

   b. Keckley Company

   c. Sure Flow Equipment Inc.

3. Standard: API 594.

4. CWP Rating: 200 psig.

5. Body Design: Wafer, spring-loaded plate.

6. Body Material: ASTM A126, gray iron.

7. Seat: EPDM or NBR.

F. Iron, Dual-Plate Check Valves with Resilient Seat, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. APCO Willamette Valve and Primer Corporation

   b. Crane

   c. Keckley Company

   d. NIBCO Inc.

   e. WATTS

3. Standard: API 594.

4. CWP Rating: 200 psig.

5. Body Design: Wafer, spring-loaded plates.

6. Body Material: ASTM A126, gray iron.

7. Seat: EPDM or NBR.

G. Iron, Dual-Plate Check Valves with Resilient Seat, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

   a. APCO Willamette Valve and Primer Corporation.

   b. Crane

   c. Val-Matic Valve & Manufacturing Corp.

3. Standard: API 594.

4. CWP Rating: 300 psig.

5. Body Design: Wafer, spring-loaded plates.

6. Body Material: ASTM A395 or ASTM A536, ductile iron.

7. Seat: EPDM or NBR.

H. Iron, Wafer, Single-Plate Check Valves with Resilient Seat, Class 250:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Sure Flow Equipment Inc.

3. Standard: API 594.

4. CWP Rating: 400 psig.

5. Body Design: Wafer, spring-loaded plate.

6. Body Material: ASTM A126, gray iron.

7. Seat: EPDM or NBR.

I. Iron, Dual-Plate Check Valves with Resilient Seat, Class 250:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Crane

c. Sure Flow Equipment Inc.

3. Standard: API 594.

4. CWP Rating: 400 psig.

5. Body Design: Wafer, spring-loaded plates.

6. Body Material: ASTM A126, gray iron.

7. Seat: EPDM or NBR.

J. Iron, Dual-Plate Check Valves with Resilient Seat, Class 300:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. APCO Willamette Valve and Primer Corporation

b. Val-Matic Valve & Manufacturing Corp.

3. Standard: API 594.

4. CWP Rating: 500 psig.

5. Body Design: Wafer, spring-loaded plates.

6. Body Material: ASTM A395 or ASTM A536, ductile iron.

7. Seat: EPDM or NBR.

2.19 CPVC BALL CHECK VALVES:

A. Manufacturers:

1. American Valve, Inc.

2. Georg Fischer Inc.

3. Hayward Flow Control

4. Legend Valve & Fitting Inc.

5. IPEX USA.

6. NIBCO Inc.

7. Spears Manufacturing Company

8. Thermoplastic Valves, Inc.

B. Description:

1. Pressure Rating and Temperature: 125 psig at 73 degrees F.

2. Body Material: CPVC.

3. Body Design: Union-type ball check.

4. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.

5. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded

6. Ball: CPVC.

7. Seals: EPDM- or FKM-rubber O-rings.

2.20 PVC BALL CHECK VALVES:

A. Manufacturers:

1. American Valve, Inc.

2. Georg Fischer Inc.

3. Hayward Flow Control

4. Legend Valve & Fitting Inc.

5. IPEX USA

6. NIBCO Inc.

7. Spears Manufacturing Company

8. Thermoplastic Valves, Inc.

B. Description:

1. Pressure Rating and Temperature: 125 psig at 73 degrees F.

2. Body Material: PVC.

3. Body Design: Union-type ball check.

4. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.

5. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded.

6. Ball: PVC.

7. Seals: EPDM- or FKM-rubber O-rings.

2.21 BRONZE GATE VALVES:

A. Bronze Gate Valves, NRS, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. American Valve, Inc.

b. Apollo Flow Controls

c. Crane

d. Hammond Valve

e. Jenkins Valves

f. Kitz Corporation

g. Legend Valve & Fitting Inc.

h. Milwaukee Valve Company

i. NIBCO Inc.

j. Red-White Valve Corp.

k. Stockham

l. WATTS

3. Description:

a. Standard: MSS SP-80, Type 1.

b. CWP Rating: 200 psig.

c. Body Material: Bronze with integral seat and screw-in bonnet.

d. Ends: Threaded or solder joint.

e. Stem: Bronze.

f. Disc: Solid wedge; bronze.

g. Packing: Asbestos free.

h. Handwheel: Malleable iron, bronze, or aluminum.

B. Bronze Gate Valves, RS, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. American Valve, Inc.

b. Apollo Flow Controls

c. Crane

d. Hammond Valve

e. Jenkins Valves

f. Kitz Corporation

g. Legend Valve & Fitting Inc.

h. Milwaukee Valve Company

i. NIBCO Inc.

j. Red-White Valve Corp.

k. Stockham

l. WATTS

3. Description:

a. Standard: MSS SP-80, Type 2.

b. CWP Rating: 200 psig.

c. Body Material: Bronze with integral seat and screw-in bonnet.

d. Ends: Threaded or solder joint.

e. Stem: Bronze.

f. Disc: Solid wedge; bronze.

g. Packing: Asbestos free.

h. Handwheel: Malleable iron, bronze, or aluminum.

C. Bronze Gate Valves, NRS, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Hammond Valve

c. Kitz Corporation

d. Milwaukee Valve Company

e. NIBCO Inc.

f. Red-White Valve Corp.

g. WATTS

3. Description:

a. Standard: MSS SP-80, Type 1.

b. CWP Rating: 300 psig.

c. Body Material: Bronze with integral seat and union-ring bonnet.

d. Ends: Threaded.

e. Stem: Bronze.

f. Disc: Solid wedge; bronze.

g. Packing: Asbestos free.

h. Handwheel: Malleable iron, bronze, or aluminum.

D. Bronze Gate Valves, RS, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Crane

c. Hammond Valve

d. Kitz Corporation

e. Milwaukee Valve Company

f. NIBCO Inc.

g. Stockham

h. WATTS

3. Description:

a. Standard: MSS SP-80, Type 2.

b. CWP Rating: 300 psig.

c. Body Material: Bronze with integral seat and union-ring bonnet.

d. Ends: Threaded.

e. Stem: Bronze.

f. Disc: Solid wedge; bronze.

g. Packing: Asbestos free.

h. Handwheel: Malleable iron, bronze, or aluminum.

2.22 IRON GATE VALVES:

A. Iron Gate Valves, NRS, Class 150:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Crane

c. Hammond Valve

d. Jenkins Valves

e. Kitz Corporation

f. Legend Valve & Fitting Inc.

g. Milwaukee Valve Company

h. NIBCO Inc.

i. Red-White Valve Corp

j. Stockham

k. WATTS

l. Zurn Industries

3. Description:

a. Standard: MSS SP-70, Type I.

b. CWP Rating: 200 psig.

c. Body Material: Gray iron with bolted bonnet.

d. Ends: Flanged.

e. Trim: Bronze.

f. Disc: Solid wedge.

g. Packing and Gasket: Asbestos free.

B. Iron Gate Valves, OS&Y, Class 125:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Crane

c. Hammond Valve

d. Jenkins Valves

e. Kitz Corporation

f. Legend Valve & Fitting Inc.

g. Milwaukee Valve Company

h. NIBCO Inc

i. Red-White Valve Corp

j. Stockham

k. WATTS

3. Description:

a. Standard: MSS SP-70, Type I.

b. CWP Rating: 200 psig.

c. Body Material: Gray iron with bolted bonnet.

d. Ends: Flanged.

e. Trim: Bronze.

f. Disc: Solid wedge.

g. Packing and Gasket: Asbestos free.

C. Iron Gate Valves, NRS, Class 250:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Crane

c. NIBCO Inc.

d. Stockham

3. Description:

a. Standard: MSS SP-70, Type I.

b. CWP Rating: 500 psig.

c. Body Material: Gray iron with bolted bonnet.

d. Ends: Flanged.

e. Trim: Bronze.

f. Disc: Solid wedge.

g. Packing and Gasket: Asbestos free.

D. Iron Gate Valves, OS&Y, Class 250:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Apollo Flow Controls

b. Crane

c. Hammond Valve

d. Milwaukee Valve Company

e. Stockham

f. WATTS

3. Description:

a. Standard: MSS SP-70, Type I.

b. CWP Rating: 500 psig.

c. Body Material: Gray iron with bolted bonnet.

d. Ends: Flanged.

e. Trim: Bronze.

f. Disc: Solid wedge.

g. Packing and Gasket: Asbestos free.

2.23 CPVC GATE VALVES:

A. Manufacturers:

1. Spears Manufacturing Company

B. Description:

1. Pressure Rating and Temperature: 125 psig at 73 degrees F.

2. Body Material: CPVC.

3. Body Design: Non-rising stem.

4. End Connections for Valves NPS 2 and Smaller: Socket or threaded.

5. End Connections for Valves NPS 2-1/2 to NPS 4: Socket or threaded.

6. Gate and Stem: Plastic.

7. Seals: EPDM rubber.

8. Handle: Wheel.

2.24 PVC GATE VALVES:

A. Manufacturers:

1. Spears Manufacturing Company

B. Description:

1. Pressure Rating and Temperature: 125 psig at 73 degrees F

2. Body Material: PVC

3. Body Design: Non-rising stem

4. End Connections for Valves NPS 2 and Smaller: Socket or threaded

5. End Connections for Valves NPS 2-1/2 to NPS 4: Socket or threaded

6. Gate and Stem: Plastic

7. Seals: EPDM rubber

8. Handle: Wheel

2.25 CHAINWHEELS:

A. Manufacturers:

1. Babbit Steam Specialty Co.

2. Roto Hammer Industries

3. Trumbull Industries

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

1. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve. Include zinc or epoxy coating.

2. Chain: Hot-dip galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION:

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Check Valves: Install check valves for proper direction of flow.

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

G. Install valve tags. Comply with requirements in Section 22 05 53.

H. Install valve tags. Comply with requirements in Section 22 05 53 for valve tags and schedules.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS:

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

4. For Steel Piping, NPS 2 and Smaller: Threaded ends.

5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.04 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE:

A. Pipe NPS 2 and Smaller:

1. Brass ball valve, one piece. Provide with threaded or solder-joint ends.

2. Bronze ball valve, one piece with bronze or stainless steel trim. Provide with threaded or solder-joint ends.

3. Brass ball valves, two-piece with full port and brass or stainless steel trim. Provide with threaded or solder-joint ends.

4. Bronze ball valves, two-piece with full port and brass or stainless-steel trim. Provide with threaded or solder-joint ends.

5. Brass ball valves, three-piece with full port and brass or stainless steel trim.

6. Bronze ball valves, three-piece with full port and bronze or brass or stainless steel trim.

7. Bronze ball valves, two-piece with regular port and bronze or stainless-steel trim.

B. Pipe NPS 2-1/2 and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.

2. Steel ball valves, Class 150 with full port.

3. Iron ball valves, Class 150.

C. CPVC Pipe NPS 2 and Smaller: Union-ball valve.

D. PVC Pipe NPS 2 and Smaller: Union-ball valve.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide hangers and supports for plumbing piping and equipment as indicated and in compliance with Contract Documents.

1. Metal pipe hangers and supports
2. Trapeze pipe hangers
3. Fiberglass pipe hangers
4. Metal framing systems
5. Fiberglass strut systems
6. Thermal hanger-shield inserts
7. Fastener systems
8. Pipe stands
9. Pipe-positioning systems
10. Equipment supports

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 7: Minimum Design Loads for Buildings and Other Structures

B. American Society of Mechanical Engineers (ASME):

1. Boiler and Pressure Vessel Code
2. B31.9: Building Services Piping

C. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

3. A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

4. A1011: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

5. B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

6. C552: Standard Specification for Cellular Glass Thermal Insulation.

7. C591: Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation

8. C1107: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)

9. D635: Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

10. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

D. American Welding Society (AWS):

1. D1.1: Structural Welding Code – Steel

E. International Association of Plumbing and Mechanical Officials (IAPMO):

1. PS 42: Pipe Alignment and Secondary Support Systems

F. Manufacturer Metal Framing Systems (MFMA):

1. 4: Standard for Integrated Fire Protection and Life Safety System Testing

2. 103: Standard for Metal Framing Selections and Applications

G. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports - Materials and Design.

H. Underwriters' Laboratories, Inc. (UL):

1. 94: Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.

2. Metal framing systems.

3. Fiberglass strut systems.

4. Pipe stands.

5. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.

2. Include design calculations for designing trapeze hangers.

D. Welding certificates.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1.

C. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00, to design trapeze pipe hangers and equipment supports.

B. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

C. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.02 METAL PIPE HANGERS AND SUPPORTS:

A. Carbon-Steel Pipe Hangers and Supports:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

3. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.

4. Nonmetallic Coatings: Plastic coated or epoxy powder coated.

5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

4. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.03 TRAPEZE PIPE HANGERS:

A. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

B. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS:

A. MFMA Manufacturer Metal Framing Systems:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. G-STRUT

b. Powerstrut Corp.

c. Unistrut Corp.

3. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.

4. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.

5. Channels: Continuous slotted Carbon-steel channel with inturned lips.

6. Channel Width: Selected for applicable load criteria.

7. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

8. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel

9. Metallic Coating: Hot-dip galvanized

10. Paint Coating: Green epoxy, acrylic, or urethane

11. Plastic Coating: PVC

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Anvil International

b. CADDY

c. Empire Industries, Inc.

d. MIRO Industries

3. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.

4. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.

5. Channels: Continuous slotted carbon-steel channel with inturned lips

6. Channel Width: Select for applicable load criteria

7. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel

8. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel

9. Metallic Coating: Hot-dip galvanized

10. Paint Coating: Green epoxy, acrylic, or urethane

11. Plastic Coating: PVC

2.05 THERMAL HANGER-SHIELD INSERTS:

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06 FASTENER SYSTEMS:

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened Portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: stainless steel

2. Outdoor Applications: Stainless steel

2.07 PIPE STANDS:

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand:

1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate

3. Hardware: Galvanized steel or polycarbonate

4. Accessories: Protection pads

C. Low-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.

2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate

3. Vertical Members: Two galvanized-steel, continuous-thread, 1/2-inch rods

4. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channels

5. Pipe Supports: Roller

6. Hardware: Galvanized steel

7. Accessories: Protection pads

8. Height: 12 inches above roof

D. High-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

2. Base: Single vulcanized rubber or molded polypropylene

3. Vertical Members: Two galvanized-steel, continuous-thread, 1/2-inch rods

4. Horizontal Member: One adjustable-height, galvanized-steel, pipe-support slotted channel or plate

5. Pipe Supports: Clevis hanger

6. Hardware: Stainless steel

7. Accessories: Protection 1/2-inch, continuous-thread, stainless-steel rod

8. Height: 36 inches above roof

E. High-Profile, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

2. Bases: Two or more; molded polypropylene

3. Vertical Members: Two or more, galvanized-steel channels

4. Horizontal Members: One or more, adjustable-height, galvanized-steel pipe support

5. Pipe Supports: Strut clamps

6. Hardware: Galvanized steel

7. Accessories: Protection pads, 1/2-inch, continuous-thread rod

8. Height: 36 inches above roof

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.08 PIPE-POSITIONING SYSTEMS:

A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.09 EQUIPMENT SUPPORTS:

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2.10 MATERIALS:

A. Aluminum: ASTM B221

B. Carbon Steel: ASTM A1011

C. Structural Steel: ASTM A36 carbon-steel plates, shapes, and bars; black and galvanized

D. Stainless Steel: ASTM A240

E. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications

1. Properties: Non-staining, noncorrosive, and nongaseous

2. Design Mix: 5000-psi, 28-day compressive strength

PART 3 - EXECUTION

3.01 APPLICATION:

A. Comply with requirements in Section 07 84 00 for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 pounds.

3.02 HANGER AND SUPPORT INSTALLATION:

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A36 carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Pipe Stand Installation:

1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 for curbs.

H. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.

   b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.

   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick

   b. NPS 4: 12 inches long and 0.06 inch thick

   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick

   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick

   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS:

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS:

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.05 ADJUSTING:

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.06 PAINTING:

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 90 00.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

3.07 HANGER AND SUPPORT SCHEDULE:

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers, and stainless-steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal hanger-shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 degrees F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 degrees F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degrees F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 pounds

    b. Medium (MSS Type 32): 1500 pounds

    c. Heavy (MSS Type 33): 3000 pounds

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.

    b. Vertical (MSS Type 55): Mounted vertically.

    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

S. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 05 33

HEAT TRACING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide plumbing piping heat tracing as shown on Drawings for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables as indicated and in compliance with Contract Documents.

1. Plastic insulated, series resistance

2. Self-regulating, parallel resistance

3. Constant wattage

1.02 REFERENCES:

A. Institute of Electrical and Electronics Engineers (IEEE):

1. 515.1: Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications

B. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

C. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.

2. Include diagrams for power, signal, and control wiring.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

F. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.08 WARRANTY:

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Three from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES:

A. Manufacturers:

1. Chromalox

2. Delta-Therm

3. Raychem

B. Comply with IEEE 515.1.

C. The self-regulating heating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be but to length in the field. The heating cable shall be covered by a radiation-crosslinking modi-

fied polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of modified polyolefin.

1. For installation on plastic piping, the heating cable shall be applied using aluminum tape.

D. In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 percent. The self-regulating factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 40 degrees F pipe temperature operation to 150 degrees F pipe temperature operation.

1. The heating cable shall operate on line voltage of 277 volts without the use of transformers.

2. Electrical Insulating Jacket: Flame-retardant polyolefin.

3. Cable Cover: Tinned-copper braid, and polyolefin outer jacket with UV inhibitor.

4. Maximum Operating Temperature (Power On): 150 degrees F.

5. Maximum Exposure Temperature (Power Off): 185 degrees F.

6. Maximum Operating Temperature: 300 degrees F.

E. Power connection, end seal, splice and tee kit components shall be applied in the field.

F. All heating-cable components shall be UL Listed, CSA Certified, or FM Approved for use as part of the system to provide freeze protection. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bust wires or that use crimps or terminal blocks, shall not be acceptable. All components that make an electrical connection shall be re-enterable for servicing. No components shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

G. Capacities and Characteristics: The heating cable for metal-pipe freeze protection shall be sized according to the table below. The required cable output rating in watts per foot at 50 degrees F assuming 1 inch thick fiberglass insulation.

Heat Output based on Min. Ambient Temp. of 0 degrees F:

Pipe Size (Inches)	**Cable Output Rating**
3 or less	5 watts

Pipe Size (Inches)	Cable Output Rating
4	5 watts
6	8 watts
8	8 watts
10 +	8 watts x 2 runs

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Capacities and Characteristics:

1. Maximum Heat Output: 8 W/ft

2. Piping Diameter: 4 inch maximum

3. Number of Parallel Cables: 2

4. Spiral Wrap Pitch: 12 inches

5. Electrical Characteristics for Single-Circuit Connection:

a. Volts: 208

b. Phase: Single

c. Hertz: 60

2.02 CONTROLS:

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Building with Mechanical System Building Automation System Available:

a. Provide controls as required to connect and control heat trace via the building automation system (BAS). All components necessary to enable/disable and monitor the heat trace system shall be provided including any gateways or translators to speak to the BacNET MSTP BAS.

b. Remote, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

c. Corrosion-resistant, waterproof control enclosure.

d. Heat trace shall be enabled/disabled via BAS system. TC contractor shall coordinate with the ME/EC for install and control of the heat trace and all other snow melt systems.

e. Basis of Design: Raychem ACS-30 with ProtoNode gateway.

2. Building Without Mechanical System Building Automation System Available:

a. Remote bulb unit with adjustable temperature range from 30 to 50 degrees F.

b. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

c. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

d. Corrosion-resistant, waterproof control enclosure.

2.03 ACCESSORIES:

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 22 05 53.

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less than 6 Inches: 3/4 inch minimum.

2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS:

A. Install the following types of electric heating cable for the applications described:

1. Temperature Maintenance for Domestic Hot Water/Piping Systems: Self-regulating, parallel-resistance heating cable.

3.03 INSTALLATION:

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.

2. Install electric heating cables according to IEEE 515.1.

3. Install insulation over piping with electric cables according to Section 22 07 19.

4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Electric Heating-Cable Installation for Temperature Maintenance for Domestic Hot Water:

1. Install electric heating cables after piping has been tested and before insulation is installed.

2. Install insulation over piping with electric heating cables according to Section 22 07 19.

3. Install warning tape on piping insulation where piping is equipped with electric heating cables.

D. Set field-adjustable switches and circuit-breaker trip ranges.

3.04 CONNECTIONS:

A. Ground equipment according to Section 26 05 26.

B. Connect wiring according to Section 26 05 20.

3.05 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

2. Test cables for electrical continuity and insulation integrity before energizing.

3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.06 PROTECTION:

A. Protect installed heating cables, including non-heating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 05 48

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide vibration and seismic controls for plumbing piping and equipment as indicated and in compliance with Contract Documents.

1. Isolation pads
2. Isolation mounts
3. Restrained elastomeric isolation mounts
4. Freestanding and restrained spring isolators
5. Housed spring mounts
6. Elastomeric hangers
7. Spring hangers
8. Spring hangers with vertical-limit stops
9. Pipe riser resilient supports
10. Seismic snubbers
11. Restraining braces and cables
12. Steel and inertia, vibration isolation equipment bases

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A492: Standard Specification for Stainless Steel Rope Wire
2. A603: Standard Specification for Zinc-Coated Steel Structural Wire Rope
3. E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

B. American Welding Society (AWS):

1. D1.1: Structural Welding Code – Steel

C. Manufacturer Metal Framing Systems (MFMA):

1. 4: Standard for Integrated Fire Protection and Life Safety System Testing

D. Manufacturers' Standardization Society (MSS):

1. SP-127: Bracing for Piping Systems: Seismic – Wind – Dynamic Design, Selection, and Application

1.03 DEFINITIONS:

A. AHJ: Authority Having Jurisdiction

B. EPDM: Ethylene-Propylene-Diene Monomer

C. Withstand: Unit will remain in place without separation of any parts from the device when subjected to seismic forces specified.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Written certification from Professional Engineer licensed in the State of Utah stating that supports systems and anchorage for equipment have been designed according to requirements of indicated according to Section 1613 of the building codes of Utah, Salt lake City and ASCE/SEI 7 for post-disaster structures at time of shop drawing submittals.

B. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.

b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

C. Shop Drawings:

1. Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components. Detail bases, and show location of equipment anchoring points, coordinated with equipment manufacturer's shop drawings.

a. Shop drawings showing structural design and details of inertia bases, steel beam bases and other custom-fabricated work not covered by manufacturer's submitted data.

(1) Furnish templates, anchor bolts and sleeve for equipment bases, foundations and other support systems for coordination of vibration isolation units with other work.

2. Submit shop drawings indicating scope of vibration isolation work and locations of units and flexible connections. Include support isolation points for piping and ductwork including risers, air housings and inertia bases.

a. Include schedule of units, showing size or manufacturer's part number, and weight supported and resulting deflection of each unit.

D. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems and anchorage for equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

2. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

3. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.

4. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.

5. Seismic-Restraint Details:

   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

   d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

6. Seismic Qualification Certificates:

   a. For pumps, accessories, and components, from manufacturer.

      (1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

      (2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

      (3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

   b. For steel water storage tanks, accessories, and components, from manufacturer.

      (1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

      (2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

      (3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

   c. For waste and vent piping, accessories, and components, from manufacturer.

      (1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

(2) Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

d. For storm drainage piping, accessories, and components, from manufacturer.

(1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

(2) Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

e. Water heaters, accessories, and components, from manufacturer.

(1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

(2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

(3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For Professional Engineer and Testing Agency.

F. Welding certificates.

G. Field quality-control reports.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

C. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

E. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval by an agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Seismic Control:

1. Design equipment, anchorage and support systems for vertical and lateral loading in accordance with Section 1613 of the Building Codes of Utah, Salt Lake City and ASCE/SEI 7.

2. Provide seismic control as required to maintain integrity of mechanical piping, ductwork, and equipment installed in this project, so they will “withstand” earthquake forces.

3. Design shall comply with requirements of this Specification, applicable codes, and requirements of Section 22 05 00.

4. Design, size and install for equipment throughout facility, whether shown or not.

5. Designed by a licensed Professional Engineer in the State of Utah.

2.02 VIBRATION ISOLATION:

A. Elastomeric Pad:

1. Oil-resistant and water-resistant elastomer or natural rubber waffle pads, arranged in single or multiple layers, molded with a nonslip pattern.

2. Waffle pads bonded each side of minimum 0.24 inch thick galvanized steel separator plate.

3. Height of waffle ribs shall not exceed 0.7 times width.

4. Maximum Loading: 60 psi.

5. Minimum Single Layer Thickness: 0.24 inches.

6. Separator plate of sufficient stiffness for uniform loading over pad area.

7. Factory cut to size that matches requirements of supported equipment.

8. Waffle Pad Material: Standard neoprene.

9. Number of Layers: As required to support equipment load; refer to manufacturer's data for load capacities.

B. Elastomeric Mount:

1. Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements.

2. Factory-drilled, encapsulated top plate for bolting to equipment.

3. Baseplate for bolting to structure.

C. Restrained Elastomeric Isolation Mounts:

1. All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.

b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

D. Open Spring Isolators:

1. Freestanding, laterally stable, open-spring isolators.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of required deflection at rated load.

4. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Baseplate:

   a. Factory drilled for bolting to structure and bonded to 0.24 inches thick rubber isolator pad attached to baseplate underside.

   b. Limit floor load to 100 psig.

   c. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolator:

1. Freestanding, steel, open-spring isolators with seismic restraint.

2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 0.24 inch thick elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and levelling bolt that acts as blocking during installation.

3. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.

4. Minimum Additional Travel: 50 percent of required deflection at rated load.

5. Lateral Stiffness: 80 percent minimum of the rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. Elastomeric Hanger:

1. Double-deflection type.

2. Molded, oil-resistant rubber or neoprene isolator elements bonded to steel housing.

3. Threaded connections for hanger rods.

G. Spring Hanger:

1. Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

3. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.

4. Minimum Additional Travel: 50 percent of required deflection at rated load.

5. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

7. Elastomeric Element:

   a. Molded, oil-resistant rubber or neoprene.

H. Steel washer-reinforced cup to support spring and bushing projecting Thrust Limit:

1. Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop.

2. Rod and angle-iron brackets for attaching to equipment.

3. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

4. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.

5. Minimum Additional Travel: 50 percent of required deflection at rated load.

6. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.

7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

8. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

9. Coil Spring: Factory set and field adjustable.

2.03 EQUIPMENT BASES:

A. Structural Steel Base:

1. Factory-fabricated, welded, structural steel base and rail.

2. Design Requirements:

   a. Lowest possible mounting height with not less than 1 inch clearance above floor.

   b. Provide equipment anchor bolts and auxiliary motor slide bases or rails.

c. Provide supports for suction and discharge elbows for pumps.

3. Structural Steel:

a. Steel shapes, plates, and bars complying with ASTM A36.

b. Bases shall have shape to accommodate supported equipment.

4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

B. Concrete Inertia Base:

1. Factory-fabricated, welded, structural steel base and rail ready for cast-in-place concrete.

2. Design Requirements:

a. Lowest possible mounting height with not less than 1 inch clearance above floor.

b. Provide equipment anchor bolts and auxiliary motor slide bases or rails.

c. Provide supports for suction and discharge elbows for pumps.

3. Structural Steel:

a. Steel shapes, plates, and bars complying with ASTM A36.

b. Bases shall have shape to accommodate supported equipment.

4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

5. Fabrication:

a. Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete.

b. Obtain anchor-bolt templates from supported equipment manufacturer.

6. Concrete: 4600 psi.

a. Through bottom of frame.

2.04 SNUBBERS:

A. Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

2.05 RESTRAINT CHANNEL BRACINGS:

A. MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.06 RESTRAINT CABLES:

A. Restraint Cables: ASTM A492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.07 SEISMIC-RESTRAINT ACCESSORIES:

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.08 MECHANICAL ANCHOR BOLTS:

A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

2.09 ADHESIVE ANCHOR BOLTS:

A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS:

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

D. Hangers and Supports for Plumbing Piping and Equipment: Comply with requirements in Section 22 05 29 and those indicated below:

1. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

a. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

(1) Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

(2) Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

(3) Design seismic-restraint hangers and supports for piping and equipment.

2. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

E. Plumbing Pumps: Comply with requirements in Section 22 11 23 and those indicated below:

1. Seismic Performance: Plumbing pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

a. The term "withstand" means "the pump will remain in place without separation of any parts from the pump when subjected to the seismic forces specified."

F. Plumbing Tanks: Comply with requirements in Section 22 12 10 and those indicated below:

1. Elevated Tanks, Ground-Mounted tanks, and Indoor Storage Tanks:

a. Seismic Performance: Elevated water-storage tank, including tank shell, structural reinforcement, supports, and foundations, shall be capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.

(1) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

b. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

c. Install tank seismic restraints on all tanks.

G. Sanitary Waste and Vent Piping: Comply with requirements in Section 22 13 16 and those indicated below:

1. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Install seismic restraints on piping.

H. Storm Drainage Piping: Comply with requirements in Section 22 14 13 and those indicated below:

1. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Install seismic restraints on piping.

I. Water Heaters (Domestic and Non-potable): Comply with requirements in Section 22 34 00 and those indicated below:

1. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Install commercial, electric, domestic-water heaters with seismic-restraint devices.

3.03 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION:

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Comply with requirements in Section 07 72 00 for installation of roof curbs, equipment supports, and roof penetrations.

D. Equipment Restraints:

1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Piping Restraints:

1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.

3. Brace a change of direction longer than 12 feet.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

K. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION:

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 22 11 13 for piping flexible connections.

3.05 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.

3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.

5. Test to 90 percent of rated proof load of device.

6. Measure isolator restraint clearance.

7. Measure isolator deflection.

8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.06 ADJUSTING:

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide equipment labels, warning signs and labels, pipe labels, stencils, valve tags, and warning tags as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. A13.1: Scheme for the identification of Piping Systems

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated.

C. Samples: For color, letter style, and graphic representation required for each identification material and device.

D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

E. Valve numbering scheme.

F. Valve Schedules: For each piping system to include in maintenance manuals.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS:

A. Metal Labels for Equipment:

1. Material and Thickness: anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Letter Color: White

3. Background Color: Black

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

6. Fasteners: Stainless-steel rivets.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick and having predrilled holes for attachment hardware.

2. Letter Color: White

3. Background Color: Black

4. Maximum Temperature: Able to withstand temperatures up to 160 degrees F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larg-

er lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

7. Fasteners: Stainless-steel rivets

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 by 11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS:

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick with predrilled holes for attachment hardware.

B. Letter Color: White

C. Background Color: Black

D. Maximum Temperature: Able to withstand temperatures up to 160 degrees F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 PIPE LABELS:

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.04 STENCILS:

A. Stencils for Piping:

1. Lettering Size: Size letters according to ASME A13.1 for piping.

2. Stencil Material: Aluminum

3. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

4. Identification Paint: Exterior, alkyd enamel or acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.05 VALVE TAGS:

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link chain

B. Valve Schedules: For each piping system, on 8-1/2 by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.06 WARNING TAGS:

A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches

2. Fasteners: Brass grommet and wire

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Safety yellow background with black lettering

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 GENERAL INSTALLATION REQUIREMENTS:

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 EQUIPMENT LABEL INSTALLATION:

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION:

A. Piping Color Coding: Painting of piping is specified in Section 09 90 00.

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.

2. Stencil Paint: Use for pipe marking.

C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, maintenance holes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe Label Color Schedule:

1. Domestic Water Piping:

a. Background: Safety green

b. Letter Colors: White

2. Sanitary Waste and Storm Drainage Piping:

a. Background Color: Safety purple

b. Letter Color: White

3.05 VALVE-TAG INSTALLATION:

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Cold Water: 1-1/2 inches, round

b. Hot Water: 1-1/2 inches, round

c. Low-Pressure Compressed Air: 1-1/2 inches, round

d. High-Pressure Compressed Air: 1-1/2 inches, round.

2. Valve-Tag Colors:

a. Cold Water: Safety green

b. Hot Water: Safety green

c. Low-Pressure Compressed Air: Safety blue

d. High-Pressure Compressed Air: Safety blue

3. Letter Colors:

a. Cold Water: White

b. Hot Water: White

c. Low-Pressure Compressed Air: White

d. High-Pressure Compressed Air: White

3.06 WARNING-TAG INSTALLATION:

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide the following plumbing piping services as indicated and in compliance with Contract Documents.

1. Potable and non-potable cold-water piping

2. Potable hot-water piping

3. Potable recirculating hot-water piping

4. Sanitary waste piping exposed to freezing conditions

5. Storm-water piping exposed to freezing conditions

6. Roof drains and rainwater leaders

7. Break tanks and pressure vessels

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

2. B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

3. C195: Standard Specification for Mineral Fiber Thermal Insulating Cement

4. C449: Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

5. C450: Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging

6. C547: Standard Specification for Mineral Fiber Pipe Insulation

7. C552: Standard Specification for Cellular Glass Thermal Insulation.

8. C585: Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing

9. C795: Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel

10. C1136: Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

11. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

12. E96: Standard Test Methods for Water Vapor Transmission of Materials

13. F1249: Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor

B. ICC Evaluation Services (ICC-ES):

1. A117.1: Accessible and Usable Buildings and Facilities

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail attachment and covering of heat tracing inside insulation.

3. Detail insulation application at pipe expansion joints for each type of insulation.

4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Detail removable insulation at piping specialties, equipment connections, and access panels.

6. Detail application of field-applied jackets.

7. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.

2. Jacket Materials for Pipe: 12 inches long by NPS 2.

3. Sheet Jacket Materials: 12 inches square.

4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

E. Qualification Data: For qualified Installer.

F. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

G. Field quality-control reports.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

C. Fire-Test Response Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.

D. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of mechanical insulation products, of types and sizes required, whole products have been in satisfactory use in similar service for not less than 3 years.

E. IECC Compliance: Insulation applied to plumbing services shall comply with International Energy Conservation Code (IECC) with regard to insulation performance, thickness, and sealing.

F. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

C. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

D. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

1.08 COORDINATION:

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29.

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.09 SCHEDULING:

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS:

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

1. Manufacturers:

a. Cell-U-Foam Corporation; Ultra-CUF

b. Pittsburgh Corning Corporation; Foamglas Super K

2. Block Insulation: ASTM C552, Type I.

3. Special-Shaped Insulation: ASTM C552, Type III.

4. Board Insulation: ASTM C552, Type IV.

5. Preformed Pipe Insulation without jacket: Comply with ASTM C552, Type II, Class 1

6. Preformed Pipe Insulation with Factory-Applied ASJ jacket: Comply with ASTM C552, Type II, Class 2.

7. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.

8. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For equipment applications, pro-

vide insulation with factory applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers:

    a. Schuller (formerly Manville Corp.)

    b. Owens-Corning Fiberglas Corp.

    c. Certain Teed Corp.

    d. Knauf Fiber Glass

    e. Manson

    f. Armstrong World Industries, Inc.

    g. Pittsburgh Corning Corp.

    h. Rubatex Corp.

H. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

1. Manufacturers:

    a. Schuller (formerly Manville Corp.)

    b. Owens-Corning Fiberglas Corp.

    c. Certain Teed Corp.

    d. Knauf Fiber Glass

    e. Manson

    f. Armstrong World Industries, Inc.

    g. Pittsburgh Corning Corp.

    h. Rubatex Corp.

2. Type I, 850 degrees F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with

ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 degrees F is 0.29 Btu x in./h x sq. ft. x degrees F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers:

    a. Schuller (formerly Manville Corp.)

    b. Owens-Corning Fiberglas Corp.

    c. Certain Teed Corp

    d. Knauf Fiber Glass

    e. Manson

    f. Armstrong World Industries, Inc.

    g. Pittsburgh Corning Corp.

    h. Rubatex Corp.

2.02 INSULATING CEMENTS:

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.03 ADHESIVES:

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass, Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 degrees F.

1. Manufacturers:

    a. Childers Products, Division of ITW; CP-96

    b. Foster Products Corporation, H. B. Fuller Company; 81-33

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers:

a. Childers Products, Division of ITW; CP-82

b. Foster Products Corporation, H. B. Fuller Company; 85-20

c. ITW TACC, Division of Illinois Tool Works; S-90/80

d. Marathon Industries, Inc.; 225

e. Mon-Eco Industries, Inc.; 22-25

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers:

a. Childers Products, Division of ITW; CP-82

b. Foster Products Corporation, H. B. Fuller Company; 85-20

c. ITW TACC, Division of Illinois Tool Works; S-90/80

d. Marathon Industries, Inc.; 225

e. Mon-Eco Industries, Inc.; 22-25

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers:

a. Dow Chemical Company (The); 739, Dow Silicone

b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive

c. P.I.C. Plastics, Inc.; Welding Adhesive

d. Red Devil, Inc.; Celulon Ultra Clear

e. Speedline Corporation; Speedline Vinyl Adhesive

2.04 MASTICS AND COATINGS:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Manufacturers:

a. Childers Products, Division of ITW; CP-30

b. Foster Products Corporation, H. B. Fuller Company; 30-35

c. ITW TACC, Division of Illinois Tool Works; CB-25

d. Marathon Industries, Inc.; 501

e. Mon-Eco Industries, Inc.; 55-10

2. Water-Vapor Permeance: ASTM F1249, 0.05 perm at 35-mil dry film thickness.

a. Service Temperature Range: 0 to 180 degrees F.

b. Solids Content: ASTM D1644, 44 percent by volume and 62 percent by weight.

c. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Manufacturers:

a. Childers Products, Division of ITW; Encacel

b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96

c. Marathon Industries, Inc.; 570

d. Mon-Eco Industries, Inc.; 55-70

2. Water-Vapor Permeance: ASTM F1249, 0.05 perm at 30-mil dry film thickness.

3. Service Temperature Range: Minus 50 to plus 220 degrees F.

4. Solids Content: ASTM D1644, 33 percent by volume and 46 percent by weight.

5. Color: White.

2.05 LAGGING ADHESIVES:

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers:

a. Childers Products, Division of ITW; CP-52

b. Foster Products Corporation, H. B. Fuller Company; 81-42

c. Marathon Industries, Inc.; 130

d. Mon-Eco Industries, Inc.; 11-30

e. Vimasco Corporation; 136

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.

3. Service Temperature Range: Minus 50 to plus 180 degrees F.

4. Color: White.

2.06 SEALANTS

A. Joint Sealants:

1. Manufacturers:

a. Childers Products, Division of ITW; CP-76

b. Foster Products Corporation, H. B. Fuller Company; 30-45

c. Marathon Industries, Inc.; 405

d. Mon-Eco Industries, Inc.; 44-05

e. Pittsburgh Corning Corporation; Pittseal 444

f. Vimasco Corporation; 750

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Permanently flexible, elastomeric sealant.

4. Service Temperature Range: Minus 100 to plus 300 degrees F.

5. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers:

a. Childers Products, Division of ITW; CP-76-8

b. Foster Products Corporation, H. B. Fuller Company; 95-44

c. Marathon Industries, Inc.; 405

d. Mon-Eco Industries, Inc.; 44-05

e. Vimasco Corporation; 750

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 degrees F.

5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers:

a. Childers Products, Division of ITW; CP-76

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 degrees F.

5. Color: White.

2.07 REMOVABLE INSULATION JACKETS

A. Manufacturers:

1. Childers

2. Ceel-Co

B. Jackets for Piping Insulation: ASTM C921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.

C. Encase pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.

D. Where piping is specified to be exposed in finished area all insulated piping shall have PVC jacketing and fitting covers as manufactured by Ceel-Co 550Z with a 25/50 flame/smoke rating not less than 15 mil thick, suitable and ready to accept a final painted finish.

E. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.

2.08 FACTORY-APPLIED JACKETS:

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C1136, Type II.

2.09 FIELD-APPLIED FABRIC-REINFORCING MESH:

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.10 FIELD-APPLIED CLOTHS:

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd.

2.11 FIELD-APPLIED JACKETS:

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

1. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

a. Manufacturers:

(1) Johns Manville; Zeston

(2) P.I.C. Plastics, Inc.; FG Series

(3) Proto PVC Corporation; LoSmoke

(4) Speedline Corporation; SmokeSafe

b. Adhesive: As recommended by jacket material manufacturer.

c. Color: White.

d. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

(1) Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

e. Factory-fabricated tank heads and tank side panels.

2. Metal Jacket:

a. Manufacturers:

(1) Childers Products, Division of ITW; Metal Jacketing Systems

(2) PABCO Metals Corporation; Surefit

(3) RPR Products, Inc.; Insul-Mate

b. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

(1) Factory cut and rolled to size.

(2) Finish and thickness are indicated in field-applied jacket schedules.

(3) Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and Kraft paper.

(4) Moisture Barrier for Outdoor Applications: 2.5-mil-thick Polysurlyn.

(5) Factory-Fabricated Fitting Covers:

(a) Same material, finish, and thickness as jacket.

(b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

(c) Tee covers.

(d) Flange and union covers.

(e) End caps.

(f) Beveled collars.

(g) Valve covers.

(h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

c. Stainless-Steel Jacket: ASTM A167 or ASTM A240.

(1) Factory cut and rolled to size.

(2) Material, finish, and thickness are indicated in field-applied jacket schedules.

(3) Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and Kraft paper.

(4) Moisture Barrier for Outdoor Applications: 2.5-mil-thick Polysurlyn.

(5) Factory-Fabricated Fitting Covers:

(a) Same material, finish, and thickness as jacket.

(b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

(c) Tee covers.

(d) Flange and union covers.

(e) End caps.

(f) Beveled collars.

(g) Valve covers.

(h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

a. Manufacturers:

(1) Pittsburgh Corning Corporation; Pittwrap

(2) Polyguard; Insulrap No Torch 125

2.12 TAPES:

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835

b. Compac Corp.; 104 and 105

c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ

d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ

2. Width: 3 inches.

3. Thickness: 11.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Manufacturers:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827

b. Compac Corp.; 110 and 111

c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK

d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ

2. Width: 3 inches.

3. Thickness: 6.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Manufacturers:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555

b. Compac Corp.; 130

c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape

d. Venture Tape; 1506 CW NS

2. Width: 2 inches.

3. Thickness: 6 mils.

4. Adhesion: 64 ounces force/inch in width.

5. Elongation: 500 percent.

6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800

b. Compac Corp.; 120

c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF

d. Venture Tape; 3520 CW

2. Width: 2 inches.

3. Thickness: 3.7 mils.

4. Adhesion: 100 ounces force/inch in width.

5. Elongation: 5 percent.

6. Tensile Strength: 34 lbf/inch in width.

2.13 SECUREMENTS:

A. Bands:

1. Manufacturers:

a. Childers Products; Bands

b. PABCO Metals Corporation; Bands

c. RPR Products, Inc.; Bands

2. Stainless Steel: ASTM A240, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.

3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

a. Manufacturers:

(1) AGM Industries, Inc.; CWP-1

(2) GEMCO; CD

(3) Midwest Fasteners, Inc.; CD

(4) Nelson Stud Welding; TPA, TPC, and TPS

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

a. Manufacturers:

(1) AGM Industries, Inc.; CWP-1

(2) GEMCO; Cupped Head Weld Pin

(3) Midwest Fasteners, Inc.; Cupped Head

(4) Nelson Stud Welding; CHP

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Manufacturers:

(1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T

(2) GEMCO; Perforated Base

(3) Midwest Fasteners, Inc.; Spindle

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low carbon steel, aluminum, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness in-

dicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Manufacturers:

(1) GEMCO; Nylon Hangers

(2) Midwest Fasteners, Inc.; Nylon Insulation Hangers

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.

c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Manufacturers:

(1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA

(2) GEMCO; Press and Peel

(3) Midwest Fasteners, Inc.; Self Stick

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low carbon steel, aluminum, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Manufacturers:

(1) AGM Industries, Inc.; RC-150

(2) GEMCO; R-150

(3) Midwest Fasteners, Inc.; WA-150

(4) Nelson Stud Welding; Speed Clips

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, provide one of the following:

(1) GEMCO

(2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

1. Manufacturers:

a. C & F Wire

b. Childers Products

c. PABCO Metals Corporation

d. RPR Products, Inc.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.14 PROTECTIVE SHIELDING GUARDS:

A. Protective Shielding Pipe Covers,:

1. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures,:

1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.15 CORNER ANGLES:

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A167 or ASTM A240, Type 304 or 316.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 degrees F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 degrees F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS:

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.

3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

   a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices

2. Testing agency labels and stamps

3. Nameplates and data plates

4. Cleanouts

3.04 PENETRATIONS:

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 07 84 00 for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 00.

3.05 BREAK TANK INSULATION INSTALLATION:

A. Mineral Fiber, Pipe and Tank Insulation Installation for Break Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area of tank and vessel surfaces.

2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

3. Protect exposed corners with secured corner angles.

4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

a. Do not weld anchor pins to ASME-labeled pressure vessels.

b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.

c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.

d. Do not overcompress insulation during installation.

e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.

f. Impale insulation over anchor pins and attach speed washers.

g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

h. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

i. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional cir-

cumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

j. Stagger joints between insulation layers at least 3 inches.

k. Install insulation in removable segments on equipment access doors, maintenance holes, handholes, and other elements that require frequent removal for service and inspection.

l. Bevel and seal insulation ends around maintenance holes, handholes, ASME stamps, and nameplates.

m. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

5. Insulation Installation on Pumps:

a. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

b. Fabricate boxes from galvanized steel or aluminum, at least 0.040 inch thick.

c. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

6. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

7. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

8. Do not apply insulation to equipment while hot.

9. Apply insulation using staggered joint method and double layer construction. Apply each layer of insulation separately.

10. Provide removable insulation sections with aluminum jacket and stainless steel bands to cover parts of equipment which must be opened for maintenance; include metal vessel covers, fasteners, flanged, frames and accessories.

3.06 GENERAL PIPE INSULATION INSTALLATION:

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.07 INSTALLATION OF CELLULAR-GLASS INSULATION:

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

3.08 INSTALLATION OF MINERAL-FIBER INSULATION:

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4. Install insulation to flanges as specified for flange insulation application.

3.09 FIELD QUALITY CONTROL:

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

F. All insulation applications will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.10 EQUIPMENT INSULATION SCHEDULE:

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Provide equipment insulation as follows:

Equipment	Material	Thickness (inches)
Potable Water Pump	Rigid Cellular Glass Mineral-Fiber Board	3 2
Filter Housing	Rigid Cellular Glass Mineral-Fiber Board	3 2

3.11 PIPING INSULATION SCHEDULE, GENERAL:

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.

2. Underground piping.

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE:

A. Provide indoor piping insulation as follows:

Piping Service	Pipe Size	Thickness (inches)	Material
Potable & non-potable Cold Water	All	1	Mineral Fiber
Potable Hot Water & Circulation	1-1/2 inches and Smaller	1	Mineral Fiber
Potable Hot Water & Circulation	2 inches and Larger	1-1/2	Mineral Fiber
Roof Drain & Overflow	All	1	Mineral Fiber
Roof Drain & Overflow Drain Bodies	All	1-1/2	Mineral Fiber
Sanitary Waste Piping Where Heat Tracing is Installed	All	1-1/2	Mineral Fiber

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE:

A. Provide outdoor, above ground piping insulation as follows:

Piping Service	Pipe Size	Cellular Glass Thickness
Potable & non-potable Cold Water	All	2 inches
Potable Hot Water & Circulation	All	2 inches
Sanitary Waste & Vent	All	1-1/2 inches

3.14 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.

B. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 2 inches thick.

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. PVC: 20 mils thick.

2. Painted Aluminum, Smooth: 0.020 inch thick.

3. Stainless Steel, Type 304 or 316, Smooth 2B Finish or Corrugated: 0.016 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger than 72 Inches:

1. Painted Aluminum, Smooth: 0.032 inch thick.

2. Stainless Steel, Type 304 or 316, Smooth 2B Finish or Corrugated: 0.020 inch thick.

F. Piping, Concealed:

1. None.

G. Piping, Exposed:

1. PVC: 30 mils thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. PVC: 20 mils thick.

2. Painted Aluminum, Smooth: 0.020 inch thick.

3. Stainless Steel, Type 304 or 316, Smooth 2B Finish or Corrugated: 0.016 inch thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Painted Aluminum, Smooth: 0.020 inch thick.

2. Stainless Steel, Type 304 or 316, Smooth 2B Finish or Corrugated: 0.016 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger than 72 Inches:

1. Painted Aluminum, Smooth: 0.032 inch thick.

2. Stainless Steel, Type 304 or 316, Smooth 2B Finish or Corrugated: 0.020 inch thick.

F. Piping, Concealed:

1. PVC: 20 mils thick.

2. Painted Aluminum, Smooth: 0.020 inch thick.

3. Stainless Steel, Type 304 or 316, Smooth 2B Finish or Corrugated: 0.016 inch thick.

G. Piping, Exposed:

1. Painted Aluminum, Smooth: 0.032 inch thick.

2. Stainless Steel, Type 304 or 316, Smooth 2B Finish or Corrugated: 0.020 inch thick.

3.17 UNDERGROUND, FIELD-APPLIED INSULATION JACKET:

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

3.18 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 11 13

FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide water-distribution piping and related components outside the building for water service as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B1.20.1: Pipe Threads, General Purpose (Inch)

2. B16.1: Pipe Flanges and Fittings

3. B16.5: Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

B. American Society of Sanitary Engineering (ASSE):

1. 1060: Performance Requirements for Outdoor Enclosures for Fluid Conveying Components

C. ASTM International (ASTM):

1. D1785: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

2. D2464: Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

3. D2467: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

4. D2774: Standard Practice for Underground Installation of Thermoplastic Pressure Piping

5. D3139: Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

6. F645: Standard Guide for Selection, Design, and Installation of Thermoplastic Water-Pressure Piping Systems

D. American Water Works Association (AWWA):

1. C110/A21.10: Ductile-Iron and Gray-Iron Fittings

2. C111/A21.11: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

3. C153/A21.53: Ductile-Iron Compact Fittings

4. C550: Protective Interior Coatings for Valves and Hydrants.

5. C600: Installation of Ductile-Iron Water Mains and Their Appurtenances.

6. C651: Disinfecting Water Mains

7. C800: Underground Service Line Valves and Fittings.

8. C900: Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution.

9. C907: Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water, Wastewater, and Reclaimed Water Service

10. M23: PVC Pipe - Design and Installation.

11. M44: Distribution Valves: Selection, Installation, Field Testing, and Maintenance

E. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports - Materials and Design.

2. SP-60: Connecting Flange Joints between Tapping Sleeves and Tapping Valves

F. NSF International (NSF):

1. 14: Plastics Piping System Components and Related Materials

2. 61: Drinking Water System Components - Health Effects

3. 372: Drinking Water System Components - Lead Content

G. Underwriters' Laboratories, Inc. (UL):

1.03 DEFINITIONS:

A. PVC: Polyvinyl chloride plastic.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Sustainable Design Submittals.

B. Product Data: For each type of product indicated.

C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sustainability Standards Certifications.

C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

D. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Preparation for Transport: Prepare valves, including hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.

2. Protect valves against damage to threaded ends and flange faces.

3. Set valves in best position for handling. Set valves closed to prevent rattling.

C. During Storage: Use precautions for valves, including hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.

2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

D. Handling: Use sling to handle valves and hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

E. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

F. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

G. Protect flanges, fittings, and specialties from moisture and dirt.

H. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.08 PROJECT/SITE CONDITIONS:

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of service.

2. Do not proceed with interruption of water-distribution service without Owner's written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS:

A. Comply with requirements in "Piping Application" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 PVC PIPE AND FITTINGS:

A. PVC, Schedule 80 Pipe: ASTM D1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D2467.

2. PVC, Schedule 80 Threaded Fittings: ASTM D2464.

B. PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket, and with spigot end.

1. PVC Fabricated Fittings: AWWA C900, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

2. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

3. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Gaskets: AWWA C111, rubber.

4. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.03 JOINING MATERIALS:

A. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.04 PROTECTIVE ENCLOSURES:

A. Freeze-Protection Enclosures:

1. Manufacturers:

a. Aquashield.

b. Hubbell.

c. Safe-T-Cover.

2. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage.

a. Standard: ASSE 1060.

b. Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.

(1) Housing: Reinforced-aluminum construction.

(a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.

(b) Drain opening for units with drain connection.

(c) Access doors with locking devices.

(d) Insulation inside housing.

(e) Anchoring devices for attaching housing to concrete base.

3. Aluminum Enclosures Products:

a. Sectionalized enclosures are factory assembled with tongue and grooved sections that slide together and are then secured to the concrete pad with the supplied anchor pads and wedge anchors.

b. Access panels have a four-point locking system with pad lockable handle and are completely removable.

c. Drain ports are sized for full port backflow discharge and are designed for a one-way operation allowing backflow discharge but not allowing wind, debris and small animals to enter the enclosure.

d. Standard enclosures shall be designed to support a minimum vertical load of 100 lb/sf.

e. Standard enclosures up to 36”W x 105”L x 64”H shall be designed to support wind speeds up to 120 mph, all larger sizes shall be designed to support wind speeds up to 80 mph.

f. Standard enclosures are ASSE 1060 certified.

g. Custom enclosures are designed and constructed in the same manner as standard certified enclosures, but have not been lab tested and listed by ASSE.

4. Materials of Fabrication:

a. Aluminum sheeting shall be 3003 aluminum (.050/18 gauge), stucco embossed finish and shall meet ASTEM B209. Stucco embossed finish reduces the glare and helps hide any surface scratches or imperfections received in the field.

b. Bracing shall be 6063 T52 aluminum and shall meet ASTM B221.

c. No wood or particle board used in the construction of any Hot Box product.

d. Anchor pads shall be galvanized steel. 3/8 16 inch x 2 3/4 long zinc plated wedge anchors are supplied.

e. Insulation shall be approximately 1.5" unicellular, non-wicking, polyisocyanate foam sprayed in place that forms a monolithic bond between the aluminum bracing and aluminum sheeting.

f. The Insulation shall have the following properties:

(1) R-Value: 9

(2) Dimensional Stability: Less than 2 percent linear change

(3) Compressive Strength: 51 psi

(4) Flame Point: 325 degrees

(5) Water Absorption: .037 psf

(6) Porosity: 91 percent

B. Enclosure Bases:

1. Description: 4-inch- minimum thickness precast concrete, of dimensions required to extend at least 6 inches beyond edges of enclosure housings. Include openings for piping.

PART 3 - EXECUTION

3.01 EARTHWORK:

A. Refer to Section 31 23 00 for excavating and backfilling.

3.02 PIPING APPLICATIONS:

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping NPS 3/4 to NPS 10 shall be the following:

1. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.

F. Aboveground Water-Service Piping NPS 3/4 to NPS 4 shall be the following:

1. PVC, Schedule 80 pipe; PVC, Schedule 80 threaded fittings; and threaded joints.

3.03 VALVE APPLICATIONS:

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, non-rising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

B. Drawings indicate valve types to be used.

3.04 PIPING INSTALLATION:

A. Make connections NPS 2 and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.

2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.

3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.

4. Install corporation valves into service-saddle assemblies.

5. Install manifold for multiple taps in water main.

6. Install curb valve in water-service piping with head pointing up and with service box.

B. Install PVC, AWWA pipe according to ASTM F645 and AWWA M23.

C. Bury piping with depth of cover over top at least 30 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least 36 inches cover over top.

2. In Loose Gravelly Soil and Rock: With at least 12 inches additional cover.

D. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

E. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

F. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.05 HEATED ENCLOSURE INSTALLATION:

A. The enclosure shall be installed on a concrete slab, on grade. Slab shall extend a minimum of 9-inces larger than the enclosure exterior dimensions.

B. The enclosure shall be assembled per the manufactures instructions provided with the enclosure.

3.06 JOINT CONSTRUCTION:

A. Make pipe joints according to the following:

1. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D2774 or ASTM D3139 and pipe manufacturer's written instructions.

3.07 ANCHORAGE INSTALLATION:

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.

2. Locking mechanical joints.

3. Heat-fused joints.

4. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

D. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

3.08 CONNECTIONS:

A. Connect water-distribution piping to existing water main. Use tapping sleeve and tapping valve.

B. Connect waste piping from concrete vault drains to storm-drainage system. See Section 33 44 00 for connection to storm-sewer piping.

C. Ground equipment according to Section 26 05 26.

3.09 FIELD QUALITY CONTROL:

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.10 CLEANING:

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.

b. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.

c. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

3.11 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 11 19

PLUMBING PIPING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide plumbing piping specialties as indicated and in compliance with Contract Documents.

1. Backflow preventers.

2. Post hydrants.

3. Drain valves.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. A112.18.1: Plumbing Supply Fittings

2. A112.21.3M: Hydrants for Utility and Maintenance Use

3. B1.20.7: Hose Coupling Screw Threads (Inch)

B. American Society of Sanitary Engineering (ASSE):

1. 1011: Performance Requirements for Hose Connection Vacuum Breakers

2. 1015: Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies

3. 1052: Performance Requirements for Hose Connection Backflow Preventers

C. American Water Works Association (AWWA):

1. C550: Protective Interior Coatings for Valves and Hydrants.

2. SP-110: Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

D. NSF International (NSF):

1. 14: Plastics Piping System Components and Related Materials

2. 61: Drinking Water System Components - Health Effects

3. 372: Drinking Water System Components - Lead Content

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Sustainable Design Submittals.

B. Product Data: For each type of product.

C. Field quality-control reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sustainability Standards Certifications.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES:

A. Potable-water piping and components shall comply with NSF 61 and NSF 14. Mark "NSF-pw" on plastic piping components.

B. Comply with NSF 372 for low lead.

2.02 PERFORMANCE REQUIREMENTS:

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

B. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers:

a. Ames

b. Mifab

c. Watts.

d. Zurn

2. Standard: ASSE 1015.

3. Operation: Continuous-pressure applications unless otherwise indicated.

4. Pressure Loss: 5 psig maximum, through middle third of flow range.

5. Size: 3 inch NPS.

6. Design Flow Rate: 150 gpm.

7. Selected Unit Flow Range Limits: 100-300 gpm.

8. Pressure Loss at Design Flow Rate: 7 psig for sizes NPS 2-1/2 and larger.

9. Body: Ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.

10. End Connections: Flanged for NPS 2-1/2 and larger.

11. Configuration: Designed for horizontal, straight-through flow.

12. Accessories:

a. Valves NPS 2-1/2 inch and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

2.03 POST HYDRANTS:

A. Non-freeze, Draining-Type Post Hydrants:

1. Manufacturers:

a. Mifab.

b. Murdock Manufacturing.

c. Watts.

d. Woodford.

e. Zurn.

2. Standard: ASME A112.21.3M.

3. Type: Non-freeze, exposed-outlet post hydrant.

4. Operation: Removable lever.

5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.

6. Casing: Bronze with casing guard.

7. Inlet: NPS 1-1/2.

8. Outlet: 1-1/2-inch FPT.

9. Drain: 1/8-inch NPT drain hole. Designed with hole to drain into ground when shut off.

10. Vacuum Breaker:

a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.

2.04 DRAIN VALVES:

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.

2. Pressure Rating: 400-psig minimum CWP.

3. Size: NPS 3/4.

4. Body: Copper alloy.

5. Ball: Chrome-plated brass.

6. Seats and Seals: Replaceable.

7. Handle: Vinyl-covered steel.

8. Inlet: Threaded or solder joint.

9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Backflow Preventers: Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in freeze proof enclosure.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.

3. Do not install bypass piping around backflow preventers.

B. Non-freeze, Draining-Type Post Hydrants: Install with 1 cubic yard of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cubic foot of concrete block at grade.

3.02 CONNECTIONS:

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.03 IDENTIFICATION:

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Double-check, backflow-prevention assemblies.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

3.04 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections:

1. Test each double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 22 11 23

PLUMBING PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide plumbing pumps as indicated and in compliance with Contract Documents.

B. Close-coupled, in-line, seal-less centrifugal pumps

C. Separately coupled, in-line centrifugal pumps

D. Sump Pumps:

1. Submersible sump pumps

1.02 REFERENCES:

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 135: A Data Communication Protocol for Building Automation and Control Networks

B. American Society of Mechanical Engineers (ASME):

1. B16.1: Pipe Flanges and Fittings

C. ASTM International (ASTM):

1. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

E. NSF International (NSF):

1. 61: Drinking Water System Components – Health Effects

2. 372: Drinking water System Components – Lead Content

F. Underwriters' Laboratories, Inc. (UL):

1. 778: Motor-Operated Water Pumps

2. 1995: Heating and Cooling Equipment

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Product Data: For each type of product.

a. Include construction details, material descriptions, and dimensions of individual components and profiles.

b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

D. Delegated-Design Submittal: For domestic-water packaged booster pumps.

1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

E. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Retain shipping flange protective covers and protective coatings during storage.

C. Protect bearings and couplings against damage.

D. Comply with pump manufacturer's written instructions for handling.

1.08 COORDINATION:

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. UL Compliance: UL 778 for motor-operated water pumps.

D. Seismic Performance: Inline, domestic-water pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified.

2. Component Importance Factor: 1.5.

2.02 SEPARATELY COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Armstrong Pumps Inc.

2. Bell & Gossett Domestic Pump; ITT Industries

3. Taco, Inc.

B. Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.

C. Pump Construction: All bronze.

D. Casing: Radially split, bronze, with threaded companion-flange connections.

E. Impeller: ASTM B36, rolled brass; or ASTM B584, cast bronze; keyed to shaft.

F. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.

G. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.

H. Bearings: Oil-lubricated; bronze-journal or thrust type.

I. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

J. Motor: Single speed, with oil-lubricated bearings, unless otherwise indicated; and resiliently mounted to pump casing. Comply with requirements in Section 22 05 13.

2.03 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Armstrong Pumps Inc.

2. Bell & Gossett Domestic Pump; ITT Industries

3. Paco Pumps, Inc.

4. Taco, Inc.

B. Factory-assembled and -tested, overhung impeller, single-stage, close-coupled, horizontally mounted, in-line centrifugal pumps as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.

C. Pump Construction: All bronze.

D. Casing: Radially split, cast iron, with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.

E. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.

F. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.

G. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.

H. Bearings: Oil-lubricated; bronze-journal or ball type.

I. Shaft Coupling: Rigid type if pump is provided with coupling.

J. Motor: Single speed, with grease-lubricated ball bearings. Comply with requirements in Section 22 05 13.

2.04 CONTROLS:

A. Pressure Switches: Electric, adjustable for control of water-supply pump.

1. Type: Water-immersion pressure sensor, for installation in piping.

2. Enclosure: NEMA 250, Type 4X.

3. Operation of Pump: On or off.

4. Transformer: Provide if required.

5. Power Requirement: 120 V ac.

2.05 SOURCE QUALITY CONTROL:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. ASME Compliance: Comply with ASME B31.9 for piping.

C. UL Compliance for Packaged Pumping Systems:

1. UL 508, "Industrial Control Equipment"

2. UL 508A, "Industrial Control Panels"

3. UL 778, "Motor-Operated Water Pumps"

4. UL 1995, "Heating and Cooling Equipment"

D. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.02 PUMP INSTALLATION:

A. Pump Installation Standards:

1. Comply with HI 1.4 for installation of centrifugal pumps.

B. Mount pumps in orientation complying with manufacturer's written instructions.

C. Pump Mounting:

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Comply with requirements for vibration isolation and seismic-control devices specified in Section 22 05 48.

6. Comply with requirements for vibration isolation devices specified in Section 22 05 48.13.

D. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.

1. Comply with requirements for vibration isolation devices specified in Section 22 05 48. Fabricate brackets or supports as required.

2. Comply with requirements for hangers and supports specified in Section 22 05 29.

E. Install pressure switches in water-supply piping.

F. Install thermostats in hot-water return piping.

G. Install timers on wall**.**

H. Install time-delay relays in piping between water heaters and hot-water storage tanks.

I. Wiring Method: Comply with requirements in Section 26 05 19.

J. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.03 BOOSTER PUMP INSTALLATION:

A. Booster-Pump Mounting:

1. Install booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00.

B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

3.04 PIPING CONNECTIONS:

A. Comply with requirements for piping specified in Section 22 11 16. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

   a. Horizontally mounted, in-line, separately coupled centrifugal pumps.

   b. Horizontally mounted, in-line, close-coupled centrifugal pumps.

   c. Comply with requirements for flexible connectors specified in Section 22 11 16.

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 22 11 19. Comply with requirements for valves specified in the following:

1. Section 22 05 23

2. Install pressure gauge at suction of each pump and pressure gauge at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 22 05 19.

E. Booster-Pump Piping Connections: Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge piping.

1. Install shutoff valves on piping connections to booster-pump suction and discharge piping. Install ball, butterfly, or gate valves same size as suction and discharge piping. Comply with requirements for general-duty valves specified in Section 22 05 23.

2. Install union, flanged, or grooved-joint connections on suction and discharge piping at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 22 05 00.

3. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge piping. Comply with requirements for domestic-water piping specified in Section 22 11 13.

4. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge piping. Comply with requirements for flexible connectors specified in Section 22 11 13.

5. Where installing piping adjacent to booster pumps, allow space for service and maintenance.

F. Connect water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, separately coupled centrifugal pumps.

b. Horizontally mounted, in-line, close-coupled centrifugal pumps.

c. Comply with requirements for flexible connectors specified in Section 22 11 19.

G. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 22 11 19.

1. Install pressure gauge at suction of each pump and pressure gauge at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges as specified in Section 22 05 19.

3.05 ELECTRICAL CONNECTIONS:

A. Connect wiring according to Section 26 05 19.

B. Ground equipment according to Section 26 05 26.

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.06 CONTROL CONNECTIONS:

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.07 IDENTIFICATION:

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53.

B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.08 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.09 STARTUP SERVICE:

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.

3. Clean strainers on suction piping.

4. Set pressure switches, thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.

5. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.

b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

7. Start motor.

8. Open discharge valve slowly.

9. Adjust temperature settings on thermostats.

10. Adjust timer settings.

3.10 ADJUSTING:

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

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SECTION 22 12 10

PLUMBING TANKS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide welded-steel reservoirs and break tanks for storage and backflow prevention of domestic water as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 7: Minimum Design Loads for Buildings and Other Structures

B. ASTM International (ASTM):

1. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

2. A234: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

3. A767: Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

4. D2240: Standard Test Method for Rubber Property-Durometer Hardness

C. American Welding Society (AWS):

1. D1.1: Structural Welding Code – Steel

2. D1.3: Structural Welding Code – Sheet Steel

3. D1.4: Structural Welding Code – Reinforcing Steel

D. American Water Works Association (AWWA):

1. C652: Disinfection of Water-Storage Facilities

2. D100: Welded Steel Tanks for Water Storage

3. D102: Coating Steel Water-Storage Tanks

4. D103: Factory-Coated Bolted Carbon Steel Tanks for Water Storage

5. M42: Steel Water – Storage Tanks

E. NSF International (NSF):

1. 61: Drinking Water System Components - Health Effects

2. 372: Drinking Water System Components - Lead Content

1.03 DEFINITIONS:

A. Bottom Capacity Level (BCL): Water level above which the specified capacity is provided. In a supported tank (reservoir or standpipe), the BCL is the water level in the tank shell when the tank is emptied through the specified discharge fittings, unless otherwise specified.

B. Capacity: Net volume, in gallons, that may be removed from a tank filled to TCL and emptied to BCL.

C. CR: Chlorosulfonated polyethylene synthetic rubber

D. Minimum Capacity within Operating Range: Capacity when water level is at BCL

E. NR: Natural rubber

F. Range of Head: Vertical distance between TCL and BCL

G. Reservoir: Flat-bottomed, cylindrical, steel water-storage tank with shell height equal to or less than its diameter

H. SDWA: Safe Drinking Water Act

I. Top Capacity Level (TCL): Water level defined by the lip of the overflow elevation

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of potable-water storage tank, include rated capacities, accessories, appurtenances, and furnished specialties.

C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details for each potable-water storage tank, including the following:

1. Tank, roof, and shell openings

2. Safety railings and ladders

3. Plans, elevations, sections, and attachment details

4. Structural analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation

5. Diagram power, signal, and control wiring

D. Qualification Data: For fabricator.

E. Seismic Qualification Data: Certificates, for potable-water storage tanks and components, from manufacturer.

1. Basis for Certification: Include calculation upon which withstand certification is based.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Welding certificates.

G. Field quality-control reports.

H. Operation and Maintenance Data: For each product type.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Fabricator Qualifications: Employ a qualified structural engineer to prepare calculations, Shop Drawings, and other structural data for fabrication and erection of potable-water storage tanks.

1. Engineering Responsibility: Preparation of data for potable-water tanks, accessories, specified appurtenances, and concrete supports and foundations, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel"

2. AWS D1.3, "Structural Welding Code - Sheet Steel"

3. AWS D1.4, "Structural Welding Code - Reinforcing Steel"

D. Pipe Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Structural Performance: Potable-water tank, including structural reinforcement, supports and foundation, shall withstand the effects of dead and live gravity loads.

B. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

C. Seismic Performance: Potable-water storage tank, including structural reinforcement, supports and foundation, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

D. Comply with NSF 61 and NSF 372.

E. Comply with 29 CFR 1910.

2.02 WELDED-STEEL, POTABLE-WATER RESERVOIRS:

A. Description: Manufactured, welded-steel tank with welded-steel plates, bolts, rods, and reinforcing steel.

B. Compliance: AIS Compliance required. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

C. Standard: Designed and fabricated according to AWWA D100 and AWWA M42.

D. Pipe Connections: Comply with AWWA D100. Match size of water-distribution pipe.

E. Overflow Piping: ASTM A53, Grade B, Schedule 40, welded-steel pipe with ASTM A234, Grade WPB, Schedule 40, carbon-steel butt-weld fittings.

F. Tank Vent: Steel pipe with stainless-steel screen, constructed to prevent entrance of air-borne contaminants.

G. Foundation: Reinforced concrete. See Section 03 30 00.

2.03 PAINT MATERIALS:

A. Paint: Comply with AWWA D102.

B. Primer: Tank fabricator's epoxy-polyamide paint.

C. Tank Shell Interior Finish Paint: Tank fabricator's epoxy-polyamide paint complying with NSF 61 and NSF 372, and compatible with prime coat.

D. Tank Shell Exterior Intermediate Paint: Tank fabricator's epoxy-polyamide paint compatible with prime and finish paint. Intermediate coat shall have a slight color contrast with finish coat.

E. Tank Shell Exterior Finish Paint: Tank fabricator's urethane paint.

2.04 SHOP PAINTING:

A. Factory coating according to AWWA D103.

B. Tank Shell Interior Finish Coat: Comply with NSF 61 and NSF 372.

C. Tank Shell Exterior Finish Coat: Factory coating according to AWWA D103.

2.05 POTABLE-WATER STORAGE TANK APPURTENANCES:

A. Water-Level Controls: Automatic controls for maintaining water level in tank, with valves, piping, and audible and visual alarms to indicate the following:

1. High- and low-water levels

2. Tank overflowing or tank not filling

PART 3 - EXECUTION

3.01 STEEL, POTABLE-WATER STORAGE TANK INSTALLATION:

A. Welded-Steel Tanks:

1. Erect tank shell, accessories, and appurtenances according to AWWA D100 and AWWA M42.

2. Fabricate steel plate sections in the shop. Erect tank shell by welding plate sections in the field.

B. Install tank vent at center of roof.

C. Install two maintenance holes in tank wall near grade.

3.02 PIPING CONNECTIONS:

A. Connect tanks to water-distribution piping.

B. Connect drains to storm-drainage piping.

C. Surface preparation is specified in Section 09 90 00.

D. Apply paint according to AWWA D102.

E. Prime-Coat Touchup: Apply primer to cleaned areas and where shop finish has been damaged during shipping, handling, and erection. Apply prime coat to a dry film thickness of 3.0 to 5.0 mils for tank interior and to a dry film thickness of 2.0 to 3.0 mils for exterior tank and support surfaces.

F. Tank Shell and Steel Support Exterior Coats: Apply intermediate paint to a dry film thickness of 2.0 to 3.0 mils. Apply finish paint to a dry film thickness of 2.0 to 3.0 mils.

G. Tank Exterior Lettering and Logo: Apply two coats of urethane paint to a dry film thickness of 2.0 to 3.0 mils for each application.

H. Overflow Pipe: Paint pipe exterior that is outside tank and structure as indicated for tank exterior.

I. Do not paint if ambient temperature is less than 50 degrees F or is expected to drop below 40 degrees F in the next 18 hours. Do not paint if temperature of steel surface is higher than 125 degrees F. Do not apply paint if surfaces are wet or damp, if precipitation is expected, or if relative humidity will exceed 85 percent. Do not spray paint when wind velocity exceeds 15 mph. Maintain at least a 24-hour waiting period between coats. Provide adequate ventilation in tank during painting to maintain clear atmosphere and provide explosion-proof flood lighting and spot lighting.

J. Complete daily painting to allow time for paint to dry before condensation is expected.

3.03 SURFACE WATER-STORAGE TANK APPURTENANCE INSTALLATION:

A. Install and adjust water-level control valves, piping, and alarms.

3.04 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections.

1. Leak Test: Comply with AWWA D100. Fill tanks with potable water and test for leaks after installation. Repair leaks and retest until no leaks exist.

a. Water will be furnished by Owner.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Unit will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.05 CLEANING:

A. Clean interior and exterior of potable-water storage tanks.

3.06 DEMONSTRATION:

A. Train Owner's maintenance personnel to adjust, operate, and maintain the following:

1. Water-level controls

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide sanitary waste and vent piping as indicated and in compliance with Contract Documents.

1. Hubless, cast-iron soil pipe and fittings

2. PVC pipe and fittings

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 7: Minimum Design Loads for Buildings and Other Structures

B. American Society of Mechanical Engineers (ASME):

1. B16.4: Gray Iron Threaded Fittings Classes 125 and 250

2. B16.12: Cast Iron Threaded Drainage Fittings

3. B16.45: Cast Iron Fittings for Solvent Drainage Systems

4. B18.2.1: Square and Hex Bolts and Screws (Inch Series)

C. ASTM International (ASTM):

1. A47: Standard Specification for Ferritic Malleable Iron Castings

2. A48: Specification for Gray Iron Castings

3. A74: Standard Specification for Cast Iron Soil Pipe and Fittings

4. A536: Standard Specification for Ductile Iron Castings

5. A888: Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

6. C564: Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

7. C1173: Standard Specification for Flexible Transition Couplings for Underground Piping Systems

8. C1277: Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings

9. C1460: Standard Specification for Shielded Transition Couplings for Use With Dissimilar DWV Pipe and Fittings Above Ground

10. C1540: Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings

11. D2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

12. D2564: Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

13. D2665: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

14. D2855: Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets

15. D3311: Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns

16. D5926: Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems

17. F402: Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

18. F477: Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

19. F656: Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

20. F891: Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core

21. F1476: Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

D. American Water Works Association (AWWA):

1. C110/A21.10: Ductile-Iron and Gray-Iron Fittings

2. C151/A21.51: Ductile-Iron Pipe, Centrifugally Cast

3. C153/A21.53: Ductile-Iron Compact Fittings

4. C219: Bolted Sleeve-Type Couplings for Plain-End Pipe

5. C606: Grooved and Shouldered Joints

E. Cast Iron Soil Pipe Institute (CISPI):

1. Cast Iron Soil Pipe and Fittings Handbook

2. 301: Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

3. 310: Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

D. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control reports.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.08 PROJECT/SITE CONDITIONS:

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

1.09 WARRANTY:

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water

B. AIS Compliance of these materials is required. Refer to Section 22 05 00, 1.01 E for description.

C. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.02 PIPING MATERIALS:

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in Table 22 13 16-1 "Plumbing Waste and Vent Piping Schedule" for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS:

A. See Section 40 23 19.05 for Pipe and fitting specifications.

B. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufac-turer if Basis of Design cannot certify AIS compliance.

C. Pipe and Fittings: ASTM A888 or CISPI 301

D. Heavy-Duty, Hubless-Piping Couplings:

1. Standards: ASTM C1277 and ASTM C1540

2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

3. Manufacturers:

a. Tyler Pipe and Coupling

b. ANACO-Husky

c. Dallas Specialty

d. Fernco Inc.

e. MIFAB, Inc.

2.04 PVC PIPE AND FITTINGS:

A. See Section 40 23 19.05 for Pipe and fitting specifications.

2.05 SPECIALTY PIPE FITTINGS:

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

3. Shielded, Non-pressure Transition Couplings:

    a. Manufacturers:

        (1) Tyler Pipe and Coupling

        (2) ANACO-Husky

        (3) Dallas Specialty

        (4) Fernco Inc.

        (5) MIFAB, Inc.

    b. Standard: ASTM C1460

    c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

    d. End Connections: Same size as and compatible with pipes to be joined.

4. Pressure Transition Couplings:

    a. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

    b. Manufacturers:

        (1) Tyler Pipe and Coupling

        (2) ANACO-Husky

        (3) Dallas Specialty

        (4) Fernco Inc.

        (5) MIFAB, Inc.

    c. Standard: AWWA C219

    d. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

    e. Center-Sleeve Material: Manufacturer's standard

    f. Gasket Material: Natural or synthetic rubber

g. Metal Component Finish: Corrosion-resistant coating or material

PART 3 - EXECUTION

3.01 EARTH MOVING:

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 23 33.

3.02 PIPING INSTALLATION:

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.

2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48.

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.

2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.

4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.

2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.

3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A674 or AWWA C105/A 21.5.

O. Install underground PVC piping according to ASTM D2321.

P. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.

3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

3.03 JOINT CONSTRUCTION:

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

E. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

G. Plastic, Non-pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendixes.

3. PVC Piping: Join according to ASTM D2855 and ASTM D2665 appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION:

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.

2. In Waste Drainage Piping: Unshielded, non-pressure transition couplings.

3. In Aboveground Forcemain Piping: Fitting-type transition couplings.

4. In Underground Forcemain Piping:

a. NPS 1-1/2 and Smaller: Fitting-type transition couplings

b. NPS 2 and Larger: Pressure transition couplings

3.05 INSTALLATION OF HANGERS AND SUPPORTS:

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48.

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29.

1. Vertical Piping: MSS Type 8 or Type 42, clamps

2. Install individual, straight, horizontal piping runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers

b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers

c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze

4. Base of Vertical Piping: MSS Type 52, spring hangers

C. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

F. Support vertical runs of cast iron soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.06 CONNECTIONS:

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

5. Install horizontal backwater valves in pit with pit cover flush with floor.

6. Comply with requirements for backwater valves cleanouts and drains specified in Section 22 13 19.

7. Equipment: Connect waste piping as indicated.

a. Provide shutoff valve if indicated and union for each connection.

b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.07 IDENTIFICATION:

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 22 05 53.

3.08 FIELD QUALITY CONTROL:

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.

b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.

c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.

b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.

c. Air pressure must remain constant without introducing additional air throughout period of inspection.

d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.09 CLEANING AND PROTECTION:

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

Table 22 13 16-1 – Plumbing Waste and Vent Piping Schedule							
Service	**Size (in)**	**Pipe Matl**	**Fittings**	**Gasket**	**Joint Type**	**Location**	**Remarks**
Sanitary Vent	All	CAST IRON, CISPI 301	Cast-Iron	Neoprene rubber with stainless clamp/shield	No-Hub CISPI 310	All	For process areas typically use 3" and greater Class 53 DIP ceramic epoxy lined or less than 3" 316 SS sched 40
Sanitary Sewer	All	CAST IRON, CISPI 301	Cast-Iron	Neoprene rubber with stainless clamp/shield	No-Hub CISPI 310	Inside Exposed, Encased, Buried within building footprint	For process areas typically use 3" and greater Class 53 DIP cement lined
Sanitary Sewer	All	PVC	PVC	N/A	Solvent Weld	Buried within building foot print (NON-Encased)	

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide sanitary waste and vent piping specialties as indicated and in compliance with Contract Documents.

1. Backwater valves

2. Cleanouts

3. Floor drains.

4. Floor sinks.

5. Roof flashing assemblies

6. Through-penetration firestop assemblies

7. Miscellaneous sanitary drainage piping specialties

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. A112.1.2: Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)

2. A112.14.1: Backwater Valves

3. A112.36.2M: Cleanouts

B. American Society of Sanitary Engineering (ASSE):

1. 1050: Performance Requirements for Stack Air Admittance Valves for Sanitary Drainage Systems

2. 1051: Performance Requirements for Individual and Branch Type Air Admittance Valves for Sanitary Drainage Systems

C. ASTM International (ASTM):

1. A48: Specification for Gray Iron Castings.

2. A74: Standard Specification for Cast Iron Soil Pipe and Fittings

3. C564: Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

D. NSF International (NSF):

1. 14: Plastics Piping System Components and Related Materials

E. Underwriters' Laboratories, Inc. (UL):

1. 1479: Standard for Safety Fire Tests of Through-Penetration Firestops

1.03 DEFINITIONS:

A. PVC: Polyvinyl chloride

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product. Include rated capacities, operating characteristics, and accessories.

C. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.

D. Field quality-control reports.

E. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTIONS:

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

C. AIS Compliance of the steel and iron components in this Section materials is required. Refer to Section 22 05 00, 1.01 E for description.

2.02 BACKWATER VALVES:

A. Horizontal, Cast-Iron Backwater Valves:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. MIFAB, Inc.

b. Zurn

3. Standard: ASME A112.14.1.

4. Size: Same as connected piping.

5. Body: Cast iron.

6. Cover: Cast iron with bolted access check valve.

7. End Connections: Hub and spigot or hubless.

8. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.

9. Extension: ASTM A74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Horizontal, Plastic Backwater Valves:

1. Manufacturers:

a. Ferguson

2. Size: Same as connected piping.

3. Body: PVC.

4. Cover: Same material as body with threaded access to check valve.

5. Check Valve: Removable swing check.

6. End Connections: Socket type.

2.03 CLEANOUTS:

A. Cast-Iron Exposed Cleanouts:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Standard: ASME A112.36.2M.

3. Size: Same as connected drainage piping

4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.

5. Closure: cast-iron plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.

3. Size: Same as connected branch.

4. Type: Heavy-duty, adjustable housing.

5. Body or Ferrule: Cast iron.

6. Clamping Device: Required.

7. Outlet Connection: Threaded.

8. Closure: Cast-iron plug.

9. Adjustable Housing Material: Cast iron with threads.

10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.

11. Frame and Cover Shape: Round.

12. Top Loading Classification: Extra Heavy Duty.

13. Riser: ASTM A74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Standard: ASME A112.36.2M. Include wall access.

3. Size: Same as connected drainage piping.

4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.

5. Closure Plug:

a. Cast iron

b. Countersunk head

c. Drilled and threaded for cover attachment screw

d. Size: Same as or not more than one size smaller than cleanout size

6. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.

D. Plastic Floor Cleanouts:

1. Size: Same as connected branch

2. Body: PVC

3. Closure Plug: PVC

4. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping

2.04 FLOOR DRAINS:

A. Cast-Iron Floor Drains:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Josam Company.

b. MIFAB, Inc.

c. WATTS.

d. Zurn Industries, LLC.

3. Standard: ASME A112.6.3.

4. Pattern: Floor drain.

5. Body Material: Gray iron.

6. Outlet: Bottom.

7. Top or Strainer Material: Bronze.

8. Top of Body and Strainer Finish: Nickel bronze.

9. Top Shape: Square.

10. Top Loading Classification: Heavy Duty.

B. Stainless-Steel Floor Drains, ASME A112.3.1

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Josam Company.

b. MIFAB, Inc.

c. WATTS.

d. Zurn Industries, LLC.

3. Outlet: Bottom.

4. Top or Strainer Material: Stainless steel.

5. Top Shape: Round.

C. Plastic Floor Drains:

1. Manufacturers:

a. Jay R. Smith Mfg Co; a division of Morris Group International.

b. Josam Company.

c. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.

3. Material: ABS or PVC.

4. Outlet: Bottom.

5. Top or Strainer Material: Plastic.

6. Top Shape: Round.

2.05 FLOOR SINKS

A. Cast-Iron Floor Sinks:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Jay R. Smith Mfg Co; a division of Morris Group International.

b. Josam Company.

c. WATTS.

d. Zurn Industries, LLC.

3. Standard: ASME A112.6.7.

4. Pattern: Floor drain.

5. Body Material: Cast iron.

6. Outlet: Bottom, no-hub connection.

7. Top Grate Material: Cast iron, loose.

8. Top of Body and Grate Finish: Nickel bronze.

9. Top Shape: Square.

10. Top Loading Classification: No traffic.

B. Stainless-Steel Floor Sinks, ASME A112.6.7:

1. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

2. Manufacturers:

a. Jay R. Smith Mfg Co; a division of Morris Group International.

b. Josam Company.

c. WATTS.

d. Zurn Industries, LLC.

3. Standard: ASME A112.6.7.

4. Pattern: Floor drain.

5. Body Material: Stainless steel.

6. Outlet: Bottom, no-hub connection.

7. Top Grate Material: Stainless steel, loose.

8. Top of Body and Grate Finish: Stainless steel.

9. Top Shape: Square.

10. Top Loading Classification: No traffic.

C. Plastic Floor Sinks:

1. Manufacturers:

a. Jay R. Smith Mfg Co; a division of Morris Group International.

b. Josam Company.

c. Zurn Industries, LLC.

2. Standard: ASME A112.6.7.

3. Pattern: Floor drain.

4. Body Material: PVC.

5. Outlet: Bottom, PVC primer and solvent cement connection.

6. Top Grate Material: PVC.

7. Top Shape: Square.

8. Top Loading Classification: No traffic.

2.06 ROOF FLASHING ASSEMBLIES:

A. Roof Flashing Assemblies.

1. assembly made of 6.0-lb/sq. ft., 0.0938-inch- thick, lead flashing collar and skirt extending at least 10 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

a. Open-Top Vent Cap: Without cap.

2.07 THROUGH-PENETRATION FIRESTOP ASSEMBLIES:

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve-and-stack fitting with firestopping plug.

2. Size: Same as connected soil, waste, or vent stack.

3. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

4. Special Coating: Corrosion resistant on interior of fittings.

2.08 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES:

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.

2. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

3. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.

2. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

3. Size: Same as connected waste piping.

a. NPS 2: 4-inch-minimum water seal

b. NPS 2-1/2 and Larger: 5-inch-minimum water seal

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

2. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

3. Size: Same as floor drain outlet with NPS 1/2 side inlet

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. Body: Bronze or cast iron.

3. Inlet: Opening in top of body.

4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.

2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.6.4

2. Compliance: AIS Compliance required. Manufacturer listed is the Basis of Design for performance product requirements. Contractor to submit compliant manufacturer if Basis of Design cannot certify AIS compliance.

3. Body: Cast iron with bronze sleeve, packing, and gland

4. End Connections: Matching connected piping

5. Size: Same as connected soil, waste, or vent piping

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Equipment Mounting:

1. Comply with requirements for vibration-isolation and seismic-control devices specified in Section 22 05 48.

2. Comply with requirements for vibration-isolation devices specified in Section 22 05 48.

B. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

4. Locate at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install fixture air-admittance valves on fixture drain piping.

G. Install stack air-admittance valves at top of stack vent and vent stack piping.

H. Install air-admittance-valve wall boxes recessed in wall.

I. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 07 60 00.

J. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 07 60 00.

K. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations. Comply with requirements in Section 07 84 00.

L. Assemble open drain fittings and install with top of hub 2 inches above floor.

M. Install deep-seal traps on floor drains and other waste outlets, if indicated.

N. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

2. Size: Same as floor drain inlet.

O. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

P. Install sleeve and sleeve seals with each riser and stack passing through floors with water-proof membrane.

Q. Install vent caps on each vent pipe passing through roof.

R. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

S. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

T. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

U. Assemble components of FOG disposal systems and install on floor.

1. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction.

2. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated.

3. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.

V. Install wood-blocking reinforcement for wall-mounting-type specialties.

W. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.02 CONNECTIONS:

A. Comply with requirements in Section 22 13 16 for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Ground equipment according to Section 26 05 26.

D. Connect wiring according to Section 26 05 20.

3.03 FLASHING INSTALLATION:

A. Comply with requirements in Section 07 60 00.

B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.

C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.

3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

D. Set flashing on floors and roofs in solid coating of bituminous cement.

E. Secure flashing into sleeve and specialty clamping ring or device.

F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 60 00.

G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.04 LABELING AND IDENTIFYING:

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. FOG disposal systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 22 05 53.

3.05 FIELD QUALITY CONTROL:

A. Perform tests and inspections, and prepare test reports.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.06 PROTECTION:

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.07 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 22 34 00

DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide electric, instantaneous potable water heaters as indicated and in compliance with Contract Documents.

1. Section Includes:

a. Flow-control, instantaneous electric water heaters.

b. Water heater accessories.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. Z21.22: Relief Valves for Hot Water Supply Systems

B. American Society of Mechanical Engineers (ASME):

1. B1.20.1: Pipe Threads, General Purpose (Inch)

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code

D. NSF International (NSF):

1. 5: Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment

2. 61: Drinking Water System Components - Health Effects

3. 372: Drinking Water System Components - Lead Content

E. Underwriters' Laboratories, Inc. (UL):

1. 1453: Standard for Electric Booster and Commercial Storage Tank Water Heaters

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:

1. Submit manufacturer's assembly type shop drawings indicating dimensions, required clearances, and methods of assembly of components.

2. Wiring Diagrams: Submit manufacturer's electrical requirements for electrical power supply wiring to water heaters. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory-installed and portions that are to be field-installed.

D. Seismic Qualification Data:

1. Certificates: For water heat exchangers, accessories, and components, from manufacturer.

E. Product Certificates: For each type of water heater.

F. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

G. Source quality-control reports.

H. Field quality-control reports.

I. Warranty: Sample of special warranty.

J. Operation and Maintenance Data: For each type of water heater to include in emergency, operation, and maintenance manuals.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.08 COORDINATION:

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.09 WARRANTY:

A. Warranty on Coil, Heat Exchanger, and Burner: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, coils, heat exchangers, and burners with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only and does not include labor for removal and reinstallation.

B. Warranty Period: 5 years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. Seismic Performance: Commercial domestic-water heaters and domestic-water heat exchangers shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.02 FLOW-CONTROL, INSTANTANEOUS ELECTRIC WATER HEATERS:

A. Comply with UL 499 for tankless electric (water heater) heating appliance.

B. Manufacturers:

1. Chronomite Laboratories, Inc.

2. Controlled Energy Corporation.

3. Eemax, Inc.

4. Hot Aqua, Inc.

5. IMI Waterheating, Ltd.

6. Stiebel Eltron, Inc.

C. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.

1. Connections: ASME B1.20.1 pipe thread.

2. Pressure Rating: 150 PSIG.

3. Heating Element: Resistance heating system.

4. Temperature Control: Flow-control fitting.

5. Safety Control: High-temperature-limit cutoff device or system.

6. Jacket: Aluminum or steel with enameled finish or plastic.

D. Support: Bracket for wall mounting.

E. Capacity and Characteristics: See plans

2.03 DOMESTIC-WATER HEATER ACCESSORIES:

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.

C. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

E. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-PSIG- (172.5-kPa-) maximum outlet pressure, unless otherwise indicated.

F. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

2.04 SOURCE QUALITY CONTROL:

A. Factory Tests: Test and inspect assembled water heaters and storage tanks specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

B. Water heaters will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 WATER HEATER INSTALLATION

A. General: Install water heaters in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances

B. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

C. Piping: Connect hot and cold water piping to units with shutoff valves and unions. Connect recirculating water line to unit with shutoff valve, check valve, and union. Extend relief valve discharge to closet floor drain, or as indicated.

D. Install water regulator, with integral bypass relief valve, in booster-heater inlet piping and water hammer arrester in booster-heater outlet piping.

E. Fill water heaters with water.

3.02 PIPING CONNECTIONS:

A. Comply with requirements for water piping specified in Section 22 11 13

B. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Ground equipment according to Division 26.

D. Connect wiring according to Division 26.

3.03 IDENTIFICATION:

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53.

3.04 FIELD QUALITY CONTROL:

A. Perform Tests and Inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

b. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2. Water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 45 00 for retesting and re-inspecting requirements and Section 22 05 00 for requirements for correcting the Work.

3. Prepare test and inspection reports.

3.05 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water heat exchangers.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 22 42 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide plumbing fixtures as indicated and in compliance with Contract Documents.

1. Commercial Water Closets:

a. Water closets

b. Flushometer valves and tanks

c. Toilet seats

d. Supports

2. Commercial Lavatories:

a. Lavatories

b. Faucets

c. Supply fittings

d. Waste fittings

e. Supports

3. Commercial Sinks:

a. Service sinks

b. Utility sinks

c. Sample sinks

d. Sink faucets

e. Supports

f. Supply fittings

g. Waste fittings

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. A117.1: Accessible and Usable Buildings and Facilities

2. SS-1: Performance Standard for Solid Surface Materials

B. American Society of Mechanical Engineers (ASME):

1. A112.18.1: Plumbing Supply Fittings

2. A112.18.2: Plumbing Waste Fittings

3. A112.18.3: Performance Requirements for Backflow Protection Devices and Systems in Plumbing Fixture Fittings

4. A112.18.6: Flexible Water Connectors

5. A112.19.1: Enameled Cast Iron and Enameled Steel Plumbing Fixtures

6. A112.19.2: Ceramic Plumbing Fixtures

7. A112.19.3: Stainless Steel Plumbing Fixtures

8. A112.19.5: Flush Valves and Spuds for Water Closets, Urinals, and Tanks

9. B1.20.7: Hose Coupling Screw Threads (Inch)

C. American Society of Sanitary Engineering (ASSE):

1. 1016: Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations

2. 1037: Performance Requirements for Pressurized Flushing Devices for Plumbing Fixtures

D. ASTM International (ASTM):

1. A1045: Standard Specification for Flexible Poly (Vinyl Chloride) (PVC) Gaskets used in Connection of Vitreous China Plumbing Fixtures to Sanitary Drainage Systems

E. International Association of Plumbing and Mechanical Officials (IAPMO):

1. IGC 156: Wash Fountains and Lavatory Systems with or without Water Closets

2. PS 99: Terrazzo, Marble, Concrete, Granite, and Slate Plumbing Fixtures

F. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

G. NSF International (NSF):

1. 61: Drinking Water System Components – Health Effects

2. 372: Drinking water System Components – Lead Content

H. Underwriters' Laboratories, Inc. (UL):

1. 1951: Standard for Safety Electric Plumbing Accessories

1.03 DEFINITIONS:

A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.

B. Remote Water Closet: Located more than from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.

C. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

D. Tepid: Moderately warm.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fixtures.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

4. Include diagrams for power, signal, and control wiring.

D. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

E. Field quality-control test reports.

F. Operation and Maintenance Data to include in operation and maintenance manuals.

G. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.

2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

3. Flushing-Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 WALL-MOUNTED WATER CLOSETS:

A. Water Closets (WC-1): Wall mounted, top spud.

1. Manufacturers:

a. American Standard

b. Briggs Plumbing Products, Inc.

c. Capizzi

d. Crane Plumbing, LLC.

e. FNW; Ferguson Enterprises, Inc.

f. Gerber Plumbing Fixtures LLC.

g. Kohler Company

h. Mansfield Plumbing Products LLC.

i. Peerless Pottery Sales, Inc.

j. Sloan Valve Company

k. TOTO USA, Inc.

l. Zurn Industries, LLC

2. Bowl:

a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.

b. Material: Vitreous china.

c. Type: Siphon jet.

d. Style: Flushometer valve.

e. Height: Standard.

f. Rim Contour: Elongated.

g. Water Consumption: 1.6 gallons per flush.

h. Spud Size and Location: NPS 1-1/2; top.

3. Water-Closet Mounting Height: See Architectural Drawings.

2.02 FLUSHOMETER VALVES:

A. Lever-Handle, Piston Flushometer Valves:

1. Manufacturers:

a. American Standard

b. Delany Products

c. Kohler Company

d. Sloan Valve Company

e. TOTO USA, Inc.

f. Zurn Industries, LLC.

2. Standard: ASSE 1037.

3. Minimum Pressure Rating: 125 psig.

4. Features: Include integral check stop and backflow-prevention device.

5. Material: Brass body with corrosion-resistant components.

6. Exposed Flushometer-Valve Finish: Chrome plated.

7. Panel Finish: Chrome plated or stainless steel.

8. Style: Exposed.

9. Consumption: 1.28 gallons per flush.

10. Minimum Inlet: NPS 1.

11. Minimum Outlet: NPS 1-1/4.

2.03 TOILET SEATS:

A. Toilet Seats:

1. Manufacturers:

a. American Standard

b. Bemis Manufacturing Company

c. Kohler Company

d. TOTO USA, Inc.

e. Zurn Industries, LLC.

2. Standard: IAPMO/ANSI Z124.5.

3. Material: Plastic.

4. Type: Commercial (Heavy duty).

5. Shape: Elongated rim, open front.

6. Hinge: Self-sustaining.

7. Hinge Material: Non-corroding metal.

8. Seat Cover: Not required.

9. Color: White.

2.04 SUPPORTS:

A. Water Closet Carrier:

1. Manufacturers:

a. Josam Company

b. Zurn Industries, LLC.

2. Standard: ASME A112.6.1M.

3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

2.05 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES:

A. Lavatory: Ledge back, vitreous china, wall mounted.

1. Manufacturers:

a. American Standard

b. Briggs Plumbing Products, Inc.

c. Gerber Plumbing Fixtures LLC.

d. Kohler Company

e. Mansfield Plumbing Products LLC.

f. Peerless Pottery Sales, Inc.

g. Sloan Valve Company

2. Fixture:

a. Standard: ASME A112.19.2/CSA B45.1.

b. Type: For wall hanging.

c. Nominal Size: Rectangular, 20 by 18.

d. Faucet-Hole Punching: One hole.

e. Faucet-Hole Location: Top.

f. Color: White.

g. Mounting Material: Chair carrier.

3. Faucet: See Plumbing Drawings.

4. Support: Type I, exposed-arm lavatory carrier.

5. Lavatory Mounting Height: See Architectural Drawings.

2.06 SOLID-BRASS, MANUALLY OPERATED FAUCETS:

A. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.

B. Lavatory Faucets: Manual-type, two-handle mixing, commercial, solid-brass valve.

1. Manufacturers:

a. American Standard

b. Delta Faucet Company

c. Elkay Manufacturing Company

d. Gerber Plumbing Fixtures LLC.

e. Kohler Company

f. Moen Incorporated

g. Zurn Industries, LLC.

2. Standard: ASME A112.18.1/CSA B125.1.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.

4. Body Type: Widespread.

5. Body Material: Commercial, solid brass.

6. Finish: Polished chrome plate.

7. Maximum Flow Rate: 0.5 gpm.

8. Maximum Flow: 0.25 gallon per metering cycle.

9. Mounting Type: Back/wall, exposed.

10. Valve Handle(s):Wrist blade, 4 inches.

11. Spout: Rigid type.

12. Spout Outlet: Laminar flow.

13. Operation: Compression, manual.

14. Drain: Not part of faucet.

2.07 WASTE FITTINGS:

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/4.

2. Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.

2.08 SUPPLY FITTINGS:

A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Wheel handle.

F. Risers:

1. NPS 3/8.

2. ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

2.09 SERVICE SINKS:

A. Service Sinks: Enameled, cast iron, floor mounted, corner sink.

1. Manufacturers:

a. Zurn Industries, LLC.

2. Fixture:

a. Standard: ASME A112.19.1/CSA B45.2.

b. Style: With front apron and raised back.

c. Nominal Size: 28 by 28 inches.

d. Color: White.

e. Drain: Grid with NPS 3 outlet.

f. Rim Guard: Coated wire.

3. Faucet: See Plumbing Drawings.

2.10 UTILITY SINKS:

1. Supply Fittings:

a. Standard: ASME A112.18.1/CSA B125.1.

b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

(1) Operation: Wheel handle.

(2) Risers: NPS 1/2, ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

2. Waste Fittings:

a. Standard: ASME A112.18.2/CSA B125.2.

b. Trap(s):

(1) Size: NPS 2.

B. Sample Sinks: Stainless steel, freestanding with drainboard.

1. Manufacturers:

a. Advance Tabco

b. Eagle Group

c. Elkay Manufacturing Company

d. Griffin Products, Inc.

e. Just Manufacturing

2. Fixture:

a. Standard: ASME A112.19.3/CSA B45.4.

b. Type: With backsplash.

c. Number of Compartments: One.

d. Overall Dimensions: 55-1/2 inches x 27-1/2 inches x 14 inches.

e. Metal Thickness: 14-gauge.

f. Compartment:

(1) Dimensions: 30 inches x 24 inches x 14 inches.

(2) Drain: Grid with NPS 2 tailpiece and twist drain.

(3) Drain Location: Centered in compartment.

g. Drainboard(s): Right side.

(1) Dimensions Each: 24 inches x 24 inches

3. Supports: Adjustable-length steel legs.

4. Faucet(s): See Plumbing Drawings.

a. Number Required: One.

b. Mounting: On backsplash.

5. Supply Fittings:

a. Standard: ASME A112.18.1/CSA B125.1.

b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

(1) Operation: Wheel handle.

(2) Risers: NPS 1/2, ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

6. Waste Fittings:

a. Standard: ASME A112.18.2/CSA B125.2.

b. Trap(s):

(1) Size: NPS 2.

(2) Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

2.11 SINK FAUCETS:

A. NSF Standard: Comply with NSF 372 for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets: Manual type, two lever handle mixing valve.

1. Commercial, Solid-Brass Faucets.

a. Manufacturers:

(1) American Standard

(2) Bradley Corporation

(3) Elkay Manufacturing Company

(4) Kohler Company

(5) Moen Incorporated

(6) Sloan Valve Company

(7) Zurn Industries, LLC.

2. General-Duty, Solid-Brass Faucets:

a. Manufacturers:

(1) American Standard

(2) Bradley Corporation

(3) Elkay Manufacturing Company

(4) Kohler Company

(5) Moen Incorporated

(6) Zurn Industries, LLC.

3. Standard: ASME A112.18.1/CSA B125.1.

4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

5. Body Type: Centerset.

6. Body Material: Commercial, solid brass.

7. Finish: Polished chrome plate.

8. Maximum Flow Rate: 2.2 gpm.

9. Handle(s): Wrist blade, 4 inches.

10. Mounting Type: Deck, exposed.

11. Spout Type: Rigid, solid brass.

12. Spout Outlet: Aerator.

C. Sink Faucets: Manual type, mop sink two lever handle mixing valve.

1. Commercial, Solid-Brass Faucets.

a. Manufacturers:

(1) American Standard

(2) Bradley Corporation

(3) Elkay Manufacturing Company

(4) Kohler Company

(5) Moen Incorporated

(6) Sloan Valve Company

(7) Zurn Industries, LLC.

2. General-Duty, Solid-Brass Faucets:

a. Manufacturers:

(1) American Standard

(2) Bradley Corporation

(3) Elkay Manufacturing Company

(4) Kohler Company

(5) Moen Incorporated.

(6) Zurn Industries, LLC.

3. Standard: ASME A112.18.1/CSA B125.1.

4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

5. Body Type: Centerset.

6. Body Material: Commercial, solid brass.

7. Finish: Polished chrome plate.

8. Maximum Flow Rate: 2.2 gpm.

9. Handle(s): Wrist blade, 4 inches.

10. Mounting Type: Deck, exposed.

11. Spout Type: Rigid, solid brass.

12. Vacuum Breaker: Required for hose outlet.

13. Spout Outlet: Hose thread according to ASME B1.20.7.

2.12 WATER-TEMPERING EQUIPMENT:

A. Hot- and Cold-Water, Water-Tempering Equipment (TMV):

1. Manufacturers:

a. Acorn Engineering Company

b. Bradley Corporation

c. Guardian Equipment Company

d. Haws Corporation

2. Description: Factory-fabricated equipment with thermostatic mixing valve.

a. Thermostatic Mixing Valve: Designed to provide 65 to 95 degrees F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 degrees F throughout required 15-minute test period, and in

case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

b. Supply Connections: For hot and cold water.

2.13 SUPPLEMENTAL EQUIPMENT:

A. Freeze-Proof Yard Hydrant:

1. Provide freeze-proof yard hydrant with inlet and nozzle size as indicated on drawings. Hydrant shall have galvanized steel pipe casing and be provided with 1/8-inch drain hole. Hydrant valve shall have a bury depth of 3 feet. Provide hydrant that can be maintained and serviced without excavation. Woodford MFG Model IOWA Y1.

2.14 SOURCE QUALITY CONTROL:

A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

2.15 GROUT:

A. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Non-shrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 COMMERCIAL WATER CLOSET INSTALLATION:

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.

2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.

3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.

2. Use carrier supports with waste-fitting assembly and seal.

3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.

4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.

2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.

2. Install deep-pattern escutcheons if required to conceal protruding fittings.

3. Comply with escutcheon requirements specified in Section 22 05 00.

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.

2. Match sealant color to water-closet color.

3. Comply with sealant requirements specified in Section 07 92 00.

3.03 COMMERCIAL LAVATORIES INSTALLATION:

A. Install lavatories level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 00.

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00.

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19.

3.04 COMMERCIAL SINK INSTALLATION:

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.

1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23.

2. Install stops in locations where they can be easily reached for operation.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 00.

G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00.

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19.

3.05 CONNECTIONS:

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 05 00.

C. Comply with traps and soil and waste piping requirements specified in Section 22 13 16.

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

E. Where installing piping adjacent to urinals, allow space for service and maintenance.

F. Install protective-shielding pipe covers and enclosures on exposed supplies and waste piping of accessible wash fountains. Comply with requirements in Section 22 07 19.

G. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 22 05 00.

H. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 22 05 00.

I. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Section 22 05 00.

J. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 22 13 16.

K. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

L. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.06 ADJUSTING:

A. Operate and adjust fixtures and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.07 CLEANING AND PROTECTION:

A. Clean fixtures and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed fixtures and fittings.

C. Do not allow use plumbing fixtures for temporary facilities unless approved in writing by Owner.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

DIVISION 23

HEATING, VENTILATING, AND AIR CONDITIONING

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SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. 841: Motors

B. National Electrical Manufacturers Association (NEMA):

1. MG-1: Motors and Generators.

1.03 COORDINATION:

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.

3. Ratings and characteristics of supply circuit and required control sequence.

4. Ambient and environmental conditions of installation location.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sustainability Standards Certifications.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS:

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.02 MOTOR CHARACTERISTICS:

A. Duty: Continuous duty at ambient temperature of 40 degrees C and at altitude of 4,300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS:

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.

2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS:

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.

2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.05 SINGLE-PHASE MOTORS:

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.01 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 23 05 19

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide meters and gages for HVAC piping as indicated and in compliance with Contract Documents.

1. Bimetallic-actuated thermometers

2. Liquid-in-glass thermometers

3. Duct-thermometer mounting brackets

4. Thermowells

5. Dial-type pressure gages

6. Gage attachments

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B1.1: Unified Inch Screw Threads

2. B1.20.1: Pipe Threads, General Purpose (Inch)

3. B40.100: Pressure Gauges and Gauge Attachments

4. B40.200: Thermometers, Direct Reading and Remote Reading

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

C. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

D. Product Certificates: For each type of meter and gage.

E. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 BIMETALLIC-ACTUATED THERMOMETERS:

A. Manufacturers:

1. Trerice
2. Ashcroft
3. Winters
4. Marsh

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in degrees F.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass or plastic.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.02 LIQUID-IN-GLASS THERMOMETERS:

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Trerice

2. Ashcroft

3. Winters

4. Marsh

B. Standard: ASME B40.200.

C. Case: Cast aluminum; 6-inch nominal size.

D. Case Form: Straight unless otherwise indicated.

E. Tube: Glass with magnifying lens and blue or red organic liquid.

F. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in degrees F.

G. Window: Glass or plastic.

H. Stem: Aluminum or brass and of length to suit installation.

1. Design for Air-Duct Installation: With ventilated shroud.

2. Design for Thermowell Installation: Bare stem.

I. Connector: 3/4 inch, with ASME B1.1 screw threads.

J. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.03 DUCT-THERMOMETER MOUNTING BRACKETS:

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.04 THERMOWELLS:

A. Thermowells:

1. Standard: ASME B40.200.

2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.

3. Material for Use with Copper Tubing: CNR or CUNI.

4. Material for Use with Steel Piping: CRES.

5. Type: Stepped shank unless straight or tapered shank is indicated.

6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.

7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.

8. Bore: Diameter required to match thermometer bulb or stem.

9. Insertion Length: Length required to match thermometer bulb or stem.

10. Lagging Extension: Include on thermowells for insulated piping and tubing.

11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.05 DIAL-TYPE PRESSURE GAGES:

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers:

a. Trerice

b. Ashcroft

c. Weiss

d. Marsh

2. Standard: ASME B40.100.

3. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.

4. Gasketed pressure relief back with solid front.

5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

6. Diaphragm assembly for corrosive service.

7. Snubber for pulsating operation.

8. Oil filled for high vibration applications.

9. Pressure Connection: Brass, with ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

10. Movement: Mechanical, with link to pressure element and connection to pointer.

11. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.

12. Pointer: Dark-colored metal.

13. Window: Glass.

14. Ring: Brass or Stainless steel.

15. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.06 GAGE ATTACHMENTS:

A. Snubbers: ASME B40.100, brass; ASME B1.20.1 pipe threads and piston surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of stainless-steel pipe.

C. Valves: Brass ball, with ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install thermowells with socket extending a minimum of one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install remote-mounted pressure gages on panel.

J. Install valve and snubber in piping for each pressure gage for fluids.

K. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

L. Install permanent indicators on walls or brackets in accessible and readable positions.

M. Install connection fittings in accessible locations for attachment to portable indicators.

N. Install thermometers in the following locations:

1. Other locations as indicated.

O. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.

2. Suction and discharge of each pump.

3.02 CONNECTIONS:

A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING:

A. Adjust faces of meters and gages to proper angle for best visibility.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide hangers and supports for HVAC piping and equipment as indicated and in compliance with Contract Documents.

B. Section Includes:

1. Metal pipe hangers and supports

2. Trapeze pipe hangers

3. Metal framing systems

4. Thermal-hanger shield inserts

5. Fastener systems

6. Pipe stands

7. Equipment supports

1.02 REFERENCES:

A. American Society or Civil Engineers and Structural Engineering Institute

1. ASCE/SEI 7: Minimum Design Loads and Associated Criteria for Buildings and Other Structures

B. American Society of Mechanical Engineers (ASME):

1. ASME Boiler and Pressure Vessel Code, Section IX

2. B31.9: Building Services Piping

C. ASTM International (ASTM):

1. A36: Standard Specification for Structural Steel

2. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

3. A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

4. A1011: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

5. B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

6. C552: Standard Specification for Cellular Glass Thermal Insulation

7. C591: Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation

8. C1107: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

9. D635: Standard Test Method for Rate of Burning and/or Extent of Burning of Plastics in a Horizontal Position

10. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

D. American Welding Society (AWS):

1. D1.1: Structural Welding Code

E. Metal Framing Manufacturer's Association (MFMA):

1. 4: Metal Framing Standards

2. 103: Guidelines for the Use of Metal Framing

F. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports - Materials and Design

G. Underwriters' Laboratories, Inc. (UL):

1. 94: Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

C. Shop Drawings: Signed and sealed by a qualified Professional Engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers

2. Metal framing systems

3. Pipe stands

4. Equipment supports

D. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.

2. Include design calculations for designing trapeze hangers.

E. Welding certificates.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00, to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.02 METAL PIPE HANGERS AND SUPPORTS:

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.

3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.03 TRAPEZE PIPE HANGERS:

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS:

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Channels: Continuous slotted carbon-steel channel with inturned lips.

4. Channel Width: Selected for applicable load criteria.

5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

7. Metallic Coating: Hot-dip galvanized.

2.05 THERMAL-HANGER SHIELD INSERTS:

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06 FASTENER SYSTEMS:

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Stainless steel

2. Outdoor Applications: Stainless steel

2.07 PIPE STANDS:

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand:

1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate

3. Hardware: Galvanized steel or polycarbonate

4. Accessories: Protection pads

C. Low-Profile, Single Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.

2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate

3. Vertical Members: Two, galvanized steel, continuous-thread 1/2-inch rods

4. Horizontal Member: Adjustable horizontal, galvanized steel pipe support channels

5. Pipe Supports: Strut clamps

6. Hardware: Galvanized steel

7. Accessories: Protection pads

8. Height: 12 inches above roof

D. High-Profile, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

2. Bases: Two or more; vulcanized rubber

3. Vertical Members: Two or more, galvanized steel channels

4. Horizontal Members: One or more, adjustable height, galvanized steel pipe support

5. Pipe Supports: Strut clamps

6. Hardware: Galvanized steel

7. Height: 36 inches above roof

E. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.08 EQUIPMENT SUPPORTS:

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.09 MATERIALS:

A. Aluminum: ASTM B221

B. Carbon Steel: ASTM A1011

C. Structural Steel: ASTM A36, carbon-steel plates, shapes, and bars; galvanized

D. Stainless Steel: ASTM A240

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, non-corrosive, and non-gaseous

2. Design Mix: 5000-psi, 28-day compressive strength

PART 3 - EXECUTION

3.01 APPLICATION:

A. Comply with requirements in Section 07 84 00 for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 pounds.

3.02 HANGER AND SUPPORT INSTALLATION:

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A36, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick

    b. NPS 4: 12 inches long and 0.06 inch thick

    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick

    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick

    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS:

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS:

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.05 ADJUSTING:

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.06 PAINTING:

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.07 HANGER AND SUPPORT SCHEDULE:

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications:

1. Wet Well

G. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.

4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.

6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

7. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.

10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.

11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

13. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

14. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

15. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

16. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

17. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

18. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.

19. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.

20. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 degrees F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degrees F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 pounds

b. Medium (MSS Type 32): 1500 pounds

c. Heavy (MSS Type 33): 3000 pounds

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

   a. Horizontal (MSS Type 54): Mounted horizontally

   b. Vertical (MSS Type 55): Mounted vertically

   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 23 05 48

VIBRATION ISOLATION AND SEISMIC CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide vibration isolation and seismic control as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

B. Conform to latest edition of CSA W59 for welding.

C. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1. Seismic Restraint Manual; Guidelines for Mechanical Systems

2. HVAC Duct Construction Standards Metal and Flexible

D. Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

1.03 DEFINITIONS:

A. AHJ: Authority Having Jurisdiction

B. EPDM: Ethylene-Propylene-Diene Monomer

C. Withstand: Unit will remain in place without separation of any parts from the device when subjected to seismic forces specified.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems and anchorage for equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and

ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

1. Seismic-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

    d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

2. Seismic Qualification Certificates:

    a. For pumps, accessories, and components, from manufacturer.

        (1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

        (2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

        (3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

    b. For steel water storage tanks, accessories, and components, from manufacturer.

        (1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

        (2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

        (3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

c. For air handling units and energy recovery units, accessories, and components, from manufacturer.

(1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

(2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

(3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

d. Hot water heaters, accessories, and components, from manufacturer.

(1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

(2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

(3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Shop Drawings, Vibration Isolators:

1. Complete set of approved shop drawings of mechanical equipment, piping, and ductwork equipment which is to be isolated.

2. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.

3. Product Data:

a. Manufacturer's product data including details of materials, construction, dimensions of individual components, installation details, and finishes.

b. Schedule of vibration isolator type with location and static and dynamic load on each.

c. Vibration Isolation Base Details:

(1) Detail fabrication, including anchorages and attachments to structure and to supported equipment.

(2) Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

D. Shop Drawings, Seismic Control Components:

1. Complete set of approved shop drawings of mechanical equipment, piping, and ductwork equipment that is to be seismically restrained.

2. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.

3. Signed and sealed by a licensed Professional Engineer licensed registered in the State of Utah.

4. Calculations (including combining shear and tensile loads) to support seismic restraint designs shall be signed and sealed by a qualified registered Professional Engineer.

5. Include, as a minimum, a tabulation of design data for each snubber, including specific anchorage details.

6. Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

7. Product Data:

   a. Manufacturer's product data including details of materials, construction, dimensions of individual components, installation details, and finishes.

   b. Schedule of seismic control component type with location and static and dynamic load on each.

   c. Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.

E. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

F. Certifications:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 33 00.

2. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 33 00.

3. Welding Certificates: Copies of certificates for welding procedures and personnel.

4. Manufacturer's Seismic Certification: Certification that specified equipment will withstand earthquake forces. Include the following:

   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

   b. Dimensioned Outline Drawing of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

   c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 EXTRA MATERIALS:

A. Furnish extra materials described below which match products installed and that are packaged with protective covering for storage and identified with labels describing content.

   1. Seismic Snubber Units: Furnish replacement neoprene inserts for snubbers.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel.".

C. Isolation materials, flexible connectors, and seismic restraints shall be same manufacturer. Select and certify using published or factory certified data.

D. Vibration isolation and seismic restraint manufacturer shall be a member of the Vibration Isolation and Seismic Control Manufacturer's Association (VISCMA).

E. Seismic Control:

   1. Designer Qualifications:

      a. Professional Engineer registered in the State of Utah.

      b. Minimum of 5 years' work experience certifying seismic snubber and anchorage details.

c. Components shall bear anchorage pre-approval “R” number, from OSHPD or other agency acceptable to AHJ, showing maximum seismic restraint ratings.

1.08 DESIGN REQUIREMENTS:

A. Seismic Control:

1. Design equipment, anchorage and support systems for vertical and lateral loading in accordance with Section 1613 of the building codes of Utah, Salt lake City and ASCE/SEI 7.

2. Provide seismic control as required to maintain integrity of mechanical piping, ductwork, and equipment installed in this project, so they will “withstand” earthquake forces.

3. Design shall comply with requirements of this Specification, applicable codes, and requirements of Section 01 41 20.

4. Design, size and install for equipment throughout facility, whether shown or not.

5. Designed by a licensed Professional Engineer in the State of Utah.

6. Seismic restraints shall conform to requirements of latest edition of SMACNA Seismic Restraint Manual.

1.09 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Mason Industries, Inc.

B. Vibro-Acoustics

C. Kinetics Noise Control Inc.

2.02 EQUIPMENT SCHEDULES:

A. Refer to Drawings and/or Shop Drawings for product type and capacities.

2.03 VIBRATION ISOLATION:

A. General:

1. Provide for mechanical piping, ductwork, and equipment as identified by this Specification.

2. Select in accordance with equipment, pipe, or duct weight distribution to produce reasonably uniform deflections.

3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 30 percent and 60 percent of maximum deflection.

B. Elastomeric Pad:

1. Oil-resistant and water-resistant elastomer or natural rubber waffle pads, arranged in single or multiple layers, molded with a nonslip pattern.

2. Waffle pads bonded each side of minimum 0.24 inch thick galvanized steel separator plate.

3. Height of waffle ribs shall not exceed 0.7 times width.

4. Maximum Loading: 60 psi.

5. Minimum Single Layer Thickness: 0.24 inches.

6. Separator plate of sufficient stiffness for uniform loading over pad area.

7. Factory cut to size that matches requirements of supported equipment.

8. Waffle Pad Material: Standard neoprene.

9. Number of Layers: As required to support equipment load; refer to manufacturer's data for load capacities.

C. Elastomeric Mount:

1. Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements.

2. Factory-drilled, encapsulated top plate for bolting to equipment.

3. Baseplate for bolting to structure.

D. Open Spring Isolator:

1. Freestanding, laterally stable, open-spring isolators.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of required deflection at rated load.

4. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Baseplate:

   a. Factory drilled for bolting to structure and bonded to 0.24 inches thick rubber isolator pad attached to baseplate underside.

   b. Limit floor load to 100 psig.

   c. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolator:

1. Freestanding, steel, open-spring isolators with seismic restraint.

2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 0.24 inch thick elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and levelling bolt that acts as blocking during installation.

3. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.

4. Minimum Additional Travel: 50 percent of required deflection at rated load.

5. Lateral Stiffness: 80 percent minimum of the rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. Elastomeric Hanger:

1. Double-deflection type.

2. Molded, oil-resistant rubber or neoprene isolator elements bonded to steel housing.

3. Threaded connections for hanger rods.

G. Spring Hanger:

1. Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

3. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.

4. Minimum Additional Travel: 50 percent of required deflection at rated load.

5. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

7. Elastomeric Element:

   a. Molded, oil-resistant rubber or neoprene.

   b. Steel washer-reinforced cup to support spring and bushing projecting through bottom of frame.

H. Thrust Limit:

1. Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop.

2. Rod and angle-iron brackets for attaching to equipment.

3. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

4. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.

5. Minimum Additional Travel: 50 percent of required deflection at rated load.

6. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.

7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

8. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

9. Coil Spring: Factory set and field adjustable.

2.04 EQUIPMENT BASES:

A. Structural Steel Base:

1. Factory-fabricated, welded, structural steel base and rail.

2. Design Requirements:

a. Lowest possible mounting height with not less than 1 inch clearance above floor.

b. Provide equipment anchor bolts and auxiliary motor slide bases or rails.

c. Provide supports for suction and discharge elbows for pumps.

3. Structural Steel:

a. Steel shapes, plates, and bars complying with ASTM A36.

b. Bases shall have shape to accommodate supported equipment.

4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

B. Concrete Inertia Base:

1. Factory-fabricated, welded, structural steel base and rail ready for cast-in-place concrete.

2. Design Requirements:

a. Lowest possible mounting height with not less than 1 inch clearance above floor.

b. Provide equipment anchor bolts and auxiliary motor slide bases or rails.

c. Provide supports for suction and discharge elbows for pumps.

3. Structural Steel:

a. Steel shapes, plates, and bars complying with ASTM A36.

b. Bases shall have shape to accommodate supported equipment.

4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

5. Fabrication:

   a. Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete.

   b. Obtain anchor-bolt templates from supported equipment manufacturer.

6. Concrete: 4600 psi

C. Rooftop Isolation Rails:

1. Factory-assembled, fully enclosed, insulated, airtight, and watertight curb rail designed to resiliently support equipment.

2. Lower Support Assembly:

   a. Sheet metal "Z" section containing adjustable and removable steel springs that support upper floating frame.

   b. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind and seismic forces.

   c. Provide means for attaching to building structure and a wood nailer for attaching roof materials.

   d. Insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

3. Isolators:

   a. Adjustable, restrained spring type, mounted on elastomeric vibration isolation pads.

   b. Provide access ports, for level adjustment, with removable waterproof covers at isolator locations.

   c. Locate so they are accessible for adjustment during the life of the installation without interfering with the integrity of the roof.

   d. Restrained Spring Isolators:

      (1) Freestanding, steel, open-spring isolators with seismic restraint.

      (2) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and levelling bolt.

      (3) Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.

(4) Minimum Additional Travel: 50 percent of required deflection at rated load.

(5) Lateral Stiffness: 80 percent minimum of rated vertical stiffness.

(6) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

e. Elastomeric Isolator Pads:

(1) Oil-resistant and water-resistant elastomer or natural rubber, arranged in single of multiple layers, molded with a nonslip pattern.

(2) Single Layer Thickness: Minimum 0.24 inches

(3) Galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to size that match requirements of supported equipment.

(4) Material: Standard neoprene

(5) Number of Layers: As required to support equipment load; refer to manufacturer's data for load capacities.

f. Snubber Bushings: All-directional, elastomeric snubber bushings at least 0.24 inches thick.

g. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter-flashed over roof materials.

2.05 FLEXIBLE CONNECTORS:

A. Flexible Pipe Connectors:

1. Braided Nonferrous: For nonferrous piping systems, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, braze-welded to hose.

2. Braided Stainless Steel: For ferrous piping, provide stainless steel hose covered with Type 304 stainless steel wire braid with NPT steel nipples or 150 psi ANSI flanges, welded to hose.

3. Rubber:

a. Neoprene or EDPM construction consisting of multiple piles of nylon tire cord fabric and elastomer, molded and cured in hydraulic rubber presses.

b. Straight or elbow connector as indicated on the Drawings, rated at 120 psi at 219.2 degrees F.

B. Flexible Duct Connectors: Refer to Section 23 33 00.

2.06 SEISMIC RESTRAINTS:

A. Resilient Isolation Washers and Bushings: One-piece, molded neoprene, having a durometer 50, plus or minus 5, with a flat washer face.

B. Seismic Snubbers: Factory fabricated using welded structural steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

C. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.

D. Anchor Bolts:

1. Seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

2.07 SHOP/FACTORY FINISHING:

A. Manufacturer's standard paint applied to factory-assembled and factory-tested equipment, before shipping.

B. Powder coating on springs and housings.

C. Electro-galvanize hardware.

D. Hot-dip galvanize metal components for exterior use.

E. Baked enamel coat metal components for interior use.

F. Color-code or otherwise mark vibration isolation and seismic control devices to indicate capacity range.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. General:

1. Install products in accordance with manufacturers' written instructions.

2. Connect wiring to isolated equipment with flexible hanging loop.

3. Install roof curbs, equipment supports, and roof penetrations as specified in Section 07 60 00.

4. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

5. Locate isolation hangers as near overhead support structure as possible.

B. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by agency acceptable to authorities having jurisdiction.

C. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

E. Hangers and Supports for HVAC Piping and Equipment: Comply with requirements in Section 23 05 29 and those indicated below:

1. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

a. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

(1) Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

(2) Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

(3) Design seismic-restraint hangers and supports for piping and equipment.

2. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

F. Metals Ducts: Comply with requirements in Section 23 31 13 and those indicated below:

1. Seismic Performance: Metal ductwork and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Install seismic restraints on ductwork.

G. Mechanical Equipment

1. In the sections below, seismic performance seismic for the mechanical equipment indicated shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

a. In each case, the term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Fans and Accessories: Comply with requirements in Section 23 34 00 and those indicated below:

a. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration isolation and seismic-control devices.

b. Comply with requirements in Section 23 33 00 for flexible duct connectors.

3. Air Conditioning Equipment: Comply with requirements indicated below:

a. Equipment Installation: Install air conditioning equipment with seismic-restraint devices.

b. Comply with requirements for hangers and supports specified in Section 23 05 29.

4. Indoor, Semi-Custom Air-Handling Units: Comply with requirements indicated below:

a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

b. Equipment Installation: Install air-handling units with seismic-restraint devices.

c. Install floor-mounted units on 4-inch (unless noted otherwise on drawings) high concrete base designed to withstand, without damage to equipment, seismic force required by code.

5. Dedicated, Outdoor Air-Handling Units: Comply with requirements indicated below:

a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

b. Equipment Installation: Install air-handling units with seismic-restraint devices.

c. Install floor-mounted units on 4-inch (unless noted otherwise on drawings) high concrete base designed to withstand, without damage to equipment, seismic force required by code.

H. Vibration Isolations:

1. Install spring hangers without binding.

2. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

I. Equipment Bases:

1. Adjust equipment level.

2. Bases with seismic snubbers shall have snubbers located close to isolators.

3. Structural Steel Bases: Set steel bases for 1 inch clearance between housekeeping pad and base.

4. Concrete Inertial Bases:

    a. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.

    b. Fill concrete inertia bases, after installing base frame, with concrete; trowel to a smooth finish.

J. Flexible Connectors: Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

K. Seismic Restraint Devices:

1. Notify local representative of seismic restraint materials manufacturer prior to installing seismic restraint devices.

2. Representative of seismic restraint materials manufacturer shall provide a written report of compliance with installed equipment.

3. No rigid connections between equipment and building structure shall be made which degrades seismic restraint system herein specified.

4. Electrical conduit to restrained equipment shall be looped to allow free motion of equipment without damage to electrical wiring.

5. Install seismic snubbers on isolated equipment.

6. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

7. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

8. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers.

9. At trapeze anchor locations, shackle piping and equipment to trapeze.

10. Install resilient bolt isolation washers on equipment anchor bolts.

11. Upon completion of seismic restraint material installation and before startup of restrained equipment, all debris shall be cleaned from beneath all protected equipment, leaving equipment free to contact snubbers.

3.03 FIELD QUALITY CONTROL:

A. Testing: Conduct the following field quality-control testing:

1. Isolator deflection

2. Isolator seismic-restraint clearance

3. Snubber minimum clearances

B. Seismic Control Component Inspection:

1. Conduct periodic inspections of material installation with assistance of manufacturer's representative. Report in writing deviations from good installation practice.

2. Upon completion of seismic restraint device installation inspect completed system with assistance of manufacturer's representative. Report in writing installation errors, improperly selected snubber devices, or other fault in the system that could affect performance of the system.

C. Manufacturer's Services:

1. Provide manufacturer's representative at Site in accordance with Section 01 33 00 for installation assistance, inspection and certification of proper installation, equipment testing, and startup assistance.

2. Manufacturer's representative present at Site for minimum person-days listed below, travel time excluded:

a. 3 person-days for installation assistance and inspection

b. 1 person-day for completion of Manufacturer's Certification of Proper Installation

3. Inspection and Report:

a. Inspect isolated equipment after installation

b. Include static deflections

c. Submit report

3.04 ADJUSTING:

A. Vibration Isolation Devices:

1. Adjust isolators after piping systems have been filled and equipment is at operating weight.

2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height.

3. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

4. Attach thrust limits at centerline of thrust and adjust to a maximum of 6 mm movement during start and stop.

5. Adjust isolators to ensure units do not exceed rated operating deflections or bottom out under loading, and are not short circuited by other contacts or bearing points.

6. Adjust levelling devices as required to distribute loading uniformly on isolators. Shim units as required where levelling devices cannot be used to distribute loading properly.

B. Seismic Control Components:

1. Adjust snubbers according to manufacturer's written recommendations and additional corrections as required by the manufacturers' representative site visit per Paragraph 3.03.B.

2. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

3. Torque anchor bolts according to equipment manufacture's written recommendations to resist earthquake forces.

C. Cleaning:

1. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide equipment labels, warning signs and labels, pipe labels, duct labels, stencils, valve tags, warning tags as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. A13.1: Scheme for the Identification of Piping Systems

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

C. Samples: For color, letter style, and graphic representation required for each identification material and device.

D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

E. Valve numbering scheme.

F. Valve Schedules: For each piping system to include in maintenance manuals.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS:

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch or aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Letter Color: Black

3. Background Color: White

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

6. Fasteners: Stainless-steel rivets or self-tapping screws.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

2. Letter Color: Black

3. Background Color: White

4. Maximum Temperature: Able to withstand temperatures up to 160 degrees F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larg-

er lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 by 11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS:

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black

C. Background Color: Yellow

D. Maximum Temperature: Able to withstand temperatures up to 160 degrees F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 3-1/2 by 1 inch.

F. Minimum Letter Size: 1/2 inch for viewing distances up to 48 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 PIPE LABELS:

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.04 STENCILS:

A. Stencils for Piping:

1. Lettering Size: Size letters according to ASME A13.1 for piping

2. Stencil Material: Aluminum

3. Stencil Paint: Exterior, gloss, in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

4. Identification Paint: Exterior, in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

B. Stencils for Ducts:

1. Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances up to 15 feet and proportionately larger lettering for greater viewing distances

2. Stencil Material: Aluminum

3. Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form

4. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form

C. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Lettering Size: Minimum letter height of 1 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances

2. Stencil Material: Aluminum

3. Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form

4. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form

2.05 VALVE TAGS:

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware

2. Fasteners: Brass beaded chain

B. Valve Schedules: For each piping system, on 8-1/2 by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.06 WARNING TAGS:

A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum

2. Fasteners: Brass grommet and wire

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE"

4. Color: Safety-yellow background with black lettering

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 GENERAL INSTALLATION REQUIREMENTS:

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 EQUIPMENT LABEL INSTALLATION:

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION:

A. Piping Color Coding: Painting of piping is specified in Section 09 90 00.

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background

2. Stencil Paint: Use for pipe marking

C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, maintenance holes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe Label Color Schedule:

1. Refrigerant Piping: White letters on a safety-purple background

3.05 DUCT LABEL INSTALLATION:

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts

2. Yellow: For hot-air supply ducts

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts

B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.06 VALVE-TAG INSTALLATION:

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Refrigerant: 2 inches round

b. Gas: 2 inches round

2. Valve-Tag Colors:

a. Toxic and Corrosive Fluids: Black letters on a safety-orange background

b. Flammable Fluids: Black letters on a safety-yellow background

c. Combustible Fluids: White letters on a safety-brown background

d. Potable and Other Water: White letters on a safety-green background

e. Compressed Air: White letters on a safety-blue background

3.07 WARNING-TAG INSTALLATION:

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide testing, adjusting and balancing for HVAC as indicated and in compliance with Contract Documents.

1. Balancing Air Systems:

a. Constant-volume air systems

b. Variable-volume air systems

2. Testing, Adjusting, and Balancing Equipment:

a. Motors

3. Testing, adjusting, and balancing existing systems and equipment

4. Vibration tests

5. Control system verification

1.02 REFERENCES:

A. Associated Air Balance Council (AABC):

1. National Standards for Total System Balance

B. Air Movement and Control Association International, Inc. (AMCA):

1. 201: Fans and Systems

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 90.1: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

2. 111: Measurement, Testing, Adjusting and Balancing of Building HVAC Systems

D. National Environmental Balancing Bureau (NEBB):

1. Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems

E. Sheet Metal and Air Conditioning Contractors National Association (SMANCA):

1. HVAC Systems – Duct Design

2. HVAC Systems – Testing, Adjusting, and Balancing

1.03 DEFINITIONS:

A. AABC: Associated Air Balance Council

B. BAS: Building automation Systems

C. NEBB: National Environmental Balancing Bureau

D. TAB: Testing, adjusting, and balancing

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work

F. TDH: Total dynamic head

1.04 PREINSTALLATION MEETINGS:

A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report

b. The TAB plan

c. Needs for coordination and cooperation of trades and subcontractors

d. Proposed procedures for documentation and communication flow

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. TAB Report: Documentation indicating that Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

B. Qualification Data: Within 90 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

C. Contract Documents Examination Report: Within 90 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

D. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

E. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

F. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

G. Certified TAB reports

H. Sample report forms

I. Instrument calibration reports, to include the following:

1. Instrument type and make

2. Serial number

3. Application

4. Dates of use

5. Dates of calibration

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.

2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

C. TAB Specialists Qualifications: Certified by NEBB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.

2. TAB Technician: Employee of the TAB specialist and certified by NEBB as a TAB technician.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.09 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine operating safety interlocks and controls on HVAC equipment.

K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION:

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.

2. Strategies and step-by-step procedures for balancing the systems.

3. Instrumentation to be used.

4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.

b. Duct systems are complete with terminals installed.

c. Volume, smoke, and fire dampers are open and functional.

d. Clean filters are installed.

e. Fans are operating, free of vibration, and rotating in correct direction.

f. Variable-frequency controllers' startup is complete and safeties are verified.

g. Automatic temperature-control systems are operational.

h. Ceilings are installed.

i. Windows and doors are installed.

j. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING:

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00.

2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13, Section 23 07 16, and Section 23 07 19.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS:

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "record drawing" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Section 23 31 13.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS:

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses, close to the fan and prior to any outlets, to obtain total airflow.

c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.

b. Measure static pressure directly at the fan inlet or through the flexible connection.

c. Measure static pressure across each component that makes up the air-handling system.

d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts

2. Adjust submain and branch duct volume dampers for specified airflow

3. Re-measure each submain and branch duct after all have been adjusted

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts

2. Measure inlets and outlets airflow

3. Adjust each inlet and outlet for specified airflow

4. Re-measure each inlet and outlet after they have been adjusted

D. Verify Final System Conditions:

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.

2. Re-measure and confirm that total airflow is within design

3. Re-measure all final fan operating data, rpms, volts, amps, and static profile

4. Mark all final settings

5. Test system in economizer mode. Verify proper operation and adjust if necessary.

6. Measure and record all operating data

7. Record final fan-performance data

3.06 PROCEDURES FOR MOTORS:

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number

2. Motor horsepower rating

3. Motor rpm

4. Phase and Hertz

5. Nameplate and measured voltage, each phase

6. Nameplate and measured amperage, each phase

7. Starter size and thermal-protection-element rating

8. Service factor and frame size

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.07 DUCT LEAKAGE TESTS:

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.08 CONTROLS VERIFICATION:

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.

2. Confirm that the sequences of operation are in compliance with Contract Documents.

3. Verify that controllers are calibrated and function as intended.

4. Verify that controller set points are as indicated.

5. Verify the operation of lockout or interlock systems.

6. Verify the operation of valve and damper actuators.

7. Verify that controlled devices are properly installed and connected to correct controller.

8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.

9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.09 TOLERANCES:

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent

2. Air Outlets and Inlets: Plus or minus 10 percent

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.10 PROGRESS REPORTING:

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT:

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves

2. Manufacturers' test data

3. Field test reports prepared by system and equipment installers

4. Other information relative to equipment performance; do not include Shop Drawings and Product Data

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page

2. Name and address of the TAB specialist

3. Project name

4. Project location

5. Architect's name and address

6. Engineer's name and address

7. Contractor's name and address

8. Report date

9. Signature of TAB supervisor who certifies the report

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:

a. Indicated versus final performance

b. Notable characteristics of systems

c. Description of system operation sequence if it varies from the Contract Documents

12. Nomenclature sheets for each item of equipment.

13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers

    b. Conditions of filters

    c. Cooling coil, wet- and dry-bulb conditions

    d. Face and bypass damper settings at coils

    e. Fan drive settings including settings and percentage of maximum pitch diameter

    f. Settings for supply-air, static-pressure controller

    g. Other system operating conditions that affect performance

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows

2. Duct, outlet, and inlet sizes

3. Terminal units

4. Balancing stations

5. Position of balancing devices

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification

    b. Location

    c. Make and type

    d. Model number and unit size

    e. Manufacturer's serial number

f. Unit arrangement and class

g. Discharge arrangement

h. Sheave make, size in inches , and bore

i. Center-to-center dimensions of sheave and amount of adjustments in inches

j. Number, make, and size of belts

k. Number, type, and size of filters

2. Motor Data:

a. Motor make, and frame type and size

b. Horsepower and rpm

c. Volts, phase, and Hertz

d. Full-load amperage and service factor

e. Sheave make, size in inches, and bore

f. Center-to-center dimensions of sheave and amount of adjustments in inches

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm

b. Total system static pressure in inches wg

c. Fan rpm

d. Discharge static pressure in inches wg

e. Filter static-pressure differential in inches wg

f. Preheat-coil static-pressure differential in inches wg

g. Cooling-coil static-pressure differential in inches wg

h. Heating-coil static-pressure differential in inches wg

i. Outdoor airflow in cfm

j. Return airflow in cfm

k. Outdoor-air damper position

l. Return-air damper position

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification

b. Location

c. Coil type

d. Number of rows

e. Fin spacing in fins per inch

f. Make and model number

g. Face area in sq. ft.

h. Tube and fin materials

i. Circuiting arrangement

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm

b. Average face velocity in fpm

c. Air pressure drop in inches wg

d. Outdoor-air, wet- and dry-bulb temperatures in degrees F

e. Return-air, wet- and dry-bulb temperatures in degrees F

f. Entering-air, wet- and dry-bulb temperatures in degrees F

g. Leaving-air, wet- and dry-bulb temperatures in degrees F

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification

b. Location

c. Make and type

d. Model number and size

e. Manufacturer's serial number

f. Arrangement and class

g. Sheave make, size in inches, and bore

h. Center-to-center dimensions of sheave and amount of adjustments in inches

2. Motor Data:

a. Motor make, and frame type and size

b. Horsepower and rpm

c. Volts, phase, and Hertz

d. Full-load amperage and service factor

e. Sheave make, size in inches, and bore

f. Center-to-center dimensions of sheave, and amount of adjustments in inches

g. Number, make, and size of belts

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm

b. Total system static pressure in inches wg

c. Fan rpm

d. Discharge static pressure in inches wg

e. Suction static pressure in inches wg

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number

b. Location and zone

c. Traverse air temperature in degrees F

d. Duct static pressure in inches wg

e. Duct size in inches

f. Duct area in square feet

g. Indicated airflow rate in cfm

h. Indicated velocity in fpm

i. Actual airflow rate in cfm

j. Actual average velocity in fpm

k. Barometric pressure in psig

I. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make

b. Serial number

c. Application

d. Dates of use

e. Dates of calibration

3.12 VERIFICATION OF TAB REPORT:

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.

B. Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

3. If the second verification also fails, Owner may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS:

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

3.14 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 23 05 94

PRESSURE TESTING OF DUCTED AIR SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide pressure testing of ducted air systems as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1. ANSI/SMACNA HVAC Air Duct Leakage Test Manual – second edition 2012.

1.03 GENERAL:

A. Ducts over 5 m in length, forming part of a supply forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment to be pressure tested for leaks

1.04 TIMING:

A. Ducts to be tested before installation of insulation or any other form of concealments.

B. Test after seals have cured.

C. Test when ambient temperature will not affect effectiveness of seals, gaskets, etc.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.08 TEST PROCEDURES:

A. Maximum lengths of ducts to be tested to be consistent with capacity of test equipment.

B. Section of duct to be tested to include:

1. Main ducts, fittings, branch ducts, tap-ins.

C. No less than 25 percent of all ductwork shall be tested at a test pressure of 3 inch wg. If a single test result is “pass” then no additional testing shall be required. If a single test result is “fail” then additional leak testing shall be performed on 50 percent of all ductwork. If the test result is “pass” then no additional testing shall be required. If the second test result is “fail” then all 100 percent of ductwork shall be tested.

D. Consultant shall randomly select duct work sections to be tested.

E. System leakage tolerances shall adhere to Paragraph F below.

F. Acceptable Leakage shall be calculated based on the following criteria:

1. Rectangular Metal Ductwork: Leakage Class 8

2. Round Metal Ductwork: Leakage Class 4

3. All ductwork to be Seal Class B

G. The equipment used shall be of sufficient capacity to perform the test. Extrapolation shall not permitted.

1. All ductwork shall be tested prior to the installation of dampers, grilles, registers, coils, openings, etc. that could cause a failure in the pressure test. Sections of ductwork shall be completely replaced where this occurs prior to the passing of the leakage testing.

H. Base partial system leakage calculations on Reference Standard.

I. Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

1.09 VERIFICATION:

A. Consultant to witness tests and to verify reported results.

B. To be certified by the same TAB agency approved by Consultant to undertake TAB on this project.

1.10 TEST INSTRUMENTS:

A. Agency to provide instruments for tests.

B. Test apparatus to include:

1. Fan capable of producing required static pressure.

2. Duct section with calibrated orifice plate mounted and accurately located pressure taps.

3. Flow measuring instrument compatible with the orifice plate.

4. Calibration curves for orifice plates used.

5. Flexible duct for connecting to ductwork under test.

6. Smoke bombs for visual inspections.

C. Test apparatus to be accurate to within +/- 3 percent of flow rate and pressure.

D. Submit details of test instruments to be used to Consultant at least three months before anticipated start date.

E. Test instruments to be calibrated and certificate of calibration deposited with Consultant no more than 28 days before start of tests.

F. Instruments to be re-calibrated every six months thereafter.

1.11 SYSTEM LEAKAGE TOLERANCES:

A. System leakage tolerances specified herein are stated as a percentage of total flow rate handled by the system. Therefore, when testing sections of ductwork this acceptable leakage shall be pro-rated to entire system. Leakage for sections of duct systems shall not exceed the total allowable leakage.

B. Leakage tests on following systems not to exceed specified leakage rates.

1. Rectangular ductwork leakage Class 8

2. Round ductwork leakage Class 4

3. All ductwork to be test to duct class 3 inch wg, Class “B”

C. Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

1.12 EQUIPMENT LEAKAGE TOLERANCES:

A. Equipment and System Components, Leakage: 2 percent

1.13 REPORT FORMS:

A. Submit proposed report form and test report format to Consultant for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Consultant.

1.14 PRESSURE TEST REPORTS:

A. Prepare report of results and submit to Consultant within 24 hours of completion of tests. Include:

1. Schematic of entire system

2. Schematic of section under test showing test site

3. Required and achieved static pressures

4. Orifice differential pressure at test sites

5. Permissible and actual leakage flow rate CFM for test sites

6. Witnessed certification of results

B. Include test reports in final TAB report.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 23 07 13

DUCT INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide duct insulation as indicated and in compliance with Contract Documents.

1. Indoor, concealed supply and outdoor air

2. Indoor, exposed supply and outdoor air

3. Indoor, concealed return located in unconditioned space

4. Indoor, exposed return located in unconditioned space

5. Indoor, concealed exhaust between isolation damper and penetration of building exterior

6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

7. Outdoor, concealed supply and return

8. Outdoor, exposed supply and return

1.02 REFERENCES:

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 90.1: Energy Standard For Buildings Except Low-Rise Residential Buildings

B. ASTM International (ASTM):

1. C1136: Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

2. C1290: Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts

3. C1338: Test Method for Determining Fungi resistance of Insulation Materials and Facings

4. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

C. Underwriters Laboratories (UL)

1. 723: Test for Surface Burning Characteristics of Building Materials

D. (Military and Government Specs & Standards (Naval Publications and Form Center (NPFC):

1. MIL-A-3316C: Adhesives, Fire-Resistant, Thermal Insulation

2. MIL-A-24179A: Adhesive, Flexible Unicellular-Plastic Thermal

3. MIL-C-20079H: Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass

4. MIL-PRF-19565C: Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor-Barrier

E. National Fire Protection Association (NFPA):

1. 90A: Standards for the Installation of Air-Conditioning and Ventilating Systems

2. 90B: Standard for the Installation of Warm Air Heating and Air-Conditioning Systems

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

C. Field quality-control reports.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.08 COORDINATION:

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29.

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.09 SCHEDULING:

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

2.02 DUCT WRAP:

A. Resin bonded fibrous glass blanket with a damage-resistant, flame retardant, reinforced aluminum foil (FRK) facing.

B. Duct wrap insulation is not known to contain penta-, octa, or deca-brominated diphenyl flame retardant substances, such as deca-Bromine (deca-BDE).

C. Certifications:

1. GREENGUARD Indoor Air Quality Certified® and GREENGUARD Gold Certified

2. Certified by SCS Global Services to contain a minimum of 53 percent recycled glass content, 31 percent pre-consumer and 22 percent post-consumer

3. UL labeled

D. Duct Wrap Insulation:

1. ASTM C1290, Type III, to maximum service temperature of 250 degrees°F, and ASTM C1136, Type II, facing material.

E. Acceptable Product: Owens Corning® SoftR® Duct Wrap FRK.

1. Type 75: 0.75 lb./cu.ft. density: 1-1/2 in, 2 in, 2.2 in or 3 in thick

2. Type 100: 1.0 lb./cu.ft. density: 1-1/2 in or 2 in thick

3. Type 150: 1.5 lb./cu.ft. density: 1-1/2 in or 2 in thick

F. The duct wrap insulation shall consist of a blanket of glass fibers factory-laminated to a foil reinforced kraft (FRK) vapor retarder facing with a 2 in. stapling and taping flange on one edge.

G. Manufacturers:

1. Owens Corning

2. Johns Manville

3. Knauf Insulation

2.03 ADHESIVES:

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers:

a. Foster

b. Johns Manville

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers:

a. Foster

b. Johns Manville

2.04 LAGGING ADHESIVES:

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers:

a. Foster

b. Childers

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.

3. Service Temperature Range: 0 to plus 180 degrees F

2.05 SEALANTS:

A. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers:

a. Childers

2. Materials shall be compatible with insulation materials, jackets, and substrates

3. Fire- and water-resistant, flexible, elastomeric sealant

4. Service Temperature Range: Minus 40 to plus 250 degrees F

5. Color: Aluminum

2.06 FIELD-APPLIED CLOTHS:

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd.

1. Manufacturers:

a. GLT Products

b. Childers

B. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.

b. Finish: Stucco embossed.

c. Moisture Barrier: Heat laminated 3-mil-thick, polyethylene–Surlyn, polyfilm moisture barrier.

2. Stainless-Steel Jacket: ASTM A167 or ASTM A240.

a. Sheet and roll stock ready for shop or field sizing.

b. Moisture Barrier: Heat laminated 3-mil-thick, polyethylene–Surlyn, polyfilm moisture barrier.

3. Manufacturers:

a. Johns Manville

b. K-flex USA

2.07 TAPES:

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Manufacturers:

a. 3M

b. Nashua

2. Width: 3 inches

3. Thickness: 6.5 mils

4. Adhesion: 90 ounces force/inch in width

5. Elongation: 2 percent

6. Tensile Strength: 40 lbf/inch in width

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape

2.08 SECUREMENTS:

A. Bands:

1. Manufacturers:

a. Johns Manville

b. Band-it

2. Stainless Steel: ASTM A167 or ASTM A240, Type 304 or Type 316; 0.020 inch thick, 3/4 inch wide with wing seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.

a. Manufacturers:

(1) GLT Products

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

a. Manufacturers:

(1) GLT Products

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Manufacturers:

(1) GLT Products

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Zinc-coated, low-carbon steel or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel

D. Wire: 16 gauge soft-annealed, stainless steel

1. Manufacturers:

a. GLT Products

2.09 CORNER ANGLES:

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A167 or ASTM A240, Type 304 or Type 316.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS:

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

    1. Install insulation continuously through hangers and around anchor attachments.

    2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

    3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

    1. Draw jacket tight and smooth.

    2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 PENETRATIONS:

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 07 84 00.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 00.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION:

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06 INSTALLATION OF MINERAL-FIBER INSULATION:

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not over-compress insulation during installation.

e. Impale insulation over pins and attach speed washers.

f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

   b. Install vapor stops for ductwork and plenums operating below 50 degrees F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

    d. Do not over-compress insulation during installation.

    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

    b. Install vapor stops for ductwork and plenums operating below 50 degrees F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.07 FIELD-APPLIED JACKET INSTALLATION:

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.

2. Install lap or joint strips with same material as jacket.

3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.

5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.08 FIRE-RATED INSULATION SYSTEM INSTALLATION:

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 07 84 00.

3.09 FINISHES:

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 90 00 and Section 09 91 00.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 DUCT INSULATION SCHEDULE, GENERAL:

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air

2. Indoor, exposed supply and outdoor air

3. Indoor, concealed return located in unconditioned space

4. Indoor, exposed return located in unconditioned space

5. Indoor, concealed exhaust between isolation damper and penetration of building exterior

6. Indoor, exposed exhaust between isolation damper and penetration of building exterior

7. Outdoor, concealed supply and return

8. Outdoor, exposed supply and return

B. Items Not Insulated:

1. Fibrous-glass ducts

2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1

3. Factory-insulated flexible ducts

4. Factory-insulated plenums and casings

5. Flexible connectors

6. Vibration-control devices

7. Factory-insulated access panels and doors

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE:

A. Concealed supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density

B. Concealed return-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density

C. Concealed outdoor-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 2 inches thick and 1.5-lb/cu. ft. nominal density

D. Concealed exhaust-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density

E. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 2 inches thick and 1.5-lb/cu. ft. nominal density

F. Concealed, outdoor-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 3 inches thick and 1.5-lb/cu. ft. nominal density.

G. Concealed, exhaust-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density

H. Exposed supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density

I. Exposed return-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density

J. Exposed outdoor-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 2 inches thick and 1.5-lb/cu. ft. nominal density

K. Exposed exhaust-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density

L. Exposed, supply-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density

M. Exposed, return-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density

N. Exposed, outdoor-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches thick and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 3 inches thick and 1.5-lb/cu. ft. nominal density

O. Exposed, exhaust-air plenum insulation shall be one of the following:

1. (Mineral-Fiber Blanket: 2 inches 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density

3.12 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE:

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Exposed or Concealed supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 3 inches thick and 2-lb/cu. ft. nominal density

C. Exposed or Concealed return-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 3 inches thick and 2-lb/cu. ft. nominal density

D. Exposed or Concealed outdoor-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 3 inches thick and 2-lb/cu. ft. nominal density

E. Exposed or Concealed, supply-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 4 inches and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 4 inches thick and 2-lb/cu. ft. nominal density

F. Exposed or Concealed, return-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 4 inches and 1.5-lb/cu. ft. nominal density

2. Mineral-Fiber Board: 4 inches thick and 2-lb/cu. ft. nominal density

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed: None

D. Ducts and Plenums, Exposed:

1. Aluminum, Stucco Embossed: 0.024 inch thick

2. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish: 0.016 inch thick

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed: None

D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Stucco Embossed: 0.032 inch thick

2. Stainless Steel, Type 316, Stucco Embossed: 0.020 inch thick

E. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Stainless Steel, Type 316, Stucco Embossed: 0.024 inch thick

3.15 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 23 08 20

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This Section describes the commissioning of the mechanical system and outlines the duties and responsibilities of the team.

B. The commissioning of the mechanical system shall be in accordance with the Code of Practice for Commissioning Mechanical Systems in Buildings and as described in this Section.

C. The commissioning process shall be applied to all products, equipment and systems provided under this Division.

D. The Contractor shall appoint a Commissioning Coordinator upon award of Contract.

1.02 SCOPE:

A. Demonstration of equipment and systems operations.

B. Instruction seminars for Owner's personnel.

1.03 QUALITY ASSURANCE:

A. Work specified shall be performed by the Contractor.

PART 2 - PRODUCTS

(Not Used)

PART 3 – EXECUTION

3.01 THE COMMISSIONING PROCESS:

A. The Commissioning Team:

1. The Commissioning Team shall be formed and consist of:

a. The Commissioning Coordinator

b. The Contractor

c. The Balancing Agent

d. The Contract Administrator’s representative

e. The Owner's staff representative

B. Duties of the Team:

1. The duties of the team are summarized below:

2. The Contractor shall within one month of the award of the Contract appoint a Commissioning Coordinator and submit the name and contact details of the Commissioning Coordinator to the Contract Administrator.

3. The Commissioning Coordinator shall plan, organize and implement the commissioning process.

4. The Commissioning Coordinator shall provide a complete description of the systems operation, performance and flow data to the Contract Administrator for review.

5. The Commissioning Coordinator shall prepare the commissioning plan and provide demonstration and instructions to the Owner's staff over a period of time to enable the staff to become familiar with the systems.

6. The Commissioning Coordinator will arrange and chair regularly scheduled meetings with the commissioning team to discuss the design intent, schedule, the commissioning plan, and anything else relevant to the commissioning of mechanical equipment installed under Division 23.

3.02 COMMISSIONING SCHEDULE:

A. Within six (6) weeks of commencing with the project work the commissioning coordinator shall review design intent and intended commissioning procedures with the Engineer. Six (6) weeks prior to the date of scheduled substantial performance, submit a detailed plan identifying the orderly progression of the prestart commissioning check and subsequent commissioning performance check of each sub-system, leading up to the ultimate commissioning of entire systems.

B. Submit a schedule for the commissioning phase of the work. This schedule shall show:

1. Completion dates for each trade in each major section of the building.

2. Timing of the various phases of the commissioning, testing, balancing and demonstration process.

3. Submission dates for the various documents required prior to verification of commissioning by the Contract Administrator.

4. Prepare a commissioning statement in which each of the four (4) phases that the process is perceived to be worked through. In sequence, the phases are expected to be:

    a. Phase 1 - System Readiness

    b. Phase 2 - System Start-up, Testing, Balancing, etc.

    c. Phase 3 - Verification of System Commissioning

    D. Phase 4 - Demonstration and Instruction

C. Within the commissioning schedule noted above, submit a copy of all commissioning worksheets to be used during the commissioning process.

D. Each phase is applicable to each major and separate system making up the work in Division 23 including controls and Division 26 interface as applicable.

1. Commissioning Phases

E. **Phase 1** - Before starting any of the separate systems, provide written verification stating that the specific system is ready for start-up and the following conditions have been met:

1. Copies of all test and certificates have been submitted to the Contract Administrator

2. All safety controls installed and fully operational (dry run test)

3. Flushing, chemical cleaning (as required), charging, fluid operating (as required), are complete

4. Equipment lubrication and pre-start checks are complete

5. Air system cleaning complete

6. Filter systems installed and sealed in place (except for air system charcoal filters)

7. Adjusting vibration isolation completed

8. Alignment of drives (direct and belt) completed

9. Control functional checks, including all alarms performed

10. Start-up verification checks by manufacturers representatives completed.

11. All deficiencies to be recorded, reviewed by the commissioning team and, subsequently corrected before proceeding to the next phase, Phase 2

F. **Phase 2** - System Commissioning shall include but not necessarily be limited to:

1. Activation of all systems

2. Testing and adjustment of all systems

3. As in the case of the System Readiness Phase, all deficiencies are to be recorded, reviewed by the Commissioning team and, subsequently, corrected. The process at the point of the deficiency shall be repeated before proceeding forward.

4. Phase 2 is concluded when the installation is in full working order and acceptable for use. The work will include the following:

    a. Position all balance dampers in ductwork

    b. Position all balance valves in piping systems (where appropriate)

    c. Make provisions for testing air pressures and flow rates

    d. Set up air diffusers, registers and grilles

    e. Set up all automatic temperature control devices

    f. Set up constant volume and variable volume fans

    g. Adjust variable volume boxes and air valves as necessary

    h. Plug all air pressure and flow measuring holes

    i. Adjust vibration isolators as necessary

    j. Verification by the air balance contractor that all fire dampers have been checked

    k. Air balance complete

5. Fine Tuning

6. Setting up automatic controls for accurate response and precise sequencing.

7. Correction of problems revealed by Balancing Agency and change of fan speed and pitch as necessary.

8. Testing

9. The commissioning coordinator shall perform a detailed check of the following:

    a. Control sequences functionality of all HVAC systems

b. Alarm functions

c. Temperature setpoints and maintenance for spaces and systems

d. Room Pressure settings and control

e. Gas detection setpoints and alarms

f. Motor loads under all operating conditions

10. All items and functions to be later demonstrated to the Owners representatives.

11. Systems operation in the fire mode (pressurisation and smoke removal) in the presence of the authorities having jurisdiction. Obtain a written statement/ certificate of approval from the authorized manual jurisdiction.

G. **Phase 3** - Verification of Commissioning.

1. Verification of commissioning by the Contract Administrator shall not commence until the commissioning process, Phase 2, has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of the following:

a. Location of and opening and closing of all access panels.

b. Operation of all automatic control dampers and automatic temperature/ volume adjustment controls.

c. Proper response of all variable air volume valves to thermostats and volume adjustment controls.

d. Operability of randomly selected fire dampers.

e. Noise level from typical variable air volume valves under extreme operating conditions.

f. Operation of all equipment and systems, under each mode of operation, including:

(1) DDC control features

(2) Automatic controls

(3) Special exhaust/make-up air systems

(4) Make-up air systems

2. At the completion of Phase 3, the Contractor shall submit the following to the Contract Administrator:

   a. A letter certifying that all work specified under this contract is complete, clean and operational in accordance with the specification and drawings.

   b. A copy of Phase 2 Verification Certificates provided by the specialist trades for submission to the Contract Administrator.

   c. Record drawings as specified

   d. A letter from the testing and balancing agency certifying that all necessary data for inclusion in operating and maintenance manuals has been received.

   e. A statement confirming completion of EMCS acceptance test, Section 15900.

3. Upon receipt of all documents and a satisfactory outcome of the verification procedure, the Contract Administrator will provide a Certificate of Verification for Phase 3.

4. Substantial Performance may, thereupon, be declared.

H. **Phase 4** - Demonstration and Acceptance shall not commence until the commissioning process Phase 3 has been successfully completed - verification certificate issued and Substantial Performance declared. The demonstration process is a statement of satisfaction from the Contract Administrator and Owner upon completion. Total Performance will not be accomplished without this achievement.

3.03 HVAC SYSTEMS:

A. Duct System: Pressure tests, insulation, identification, air balance identification.

B. Air Handling and Make-up Air Units: Installation vibration isolation, duct connections, motor rotation, air balance, filters, capacity identification, controls.

C. Control Dampers: Installation, operation, identification, capacity modulation, connection to EMCS.

D. Controls: See Section 23 09 13, Section 23 09 93.11 and SCADA specifications. Commissioning of controls by the SCADA Contractor under the supervision of the commissioning coordinator.

E. Terminal Devices: Installation, capacity modulation, reheat, response to controls, air balance.

3.04 GENERAL:

A. Independent Agency shall chair the demonstration and instruction sessions.

B. Contractor shall arrange for presentation and demonstration of mechanical equipment and systems by appropriate specialists and shall ensure that required manufacturer's representatives are in attendance.

3.05 DEMONSTRATIONS:

A. Provide three (3) working days for demonstration of equipment to the Owner.

B. Demonstrate specific starting and general maintenance requirements for each major piece of equipment. Ensure all labelling and identification is completed.

C. Demonstrate the following systems, in the form of instruction seminars and contractor-guided tour of the facility.

1. Air Systems

2. Control Systems

D. Demonstrate the following pieces of equipment:

1. Air Handling and Make-up Air Units

2. As requested by Owner

E. Prepare a schedule identifying the proposed sequence of demonstration. Sequence of demonstration shall correspond to full system starting. Submit for review by Contract Administrator one month prior to demonstration.

F. Answer all questions raised by Owner at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.

G. Provide a professionally produced video of all instructions and demonstrations. Engage the services of a professional video production company to provide four (4) copies of the edited DVD(s).

3.01 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 23 09 13

HVAC CONTROLS, FIELD COMPONENTS AND INSTRUMENTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This Section specifies the general requirements for monitoring and controlling HVAC equipment.

B. All HVAC systems and sub-systems as indicated, except for Odor Control Removal are to be controlled by the Building Management System (BMS).

C. The Odor Control Removal system will be controlled by the SCADA system.

D. Building control will be provided directly by the BMS with designated alarming and warnings reported to the SCADA. All programming of the BMS will be by the BMS provider.

E. Automation system programming, configuration, testing and commissioning to be the responsibility of the automation system integrator under supervision of the controls lead see Section 40 61 96

F. The SCADA system is Schneider M580 PLC based. The BMS communication protocol must be capable of interfacing directly with M580 communication protocols (Ethernet, Modbus, TCP/IP, etc.)

G. The BMS provider and the automation systems integrator will work together to ensure all controls, alarms, setpoints etc. associated with the BMS are integrated into the SCADA.

H. The HVAC system is to be complete with all necessary control components and connections to achieve the specified functions. Reference all control narratives for general outline of expected functionality.

I. While the intent is to have the HVAC, systems controlled (Temperature) by the SCADA via BMS. Should the SCADA/BMS connection fail, the HVAC systems will be capable of being controlled directly through the BMS system.

J. Furnish all materials, including all Human Machine Interface (HMI) hardware and software, operator input/output peripherals, standalone local control panels, automation sensors and controls, wiring, and interface systems.

K. The control system is to be set up and adjusted to achieve energy efficient operation of the HVAC system. This includes sequencing, timing and re-adjustment, as required.

L. This section is a performance specification clarified in certain sections to establish minimum standard of equipment, installation and level of control.

M. This Section is a supplement to instruments and controls in Division 40.

N. The requirements of this Section shall be provided in addition to those listed in Division 40.

1.02 REFERENCES:

A. National Fire Protection Association (NFPA):

1. 70: National Electrical Code

2. NFPA 820 for Water Treatment Plants

3. ASHRAE 62.1

1.03 SUBMITTALS:

A. Provide submittals in accordance with Section 01 33 00 and the following:

1. Manufacturer's descriptive literature for materials.

2. Control center layouts.

3. Interconnection schematics.

4. Wiring and piping diagrams.

5. One-line diagram from sensor and control points to Field Interface device and/or standalone DDC panel including all components and cables.

6. Terminal cabinets, including termination listing.

7. Written description indicating sequence of operation.

8. Shop Drawings will be rejected if the written description is not included with the submission. Sequences should reference English descriptors and labels for each point described. Follow any established client cable and equipment tagging system.

9. All input/output points which are to include the following information associated with each point.

a. Sensing element type and location.

b. Details of associated field wiring schematics and schedules.

c. Software and programming details.

10. Detailed block diagrams of transmission trunk routing and configuration.

11. Valve and damper schedules indicating size, configuration, capacity and locations.

12. Detailed description/list of HVAC controls, alarms and setpoints available on the SCADA

13. Provide transfer table/data reference points to be used by SCADA system to control the HVAC systems

B. Submit the following shop drawings in accordance with Section 01 33 00.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.07 FREEZE PROTECTION:

A. BMS to shut down all supply air handling units containing coils, upon sensing air off the coils at 4 degrees C/40 degrees ^{o}F.

B. Allow up to three (3) restarts, over short period before generating an alarm.

1.08 ALARMS – GENERAL:

A. No alarm is to be triggered for a device until the device has been started and is in stable operation. Use software time delays to achieve this requirement.

B. Generate an alarm on the SCADA if any equipment is not in the intended operating condition or if any analog input is not within the intended operating range.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Provide a BACNet BMS system as a distributed control system. The system shall have Stand-Alone Digital Controllers (SDC's), a communications network, and a separate workstation computer with workstation software. The workstations and network

controllers shall communicate to any outside network including the SCADA network, using TCP/IP protocol and addressing.

B. Provide an operator programmable system to perform closed-loop, modulating control of building equipment. Connect all digital controllers through the communication network to share common data and report to workstation computer. Provide workstation BMS software capable of programming and monitoring the digital controllers. The control system shall be capable of downloading programs between the workstation and digital controllers.

C. Apply digital controllers in a distributed control manner.

D. Total number of I/O hardware points, including those communicated over a LAN, used by a single SDC, including I/O expansion units shall not exceed 48.

E. Design, provide and install all conduit and wiring linking all elements of system, including future capability.

F. All control units in the BMS are to be BACnet compliant with open protocol to allow future replacement of obsolete components or integration of another manufacturer's BACnet compliant components and any existing BMS system

G. All control units in the BMS are to be BACnet compliant with open protocol to allow for integration with the SCADA system.

H. Location of controllers to be approved by the Engineer prior to installation.

I. Provide analog output and input devices utilizing a 0-10 VDC or 4-20 mA control signal. Verify input and output requirements from BMS to other vendor supplied equipment controls and configure accordingly.

J. Provide field instrumentation and sensing devices analog or digital as applicable which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc., and which input signals to the SCU terminal strip that conform to the input requirements. All field devices will be of industrial grade.

K. Provide output devices and actuators which convert the digital or analog output signal from the SCU to activate relays or open and close valves, dampers, etc.

L. The end to end accuracy called for in Subsection 2.9 includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the input to the analog-to-digital converter in the SCU or between the SCU input to the digital-to-analog converter and the controlled variable for the full sensing range.

M. Acceptable system suppliers:

1. Honeywell

2. Johnson Controls

3. Siemens

4. Schneider

2.02 BMS SYSTEM WORLD WIDE WEB BASED ACCESSIBILITY

A. The control system must be capable of Web accessible with four (4) simultaneous users. Web accessibility will be provided with same level of password protection (four levels) for internal accessibility. Web Based accessibility will provide full access to the BMS system including monitoring, diagnostic functions, setpoint adjustment, access to real time and archived trending data and reports. The Facility Operations will control when the system accesses the Web is permitted.

2.03 STAND-ALONE DIGITAL CONTROLLERS (SDC'S):

A. Inputs:

1. Provide input function integral to the SDC. Provide input type(s) as required by the systems design. For each type of input used on high-level controllers, provide at least one similar spare input point per controller.

2. Analog Inputs: Allowable input types are 100-ohm (or higher) platinum RTDs, 4-20 mA, and 2-10 VDC. Direct RTD inputs must have appropriate conversion curves stored in controller software or firmware. Analog to digital (A/D) conversion shall have 16-bit minimum resolution.

3. Digital Inputs: Digital inputs shall sense open/close, on/off, or other two state indications.

B. Outputs:

1. Provide output function integral to the direct digital controller. Provide output type(s) as required by the systems design. For each type of output used on high-level controllers, provide at least one (1) similar spare output point per controller.

2. Analog Outputs: Provide controllers with 16-bit minimum output resolution. Output shall be 4-20 mA or 2-10 VDC.

3. Digital Outputs: Provide contacts rated at a minimum of 1 ampere at 24 V.

C. PID Control:

1. Provide controllers with proportional integral and derivative control capability.

2. The upper level digital controllers shall be capable of networking with other similar upper level controllers. Upper level controllers shall also be capable of communicating over a network between buildings.

D. Communications Ports:

1. Controller-to-Controller LAN Communications Ports: Controllers in the building BMS system shall be connected on a communications network. Controllers shall have controller to controller communication ports to both peer controllers (upper level controllers) and terminal controllers (lower level controllers). Network may consist of more than one level of local area network and one level may have multiple drops. Communications network shall permit sharing information between controllers, allowing execution of dynamic control strategies, and coordinated response to alarm conditions. Minimum speed for all LAN's is 100 Mbps.

2. Interface Ports: Provide a RS-232 or RS-485 communications ports for each digital controller that allows direct connection of a computer or handheld terminal and through which the controller may be fully accessed. Controller access shall not be limited to access through another controller. Interface communication ports shall be in addition to the communications port(s) supporting controller to controller communications. Communication rate is 9600 Baud minimum. Every controller on the highest-level LAN shall have a communications port supporting direct connection of a computer; a hand held terminal port is not sufficient. By connecting a computer to this port, every controller in the direct digital control system shall be accessible and programmable. The following operations shall be available: downloading and uploading control programs, modifying programs and program database, and retrieving or accepting trend reports, status reports, messages, and alarms.

3. Remote Workstation Interface Port: Provide one (1) additional direct connect computer port in each BMS system for permanent connection of a remote operator's work station, unless the workstation is a node on the LAN. All operations possible by directly connecting a computer to a controller at the highest-level LAN shall be available through this port.

2.04 ETHERNET NIC:

A. Provide one (1) Ethernet NIC per BMS system to communicate between the digital control system and the computer workstation. Minimum Ethernet transmission rate is 100 Gigahertz.

B. The BACnet communication network system will be redundant design such that a failure of a single communication link or node will not impact the ability of the system/sub-system to communicate with other nodes or from the SCADA system

2.05 DIGITAL CONTROLLER CABINET:

A. Each indoor digital controller cabinet shall protect the controller from dust and rated NEMA 1, unless specified otherwise. Refer to Electrical drawings for area classifications and categories. Each outdoor digital controller cabinet shall protect the controller from all outside conditions and rated NEMA 4. Cabinets for high level controllers shall be hinged door, lockable, and have offset removable metal back plate.

B. Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.

C. Identify all wiring by means of stamped markings on heat shrinkable tubing. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum twenty-five (25) conductors to each wire bundle.

D. Install "Hand-Off-Auto" selector switches such that safety controls and electrical over current protection are not overridden when selector switch is in the "Hand" position.

2.06 MAIN POWER SWITCH:

A. Each controller on the highest-level LAN or each control cabinet shall have a main external power switch for isolation of the controller from AC power. The switch shall be in the BMS cabinet.

2.07 TERMINAL CONTROL UNITS (TCUS):

A. The same company as the digital controllers shall manufacture TCUs.

B. TCUs shall automatically start-up on return of power after a failure, and previous operating parameters shall exist or shall be automatically downloaded from a digital controller on a higher level LAN.

C. TCUs do not require an internal clock if they get time information from a higher level digital controller.

2.08 WIRE

A. Control wiring for digital functions shall be 18 AWG minimum with 300 V insulation control wiring for analog functions shall be 18 AWG minimum with 300 V insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.

B. Sensor wiring shall be 18 AWG minimum twisted and shielded, 2 or 3 wire to match analogue function hardware or 16 AWG as required by code.

C. Transformer current wiring shall be 16 AWG minimum.

2.09 CONDUITS AND CABLES

A. All wiring shall be in conduit or trays. Conform to Division 23 requirements for conduit and tray Specifications.

B. Seal conduit where such conduit leaves heated areas and enters unheated area.

C. Run low level signal lines in separate conduit from high level signal and power transmission lines.

D. Identify each cable and wire at every termination point.

E. Where applicable, mount field interface equipment (i.e. relays, transducers, etc.) in local device cabinets adjacent to field interface panels.

F. Separate conduits shall be provided for pneumatic tubing and electrical wiring runs.

G. Color code all conductors and conduits by permanently applied color bands on maximum 30-foot intervals. Color code shall follow base building schedule.

2.10 RELATED ACCESSORIES

A. Provide and install all necessary transformers, transducers, interposing relays, interface devices, contractors, and EP's to perform control functions required.

B. It is the responsibility of the Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

C. Items required but not identified at the time of tender acceptance shall be the Contractor's responsibility.

2.11 CONTROL DAMPERS:

A. General:

1. See Section 23 09 23.12.

2. Furnish opposed-blade type for proportional action and parallel-blade type for two-position action, except where indicated otherwise in the Contract Documents.

B. Instrumentation and Controls:

1. The dampers shall have the option of being controlled locally or remotely via the main BMS system.

C. Shop Assembly:

1. The dampers shall be fully assembled to the maximum extent possible.

2.12 CONTROL DAMPER OPERATORS:

A. General:

1. See Section 23 09 23.12.

2. Drawings and Control Diagrams indicate only one damper motor for each motorized damper (M).

3. Select actual quantity of motors required to operate each damper in accordance with the size of damper provided.

4. Coordinate exact quantity of damper motors with electrical Work to ensure that necessary wiring and conduit is provided for installation.

5. Provide operators for motorized dampers and motorized louvers for all cases where an operator is not supplied as part of a unit.

2.13 AUTOMATIC CONTROL VALVES:

A. General:

1. See Section 23 09 93.11.

2.14 VALVE ACTUATORS:

A. General:

1. See Section 23 09 93.11.

2.15 ELECTRIC THERMOSTATS:

A. Office Area Room Thermostat:

1. Modulating electric type, except where two-position action is required.

2. Temperature Scale: Furnish 35 to 95 degrees F dial.

3. Concealed adjustments.

4. Adjustable sensitivity.

5. Removable, tamper-proof cover.

6. Insulating back, where exterior wall mounting is indicated in the Contract Documents.

B. Process Area Room Thermostat:

1. Modulating electric type, except where two-position action is required.

2. Temperature Scale: Furnish 35 to 95 degrees F dial.

3. External adjustments, temperature display.

4. Adjustable sensitivity.

5. Insulating back where exterior wall mounting is indicated in the Contract Documents.

6. Locking wire protective guard.

7. Enclosure and sensing element to match area classification and moisture/corrosion category.

C. Outdoor Thermostat:

1. Modulating electric type, except where two-position action is required.

2. Temperature Scale: Furnish -40 degrees F to 140 degrees F dial.

3. External adjustments, temperature display.

4. Adjustable sensitivity.

5. Insulating back where exterior wall mounting is indicated in the Contract Documents.

6. Locking wire protective guard.

7. Sunshield

8. Enclosure and sensing element to match area classification and moisture/corrosion category.

2.16 ELECTRONIC SENSORS:

A. Temperature:

1. General Requirements:

a. Sensors and transmitters shall be provided, as outlined in the control schematics, input/output summary and sequence of operations.

b. Temperature sensor shall be resistance type, and shall be two-wire 1,000-ohm platinum RTD.

c. The following point types (and accuracy of each) are required, and their associated accuracy values include errors associated with sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Hot / Chilled Water	+ 0.5 degrees F
Room Temperature	+ 0.5 degrees F
Duct Temperature	+ 0.5 degrees F
All Others	+ 0.7 degrees F

2. Room Temperature:

   a. Constructed for either surface or wall box mounting.

   b. Non-locking wire protective guards for room temperature sensors installed in process areas.

3. Room Temperature Sensors with Integral Display

   a. Constructed for either surface or wall box mounting.

   b. Non-locking wire protective guards for room temperature sensors installed in process areas.

   c. Integral LCD display and four button keypad with the following capabilities:

      (1) Display room and outside air temperatures

      (2) Display and adjust room comfort set point

      (3) Display and adjust fan operation status

      (4) Timed override request pushbutton with LED status for activation of after-hours operation

      (5) Display controller mode

      (6) Password selectable adjustment of set point and override modes

4. Duct Temperature:

   a. Accuracy: +/-1 degree F

   b. Range:

      (1) Heating: 40 to 140 degrees F

(2) Cooling: 30 to 100 degrees F

c. Element:

(1) Rigid insertion, 12-inch length, through sealed opening in center of duct.

(2) Averaging, for ducts or plenums with any dimension greater than 36 inches. Sealed opening in duct. Sensing element incorporated in copper capillary a minimum of 20 feet long, serpentined across full area of airflow.

B. Pressure (PS):

1. Air Pressure:

a. Accuracy: 5 percent of range

b. Range: 150 percent of measured variable

c. Mount non-vibrating

d. Cover: NEMA 250 Type, suitable for area classification; in accordance with NFPA 70

2. Water Pressure:

a. Dwyer Instruments Inc.; No. 630 Series, 0 to 20 psi

b. Transicoil Inc. (Robinson Halpern); No. 151 Series

C. Differential Pressure:

1. General:

a. Temperature compensated.

b. Vary output voltage with change in differential pressure. Voltage shall vary linearly from 0 to 10V DC according to differential pressure between high and low pressure ports.

c. Sensing range shall be suitable for application with linearity of 1.5 percent of full scale and offset of less than 1 percent of full scale.

d. Capable of withstanding up to 150 percent of rated pressure without damage.

e. Compatible with 14V to 30V DC supply voltage range.

2. Duct Air Static Differential Pressure (Flow Measurement):

    a. Ultra-low differential pressure and flow transmitter

    b. 0.5 percent of natural span accuracy

    c. 4-20 mA output.

    d. Pressure range to sit application

    e. Integral 3-way zeroing valve

    f. Built-in square root function

    g. NEMA 12 enclosure

    h. Veltron DPT 2500 transmitter with NEMA 12 enclosure

    i. Sensocon A3 controller/display with NEMA 12 enclosure

3. Space Air Static Differential Pressure: MAMAC Systems Inc. or Setra transmitter

4. Water Differential Pressure:

    a. Dwyer Instruments Inc.; No. 630 Series, 0 to 20 PSI range

    b. Rosemount Controls Inc.; No. 1151-DP Series

    c. Include three-valve manifold connection

D. Position Indicator:

1. 0 to 100 percent open, for damper, inlet vane, or similar

2. Potentiometer, 0 to 2,000 ohm equals 0 to 100 percent

E. Relative Humidity (RH):

1. Room Relative Humidity

2. Accuracy: +/-2 percent

3. Range: 10 to 95 percent

4. Solid state

F. Current Sensors (CS):

1. Fixed Setpoint, Digital Output Current Switch:

a. Manufacturer:

(1) Veris Industries Inc.; Hawkeye 600/800

b. Application: Monitoring status of direct drive equipment

c. Current-operated solid state relay

d. Split core design

e. Trip Setpoint: Fixed

f. Output: Digital switch

g. Sensor Power: Induced from line

2. Adjustable Setpoint, Analog Output Current Sensor:

a. Manufacturer:

(1) Veris Industries Inc.; Hawkeye H721LC/721HC

b. Application: Monitoring status of belt drive equipment

c. Current-operated solid state transducer

d. Split core design

e. Output: Analog

f. Sensor Power: Induced from line

3. Adjustable Setpoint, Digital Output, VFD Current Switch:

a. Manufacturer:

(1) Veris Industries Inc.; Hawkeye 904

b. Application: Monitoring status of belt-drive or direct-drive equipment controlled by a VFD

c. Microprocessor-based current-operated solid state relay

d. Automatic compensation for VFD frequency and current changes

e. Split core design

f. Trip Setpoint: Self-calibrating

g. Output: Digital switch, with normal and alarm status LED

h. Sensor Power: Induced from line

2.17 AIRFLOW MONITORING STATION

A. The airflow monitoring station shall consist of multiple aluminum airflow measuring elements containing multiple total and static pressure sensing ports placed along the leading edge of the cylinder. The static pressure chamber shall incorporate dual offset static taps on opposing sides of the averaging chamber capable of accommodating flow angle variations of plus or minus 20 degrees in the approaching airstream. The probes shall be manifolded together in a 0.06 inch type 316 stainless steel duct section with 90 degree undrilled flanges, fabricated to the duct size, and shall contain multiple interconnected airflow traverse elements.

B. Where primary flow elements are located outside of the Manufacturer's published installation guidelines the manufacturer shall be consulted, and approve of any special configurations, such as air equalizers and/or additional and strategically placed measuring points, as may be required.

C. The airflow traverse elements shall be capable of producing steady, non-pulsating signals of true total and static pressure. Signal amplifying sensors requiring flow correction (K factors) for field calibration are not acceptable.

D. Accuracy: plus or minus 2 percent

E. Operating Velocity Range: 100 to 1000 feet per minute

F. Operating Temperature Range: minus 40 to 104 degrees F

G. Air Pressure Drop: < 0.18 inches WG Pa at 4000 feet per second

H. Generated Noise Level: < NC40

I. Acceptable Manufacturers:

1. PCI

2. Ebtron

2.18 HIGH TEMPERATURE DETECTORS:

A. The high temperature switch shall be of the automatic reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC. An auxiliary contact shall be provided for remote alarm (EMS) monitoring of a high temperature condition.

B. The sensing element shall be bi-metal type.

C. Sensing element shall react to the warmest section of the multi section element.

D. Thermostat element shall be a probe type.

E. For large duct areas where the sensing element does not provide full coverage of the air stream, additional thermostats shall be provided as required to provide full protection of the air stream.

F. Provide means of providing a time delay on the high temperature cut out where required and indicated on the Drawings.

2.19 LOW TEMPERATURE DETECTORS:

A. The low temperature switch shall be of the automatic reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC. An auxiliary contact shall be provided for remote alarm (EMS) monitoring of a low temperature condition.

B. The sensing element shall be a minimum of 20 feet in length and shall react to the coldest 18 inch section.

C. Element shall be of sufficient length to allow a serpentine distribution across the duct cross section and provide an accurate indication of the air flow temperature, especially in the case where a mixed air temperature is being measured.

D. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

E. Provide means of providing a time delay on the low temperature cut out where required and indicated on the Drawings.

2.20 TIMER PUSHBUTTON STATIONS:

A. Provide NEMA 12 panel complete with surface-mounted on and off momentary pushbuttons/contacts, LED feedback lamp and flush-mounted LCD display on outer surface of panel.

B. LED shall go ON when ‘ON’ pushbutton is pressed to indicate that ventilation system has been activated.

C. LCD display shall indicate the ventilation system run time remaining following each press of the 'ON' pushbutton. For each time the 'ON' pushbutton is pressed, an operator-adjustable run time interval will be banked up to a maximum of one hour and the display will count down from the total accumulated value selected.

D. The 'OFF' pushbutton, when pressed, shall override the time remaining and stop the ventilation, except where the space temperature exceeds the maximum space temperature setpoint.

E. Provide non-wear, securely fastened signage next to each pushbutton station with the following wording: "Press ON Pushbutton until Desired Room Ventilation System Run Time is Displayed. To Override Selected Runtime, Press OFF Pushbutton.

2.21 BMS SOFTWARE:

A. Provide, in the digital controllers, software to execute the sequence of control. Provide one (1) registered copy of all software used to program control sequences in all direct digital controllers and LAN controllers on the computer workstation. Provide any access keys which restrict programming language software functions or the ability to compile or prepare programming for download to controllers. Provide final copy of each program used in the system in both compiled and editable formats. Where specially programmed factory configured smart controllers are used in the system, provide minimum factory programming tools and specialized controller programs ready for download to replacement controllers. At minimum, controllers must be capable of performing programming functions outlined in the following "Parameter Modification" section.

B. Provide software to modify control parameters. Parameter modification for all controllers (high level and low-level application specific) is through the main workstation computer and with laptop computer or keypad terminal directly at each controller. Modifications are to be accomplished without having to make changes directly in line-by-line programming. When the control program is of the line-by-line type, database parameters in the following list that take real number values require assignment of variable names so parameters can be changed without modifying programming. Alternatively, block programming languages shall provide for modification of these database parameters in fill-in-the-blank screens. Parameters of like type, including those in different high level and low-level controllers, may be grouped together for a single, global change. For example, an operator may group all second floor space temperature setpoints into a group and raise the setpoint by two degrees with a single command. The following parameters shall be modifiable in this way:

1. Setpoints.

2. Dead band limits and spans.

3. Reset schedules.

4. Switch over points.

5. PID gains and time between control output changes.

6. Time.

7. Timed local override time.

8. Occupancy schedules.

9. Holidays.

10. Alarm points, alarm limits, and alarm messages.

11. Point definition database.

12. Point enable, disable, and override.

13. Trend points, trend intervals, trend reports.

14. Analog input default values.

15. Passwords.

16. Communications parameters including network and telephone communications setups.

C. Differential:

1. Where setpoint is in response to some analog input such as temperature, pressure, or humidity, include a setpoint differential to prevent short cycling of control devices.

D. Motor and Flow Status Delay:

E. Provide an adjustable delay between when a motor is commanded on or off and when the control program looks to the motor or flow status input for confirmation of successful command execution.

F. Run Time Accumulation:

1. Provide resettable run time accumulation for each controlled digital output.

G. Time Programs:

1. Provide programs to automatically adjust for leap years, daylight savings time, and operator time adjustments.

H. Scheduling:

1. Individual controlled equipment shall be schedulable with schedule based on time of day, day of week, and day of year. Equipment may be associated into groups. Each group may be associated with a different schedule. Changing the schedule of a group shall change the schedule of all equipment in the group. Groups may be modified, created, and deleted by the operator.

2. Provide capability to view and modify schedules in a seven-day week format. When control program does not automatically compute holidays, provide capability to enter holiday schedules one (1) full year at a time.

I. Point Override:

1. I/O and virtual points shall accept software overrides to any possible value.

J. Alarming:

1. I/O points and software points shall be alarmable. Alarms may be enabled and disabled for every point. Alarm limits shall be adjustable on analog points. Controllers connected to an external communications device such as a printer, terminal, or computer, shall download alarm and alarm message when alarm occurs. Otherwise alarms will be stored and automatically downloaded when a communications link occurs. In addition to those described in Schedule 18 C11.4, the following conditions shall generate alarms:

   a. An analog input takes a value indicating sensor failure.

   b. A module is not communicating on the LAN.

   c. A power outage occurs.

   d. Activation of any emergency eyewash or emergency shower.

K. Messages:

1. Messages shall consist of the device tag number, the device/associated equipment description and fault, and be assigned to alarm or status conditions. An example of a message for the activation of a pressure switch would be, “80-PDS-XXXXX, - Air Handling Unit 80-AHU-XXXXX - Summer Filter Dirty”. Messages shall be displayed on the workstation and be capable of being printed when these conditions occur.

L. Trending:

1. BMS system shall have the capability to trend all I/O and virtual points. Points may be associated into groups. A trend report may be set up for each group. The period between logging consecutive trend values shall range from fifteen seconds to sixty

(60) minutes at a minimum. The minimum number of consecutive trend values stored at one time shall be 6000 per variable. Trend data shall be uploaded to workstation computer automatically for archiving and processing prior to controller storage being exceeded, maximum once per day. Trend data shall be available on a real time or archived basis; trend data shall appear numerically and graphically on a connected computer's screen as the data is processed from the BMS. Workstation software will process the data into user defined reports. The system must be able to show single or multiple values in multiple ranges on a single graph, including the ability to mix analog and digital signals. The time scale must be user definable. The line types must be able to be displayed in a variety of formats including column, line, symbol, scatter or area. The user must be able to zoom and scroll on the trend. The trend should be capable of displaying a user selected point value. Database for storing of archived data and reports shall be in ASCII format compatible for export to common database manipulation programs (e.g. Microsoft Access, Microsoft Excel). Archived data and reports shall be kept and be retrievable for a minimum of two (2) years.

2. All Trended and archived data will be accessible by the SCADA system

M. Status Display:

1. Current status of I/O and virtual points shall be displayed on command. Points shall be associated into functional groups, such as all the I/O and virtual points associated with control of a make-up air unit, and displayed as a group, so the status of a single mechanical system can be readily checked. A group shall be selectable from a menu of groups having meaningful names; such as 80- MAU-XXXXX, Screen Room, Electrical room Heat Cooling System, and other such names.

N. Diagnostics:

1. Each controller shall perform self-diagnostic routines and provide messages to an operator when errors are detected. The BMS shall be capable of recognizing a non-responsive module on a LAN. The remaining, responsive modules on a LAN shall not operate in a degraded mode.

O. Power Loss:

1. During a power outage, each controller shall assume a disabled status and outputs shall go to a user definable state. Upon restoration of power, the BMS shall perform an orderly restart, with sequencing of outputs.

P. Program Transfer:

1. Provide software for download of control programs and database from a computer to controllers and upload of same to a computer from controllers. Every digital controller in the BMS shall be capable of being downloaded and uploaded to through a single controller on the highest-level LAN.

Q. System Back-up and Restoration:

1. The entire control system shall be capable of being backed-up or restored to or from a single back-up storage media.

R. Password Protection:

1. Provide at least four (4) levels of password protection to the BMS permitting different levels of access to the system. The lowest level allows monitoring only. The highest level allows full control of all functions, including setting new passwords.

S. Operator Workstation:

1. BMS System provider will confirm the Operator Work Station (OWS) being supplied conforms to the requirements with the Facility Information Management System Standards. OWS will be at a minimum

2. Desktop Computer:

a. Processor: 7th Generation Intel® Core™ processor (8M Cache, up to 4.00 GHz).

b. OS: Windows 10 Professional.

c. Memory: 8 GB Dual Channel DDR3 1600 MHz.

d. Hard Drive: 1TB 7200 RPM SATA Hard Drive 6.0 Gb/s.

e. Video Card: NVIDIA GeForce GT 720 1GB DDR3.

f. Sound Card: Integrated 7.1 with WAVE MAXXAudio 4.

g. Optical Drive: Tray load DVD drive (reads and writes to DVD/CD).

h. Internal battery-backed real time clock.

i. Provide at a minimum 4 USB, 3 serial and 2 parallel port to connect I/O devices.

3. Monitor:

a. BMS System provider will confirm monitor being supplied conforms to the requirements with the Facility Information Management System Standards. Monitor will be at a minimum:

b. Diagonally Viewable Size: 23.8 inches.

c. Aspect Ratio: Widescreen (16:9).

d. Panel Type, Surface: In-plane switching, anti-glare with hard coat 3H.

e. Optimal resolution: 1920 x 1080 at 60Hz.

f. Contrast Ratio: 1000: 1 (typical), 2 Million: 1 (Max) (Dynamic Contrast Ratio).

g. Brightness: 250 cd/m^2 (typical).

h. Response Time: 8 ms (gray to gray).

i. Viewing Angle: (178° vertical / 178° horizontal).

j. Color Support: Color Gamut[7] (typical): 85% (CIE1976), sRGB 96% (average Delta E of>4) 16.77 Million colors.

k. Pixel Pitch: 0.274 mm.

l. Backlight Technology: LED.

m. Display Type: Widescreen Flat Panel Display.

n. Display Screen Coating: Antiglare with hard-coating 3H.

o. Stand: Height adjustable stand, tilt, pivot, swivel and built in cable management.

p. Connectivity: 2 HDMI(MHL) connectors, 1 Mini DisplayPort, 1 DisplayPort (version 1.2a), 1 DisplayPort out (MST), 1 Audio Line out, 4 USB 3.0 ports - Downstream (4 at the back, 1 with battery charging), 1 USB 3.0 port – Upstream.

4. Printer:

a. BMS System provider will confirm printers being supplied conforms to the requirements with the Facility Information Management System Standards. Printers will be at a minimum:

b. Inkjet type printer.

c. Normal print resolution 600 x 600 dpi.

PART 3 - EXECUTION

3.01 GENERAL – INSTALLATION OF FIELD COMPONENTS AND INSTRUMENTS:

A. The control drawings and/or control sequences indicate only the principal items of equipment controlling the systems. Supplement each control system with all devices (e.g. relays) gauges and auxiliaries required to enable each system to perform as specified and to permit proper operation and supervision of same.

B. Upon completion of the Work, all control devices shall be calibrated, tested and verified, as required, to place the system in complete and satisfactory operating condition.

C. Notify the Consultant in writing of any conflict between these Specifications and the manufacturer's instructions.

D. All equipment installed shall be mechanically stable and, as necessary, fixed to floor or wall. Anti-vibration mounts to be provided, where required, for the proper isolation of equipment.

E. Install equipment so as to allow for ease of maintenance access such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.

F. Install equipment in locations having suitable ambient conditions for its specified functioning, allowing for adequate ventilation and the prevention of condensation traps.

G. Outdoor installation is to be weatherproof construction in NEMA 4X enclosures.

H. Ensure that all holes drilled in ductwork and HVAC equipment housings are properly sealed to eliminate leakage and to maintain the pressure rating of the equipment in question.

I. Confirm Operator Workstation location with Engineer prior to installation.

J. Install damper motors on outside of ducts. Do not locate in air stream.

K. Wire "hand/off/auto" selector switches such that automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.

L. Coordinate and confirm all controller set points with the balancing Contractor to verify all minimum and maximum air volumes on VSD controlled fans, air handlers and make-up air units.

M. The BMS provider and the SCADA System Integrator shall work together to ensure all controls, alarms, setpoints are integrated into the SCADA system.

N. Provide copies of proposed control screens to Engineer for review prior to implementation.

3.02 TEMPERATURE SENSORS AND THERMOWELLS:

A. Provide mixed air temperature sensors of a sufficient length to give an accurate temperature indication for the cross section of mixing plenum or duct involved. Install sensors in a serpentine arrangement about the plane of stratification (horizontal or vertical) so that an equal length of the sensing element covers an equal area of the mixing plenum and an accurate measurement of the mixed air temperature is achieved.

B. Unless otherwise indicated in the Contract Documents, mount space sensors 60 inches above the finished floor level. Confirm exact location of all thermostats prior to roughing-in.

C. In process/service areas, utility rooms and other areas where the thermostat might be subject to damage, provide a metal cage or cast aluminum thermostat guard.

D. Drill holes, weld thread-o-lets and mount thermowells in piping after isolating and draining the section to be worked on. Notify the Consultant/Regions before doing so. Install sensors in thermowells with dust-tight connection heads. Ensure sensor element is immersed in heat transfer compound and firmly seated against tip of well. Element shall extend at least two thirds of the pipe diameter into the pipe. Install sensor in region of piping where well-mixed conditions exist (e.g. at a pipe bend) wherever possible. Where pipe diameter is less than the length of the sensing element, mount sensor at piping elbow. Use stainless steel thermowells with extensions, where required, to accommodate thickness of insulation. Replace and repair insulation and pipe jacketing to return to original condition.

3.03 INSTALLATION OF DIRECT DIGITAL CONTROL SYSTEM COMPONENTS:

A. Provide all control (including 120V where indicated on the Drawings) and power wiring, including installation required to interconnect control components located on air handling units and power wiring between lighting panel circuits provided under Division 26 and field-mounted controllers . Refer to electrical wiring diagrams for details regarding interconnection wiring requirements with control components.

B. Sensor and control device wiring are to be as recommended by the control system manufacturer.

C. Provide all contacts and interfaces required for pickup of alarm and status points for systems and equipment other than the SCADA controlled devices as indicated on the Drawings.

3.04 INSTALLATION OF DAMPERS AND OPERATORS:

A. Provide the required number of electric operators to properly drive all system dampers. Check and test operation, and adjust as required.

B. Securely mount operators on damper frames to withstand counter torque created by dampers.

C. Install at locations indicated on the Drawings and in accordance with the manufacturer's instructions.

D. Install square and free from racking with blades running horizontally.

E. Operate opposed blade dampers from a power blade or drive axle.

F. Bracing:

1. Install for multiple section assemblies to support assembly weight and to hold against system pressure.

2. Install at every horizontal and vertical mullion.

3.05 INSTALLATION OF THERMOSTATS:

A. Unless otherwise specified in the Contract Documents, provide all required line voltage thermostats, including those for unit heaters and fan coils.

B. In process areas, utility rooms and other areas where the thermostat might be subject to damage provide a metal cage or cast aluminum thermostat guard. Note; No guard is required where Farm-o-Stats are used.

C. Unless otherwise indicated in the Contract Documents, mount room thermostats 60 inches above the finished floor level. Confirm exact location of all thermostats prior to roughing-in.

D. Provide stand-off mounting and an insulated sub-base for thermostats on outside walls.

3.06 INSTALLATION OF HIGH AND LOW TEMPERATURE DETECTORS, AND ACCESSORIES:

A. Place where indicated on the control Drawings.

B. Element shall be mounted across duct to in a serpentine arrangement about the plane of stratification (horizontal or vertical) so that an equal length of the sensing element covers an equal area of the mixing plenum and an accurate measurement of temperature is achieved.

3.07 INSTALLATION OF CONTROL COMPONENT PANELS:

A. Provide at locations indicated on the Drawings or implied by the Drawings and Control Specifications. Locate panels to provide a convenient operator interface with control system.

B. Surface wall mount or secure in place between free-standing galvanized structural steel members.

C. Confirm exact cabinet locations prior to roughing-in.

3.08 ACCEPTANCE TESTING:

A. A final operational acceptance test of seven (7) consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the Specifications.

1. Acceptance testing will require the SCADA/BMS integrated systems to be functional

B. The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control programs and algorithms, diagnostics and all other software.

C. In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven (7) failure-free test days have occurred.

D. After successful completion of the acceptance test, the Engineer will issue written acceptance of the control system.

E. Prior to acceptance of the Work, submit hard copy and electronic copy on disk of final database listings.

3.09 TRAINING:

A. Construction Contractor to provide three (3) weeks written notice to the Engineer prior to commencing formal training sessions.

B. Formal training sessions shall commence only after "As-Constructed" Drawings have been completed, reviewed and approved by the Engineer.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 23 09 23.12

CONTROL DAMPERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide control dampers and actuators for DDC systems as indicated and in compliance with Contract Documents.

1. Rectangular control dampers

2. General control-damper actuator requirements

3. Electric and electronic actuators

B. Drawings and Control Diagrams indicate only one damper motor for each motorized damper (M).

C. Select actual quantity of motors required to operate each damper in accordance with the size of damper provided.

D. Coordinate exact quantity of damper motors with electrical Work to ensure that necessary wiring and conduit is provided for installation.

1.02 REFERENCES:

A. Air Movement and Control Association International, Inc. (AMCA):

1. 500D: Laboratory Methods of Testing Dampers for Rating

2. 511: Certified Ratings Program Product Rating manual for Air Control Devices

B. American Society of Mechanical Engineers (ASME):

1. Boiler and Pressure Vessel Code

C. ASTM International (ASTM):

1. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

2. B211: Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code

1.03 DEFINITIONS:

A. DDC: Direct-digital control

B. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.

3. Product description with complete technical data, performance curves, and product specification sheets.

4. Installation instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.

2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

4. Include diagrams for air and process signal tubing.

5. Include diagrams for pneumatic signal and main air tubing.

D. Delegated-Design Submittal:

1. Schedule and design calculations for control dampers and actuators, including the following.

a. Flow at project design and minimum flow conditions.

b. Pressure drop across damper at project design and minimum airflow conditions.

c. Maximum close-off pressure.

d. Torque required at worst case condition for sizing actuator.

e. Actuator selection indicating torque provided.

E. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to room, duct, and equipment.

2. Size and location of wall access panels for control dampers and actuators installed behind walls.

3. Size and location of ceiling access panels for control dampers and actuators installed above inaccessible ceilings.

F. Operation and Maintenance Data: For control dampers to include in operation and maintenance manuals.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 MOTORIZED THERMALLY INSULATED CONTROL DAMPERS:

A. Extruded aluminum (6063-T5) damper frame shall not be less than 0.08 inches in thickness. Damper frame shall be 4 inches deep x 1 inch, with duct mounting flanges on both sides of frame. Damper frame shall have a 2-inch mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame to be assembled using zinc-plated steel mounting fasteners.

B. Blades shall be a maximum of 6 inches deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 0.06 inches. Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55 (tested to AAMA 1502.7 Test Method).

C. Blade seals shall be extruded EPDM, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.

D. Frame seals shall be extruded silicone, secured in an integral slot within the aluminum frame extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Metallic compression type jamb seals will not be approved.

E. Bearings shall be a dual bearing system composed of a Celcon inner bearing (fixed around a 0.437-inch aluminum hexagon blade pivot pin), rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable.

F. Hexagonal control shaft shall be 0.437-inches. It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be zinc-plated steel.

G. Linkage hardware shall be aluminum and corrosion-resistant zinc-plated steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with cup-point trunnion screws to prevent linkage slippage. Linkage that consists of metal rubbing metal will not be approved.

H. Dampers shall be designed for operation in temperatures ranging from -40 degrees F to 212 degrees F.

I. Dampers shall be AMCA rated for Leakage Class 1A at 1-inch water gage static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.

J. Dampers shall be custom made to required size, with blade stops not exceeding 1.25 inches in height.

K. Dampers shall be opposed blade action for modulating airflow control and parallel blade for two position open – close action.

L. Standard of Acceptance: TAMCO Series 9000 thermally insulated damper

M. Manufacturers:

1. Tamco

2. Nailor

3. Ruskin

2.02 MOTORIZED CONTROL DAMPERS:

A. Extruded aluminum (6063-T5) damper frame shall not be less than 0.08 inches in thickness. Damper frame shall be 4 inches deep x 1 inch, with duct mounting flanges on both sides of frame. Damper frame shall have a 2-inch mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame to be assembled using zinc-plated steel mounting fasteners.

B. Blades shall be maximum 6 inches deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 0.06 inches.

C. Blade seals shall be extruded EPDM, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.

D. Frame seals shall be extruded silicone, secured in an integral slot within the aluminum frame extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Metallic compression type jamb seals will not be approved.

E. Bearings shall be a dual bearing system composed of a Celcon inner bearing (fixed around 0.437 inch aluminum hexagon blade pivot pin, rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable.

F. Hexagonal control shaft shall be 0.437 inch. It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be zinc-plated steel.

G. Linkage hardware shall be aluminum and corrosion-resistant zinc-plated steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with cup-point trunnion screws to prevent linkage slippage. Linkage that consists of metal rubbing metal will not be approved.

H. Dampers shall be designed for operation in temperatures ranging from -40 degrees F to 212 degrees F.

I. Dampers shall be AMCA rated for Leakage Class 1A at 1 inch water gage static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.

J. Dampers shall be custom made to required size, with blade stops not exceeding 1.25 inches in height.

K. Dampers shall be opposed blade action for modulating airflow control and parallel blade for two position open – close action.

L. Standard of acceptance: TAMCO Series 1000 Air-Foil Control Damper

M. Manufacturers:

1. Tamco

2. Nailor

3. Ruskin

2.03 DAMPER OPERATORS:

A. Electronic Operators for Modulating Damper:

1. Fail-safe spring return, 24 VAC operating voltage, 0 to 10 VDC input signal, 0 to 10 VDC position output signal, seventy (70) seconds maximum running time for 90 degrees opening and thirty (30) seconds maximum closing time.

2. Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one damper operator per damper section.

3. Provide manual override gear release or crank.

4. For modulating actuators provide actuator with 0-10V feedback proportional to damper position.

5. Provide position indicator.

6. Provide two (2) auxiliary switches for position proofing, one (1) at 10 degrees rotation and one (1) adjustable up to 90 degrees rotation.

7. Unless otherwise shown on the Drawings, operators to be provided and set up such that all return air dampers are normally open (fail open) and exhaust and outdoor air dampers fail normally closed (fail closed).

8. Provide “fail safe”, spring return, direct coupled type, 24 volt or 120 volt A.C. operators with accessories as required, each suitable in all respects for the application.

9. Provide Class 1 Division 2 or Class 1 Division 1 rated actuators or explosion-resistant enclosures where required.

10. All actuators provided shall be from a single manufacturer.

11. Acceptable manufacturers:

    a. Belimo Aircontrols Inc.

    b. Johnson Controls Inc.

    c. Siemens Building Technologies Inc.

B. Electronic Operators for Two Position Damper:

1. Spring return, 24 VAC operating voltage, seventy (70) seconds maximum running time for 90 degrees opening and thirty (30) seconds maximum closing time.

2. Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one damper operator per damper section.

3. Provide manual override gear release or crank.

4. Provide position indicator.

5. Provide two (2) auxiliary switches for position proofing, one (1) at 10 degrees rotation and one (1) adjustable up to 90 degrees rotation.

6. Provide Class 1 Division 1 or 2 rated actuators or explosion-resistant enclosures where required

2.04 PERFORMANCE REQUIREMENTS:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

C. Backup Power Source: Systems and equipment served by a backup power source shall have associated control damper actuators served from a backup power source.

D. Environmental Conditions:

1. Provide electric control-damper actuators, with protective enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Electric control-damper actuators not available with integral enclosures, com-

plying with requirements indicated, shall be housed in protective secondary enclosures.

a. Hazardous Locations: Explosion-proof rating for condition

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CONTROL-DAMPER APPLICATIONS:

A. Select from damper types indicated in "Control Dampers" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

1. Rectangular Exhaust Air Duct Applications: Rectangular dampers with aluminum airfoil blades. Insulated rectangular dampers.

2. Rectangular Outdoor Air Duct Applications: Rectangular dampers with aluminum airfoil blades. Insulated rectangular dampers.

3. Rectangular Return Air Duct Applications: Rectangular dampers with aluminum airfoil blades.

4. Rectangular Supply Air Duct Applications: Rectangular dampers with aluminum airfoil blades.

3.03 INSTALLATION, GENERAL:

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment..

C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Seal penetrations made in fire-rated and acoustically rated assemblies.

E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.

2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:

a. Laboratory exhaust airstreams

b. Process exhaust airstreams

c. Odor Control Systems

3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.

4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.

5. Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.04 ELECTRIC POWER:

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install raceways. Comply with requirements in Section 26 05 33.

3.05 CONTROL DAMPERS:

A. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

B. Clearance:

1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.

2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.

C. Service Access:

1. Dampers and actuators shall be accessible for visual inspection and service.

2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 23 33 00.

D. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

E. Attach actuator(s) to damper drive shaft.

F. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.06 CONNECTIONS:

A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 26 05 26.

3.07 IDENTIFICATION:

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53.

B. Install engraved phenolic nameplate with damper identification on damper.

3.08 CHECKOUT PROCEDURES:

A. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.

2. Check dampers for proper location and accessibility.

3. Verify that control dampers are installed correctly for flow direction.

4. Verify that proper blade alignment, either parallel or opposed, has been provided.

5. Verify that damper frame attachment is properly secured and sealed.

6. Verify that damper actuator and linkage attachment are secure.

7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.

8. Verify that damper blade travel is unobstructed.

3.09 ADJUSTMENT, CALIBRATION, AND TESTING:

A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressure.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 23 09 93.11

SEQUENCE OF OPERATIONS FOR HVAC DDC

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide control sequences for DDC for HVAC systems, subsystems, and equipment as indicated and in compliance with Contract Documents.

1.02 DEFINITIONS:

A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA)

B. Binary Output: On/off output signal or contact closure

C. DDC: Direct digital control

D. Digital Output: Data output that must be interpreted digitally

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data:

1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.

2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

C. Shop Drawings:

1. Riser diagrams showing control network layout, communication protocol, and wire types.

2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.

3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.08 MAKE UP AIR-UNIT CONTROL SEQUENCES:

A. Make Up Unit 01-MAU-81210 – Pump Room 101:

1. Makeup air unit 01-MAU-81210 will be started via the BMS based on scheduling to be determined by the owner (initially set to run continuously).

2. Motorized dampers 01-MD-81570 and 01-MD-81580 shall be energized to open and proven to be open.

3. The 01-MAU-81210 shall be started.

4. The BMS will monitor the space temperature in the Pump Room 101. The BMS will allow a signal from the SCADA to adjust the space temperature set point.

5. The lower space temperature setpoint will be set to 65 degrees F.

6. In the event the space temperature drops below 65 degrees F the makeup air units' discharge air temperatures will be adjusted upward proportionally to the error from the set point by a signal to the gas burner controls.

7. If the space temperature goes above 67 degrees F for the space the discharge temperature setpoint of 01-MAU-81210 will be decreased proportionally until the gas burner shuts off. The minimum discharge air temperature will be 45 degrees F.

8. If the space temperature in the room exceeds 100 degrees F (adjustable) a high temperature alarm will be generated via the BMS to the SCADA.

9. If the space temperature in the room drops below 45 degrees F (adjustable) a low temperature alarm will be generated via the BMS to the SCADA.

10. Pressure drop across the air filters will be continuously monitored with an alarm being initiated to the BMS if the pressure drop exceeds a predetermined set point. The pressure drop of the filter at the alarm point is not to affect the airflow by more than 10 percent of design. The set point of the alarm is to be provided by the air handler manufacturer based on the unit's fan performance and the performance of the specified filter.

B.

1.09 COOLING FANS CONTROL SEQUENCES:

A. Cooling Fans 01-F-81410 and 01-F-81420 - Pump Room 101:

1. The high horsepower effluent pumps result in a large, rejected heat load to the space. To control the space temperature supply fans will induce outside air in amounts proportional to the current heat load and exhaust fans will expel room air at a rate to avoid over pressurizing the space.

2. Upon exceeding a space temperature setpoint of 85 degrees F motorized damper 01-MD-81550 will open and supply fan 01-F-81410 will be started with the VFDs set to 20%.

3. At the same time 01-F-81410 is started motorized damper 01-MD-81560 will open and exhaust fan 01-F-81420 will be started to keep the space positively pressurized at 0.10" water gage (adjustable) relevant to outside.

4. Exhaust fan 01-F-81420, controlled by a VFD, will be adjusted to maintain the room pressure set point.

5. If the space temperature drops below 85 degrees F supply fan 01-F-81410 will slow proportionally to room temperature deviation to a low speed of 20%.

6. If the space temperature drops below 65 degrees F both 01-F-81410 and 01-F-81420 will stop and motorized dampers 01-MD-81550 and 01-MD-81560 will close.

7. Pressure drop across the air filters will be continuously monitored with an alarm being initiated in the BMS if the pressure drop exceeds a predetermined set point. The pressure drop of the filter at the alarm point is not to affect the airflow by more than 10 percent of design.

1.10 AIR HANDLING UNIT CONTROL SEQUENCES:

A. Air Handling Unit 10-AHU-81310 and 10-AHU-81320 – Electrical Room:

1. The air handling units will be started via the BMS system based on load requirements per the following.

2. With the air handler off mixing dampers are to be set to full return air and the supply air isolation dampers are to be closed.

3. On start of the air handler's 10-AHU-81310's or 10-AHU-81320 supply fan return air damper will be fully open, outside air damper fully closed and relief air damper closed. Damper positions will be confirmed prior to starting the fans.

4. After startup the default position of the return and outside air damper will allow the scheduled minimum outside air to enter the unit.

5. Only one air handler will be started at a time and will be designated the primary unit.

6. The second air handler shall be designated the primary unit and the first air handler shutdown on a schedule to maintain equal service time. Set initial switchover schedule at 30 days (adjustable).

7. In the event of the primary unit failing the BMS will automatically switch primary duty to the other unit.

8. The BMS will monitor the space temperature in Electrical Room and adjust the discharge air temperature proportionally to the error from setpoint. The BMS will allow a signal from the SCADA to adjust the space temperature set point.

9. Minimum space temperature set point for the Electrical Room will be 68 degrees F and the maximum will be 80 degrees F.

10. If the space temperature falls below the minimum space temperature setpoint the electric heating coil in the unit will be activated. The coil output shall modulate proportionally to the deviation from setpoint with maximum output at 5 degrees F below setpoint.

11. If the Electrical Room space temperature is above 75 degrees F and the outside air is below 65 degrees F the unit's outside air damper will be modulated open from its minimum position with the return air damper modulating closed to achieve a discharge air temperature proportional to the temperature error from setpoint with a minimum limit of 55 degrees F discharge temperature. This provides free cooling.

12. As the Outside air damper opens the relief air dampers 10-MD-81520 and 10-MD-81540 will open to maintain a positive space pressure of 0.1 inches water gage relative to adjacent spaces.

13. If the unit is at maximum free cooling and the maximum space temperature cannot be held the unit will revert to minimum outside air with the dampers and the mechanical cooling will be engaged..

14. The BMS will monitor the space temperature in Electrical Room and adjust the discharge air temperature proportionally to the error from setpoint with a minimum limit of 55 degrees F discharge temp. The BMS will allow a signal from the SCADA to adjust the space temperature set point.

15. Upon dropping 2 degrees Fahrenheit below the maximum space temperature the mechanical cooling will shut down.

16. If the space temperature in the Electrical Room exceeds 90 degrees F a high temperature alarm will be generated via the BMS to the SCADA.

17. If the space temperature in the Electrical Room drops below 55 degrees F a low temperature alarm will be generated via the BMS to the SCADA.

18. Pressure drop across the air filters will be continuously monitored with an alarm being initiated in the BMS if the pressure drop exceeds a predetermined set point. The pressure drop of the filter at the alarm point is not to affect the airflow by more than 10 percent of design. The set point of the alarm is to be provided by the air handler manufacturer based on the unit's fan performance and the performance of the specified filter.

B. Force Flow Heater, Electric (Typical): Space thermostat cycles fan and sequences stages of heating.

1. Space Temperature:

a. Input:

(1) Device: Electric thermostat

(2) Location: Space

b. Output:

(1) Device: Hard wired

(2) Location: Unit control panel

(3) Transference: Electric contactors

c. Action: Sequence electric coil stages and fan to maintain 65 degrees F space temperature.

C. Baseboard Heater, Electric (Typical): Space thermostat cycles heating.

1. Space Temperature:

a. Input:

(1) Device: Electric thermostat

(2) Location: Integral

b. Output:

(1) Device: Hard wired

(2) Location: Unit control panel

(3) Transference: Electric contactors

c. Action: Baseboard heater cycles to maintain 65 degrees F space temperature.

D. Split-type Air Conditioner (Typical): Space thermostat cycles fan and cooling capacity.

1. Space Temperature:

a. Input:

(1) Device: Electronic thermostat

(2) Location: Space

b. Output:

(1) Device: Hard wired

(2) Location: Unit control panel

c. Action: Modulate cooling capacity and fan to maintain 75 degrees F space temperature.

1.11 BOOSTER PUMP:

A. General:

1. The purpose of this system is to boost the site distribution water pressure, which is discharged into a break tank to prevent cross-contamination. The ASHRAE

90.1 controls and the hydro-pneumatic tank allow the system to shut down during periods of low demand.

2. This system consists of the following, all furnished as a part of the booster pump package:

   a. Two (2) centrifugal booster pumps; each selected for (50 percent duty)

   b. Two (2) variable frequency drives (VFD)s

   c. Inlet manifold

   d. Discharge manifold

   e. Diaphragm tank to smooth out flow and pressure changes

   f. Suction line pressure transmitter

   g. Remote discharge line pressure transmitter (on Screw Press Level)

   h. Turbine flow meter on discharge line. (turbine meter may be eliminated where the power consumed by the pump based on rpm can determine the approximate flow.)

   i. Electronic microprocessor control system

   j. Gateway for interconnecting booster pump control system with the SCADA system.

   k. Two (2) current switch inputs to the SCADA indicating which pumps are running.

   l. A digital output to indicate the system is in low water pressure alarm.

3. All adjustments to the system operating parameters will be required to be performed at the HMI located on the local pump controller provided by the booster pump manufacturer; not on the SCADA system.

B. Integral Microprocessor Control System:

1. The control system provided is required to meet the minimum requirements of section 10.4.2 of ASHRAE standard 90.1. In addition, the pump includes a pump suction pressure transmitter. The purpose of the transmitter is to ensure the booster pump does not pull excessive suction on the incoming water line, thus reducing the pressure to other system users.

   a. Section 10.4.2 of ASHRAE standard 90.1-2013 (or later) states as follows:

(1) One or more pressure sensors shall be used to vary the pump speed and/or start and stop of pumps. The sensor(s) shall either be located near the critical fixture(s) that determine the pressure required, or logic shall be employed that adjusts the setpoint to simulate operation of remote sensor(s).

(2) No device(s) shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster system, except for safety devices.

(3) No booster system pumps shall operate when there is no service water flow.

b. The control shall therefore employ the following sequence of operation:

C. Sequence of Operation:

1. The control system shall include logic for each pump so that the control system knows where the pump is operating on the pump curve including flow, pressure, speed, efficiency, and brake horsepower.

2. At greater than 25 percent flow capacity, the control system will determine the number of pumps in operation based on efficiency or brake horsepower. Some delay in the logic may be incorporated such that the number of pumps in operation does not fluctuate at a rate greater than the booster pump manufacturer recommends.

3. For one or more remote pressure transmitters:

a. At greater than 25 percent flow capacity, if the booster pump system is provided with one or more remote pressure transmitters, the pump speed will be modulated in direct response to the remote pressure transmitter readings; particularly the one that is most different from its low pressure setpoint.

b. The minimum suction pressure setpoint will be used to limit the amount of water that is drawn from the pump water supply. The initial setting will be 5 psig less than the expected minimum inlet pressure. When a suction pressure lower than this value is attained, the discharge pressure setpoint variable will be overridden and the pump speed will be reduced to meet this minimum inlet pressure variable requirement.

c. When the number of pumps is required to change, the system shall employ a rotational sequence to maintain an even distribution of pump starts and pump run time.

d. When more than one pump is in operation, the operating pumps will operate at the same speed.

4. Manual Operation:

    a. A “test-off-auto” selector switch is provided on the booster pump control cabinet on the HMI or VFD for each pump. The “test” position includes a spring return to the “off” position and is used to initiate the operation of each pump independent of the pump pressure/speed controls.

D. SCADA Interface and Monitoring:

1. The SCADA system will monitor the following:

    a. Pump number of starts (each)

    b. Pump run time (each - based on current switches)

    c. “Lag” pump in operation (two pumps running)

    d. Suction pressure

    e. Local discharge pressure

    f. Remote discharge pressure

    g. Water flow

    h. Pump speed

2. The SCADA system operators will be alerted with the following events:

    a. High discharge pressure alarm

    b. Low discharge pressure alarm

    c. Low suction pressure alarm

    d. “Lag” pump in operation

    e. Pump in low suction override condition

    f. Pump failure to stop

    g. Pump failure to start

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 23 11 23

FACILITY NATURAL GAS PIPING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide new and modify existing gas piping systems, complete and ready for operation. The Work of this Section shall include all labor, materials, tools, equipment and appurtenances, and performing all operations necessary to furnish and install complete and operable systems in accordance with this Section of these Specifications, the Drawings, and the codes and standards listed herein.

B. Coordinate with Dominion Energy as to any Local restrictions or requirements relative to the installation of the system.

C. Limits of Work shall be as indicated on the Drawings. Items of Work shall consist of the following:

1. All gas piping downstream of gas meter/regulator outlets. Meter/regulators and gas piping upstream of meter/regulators will be furnished and installed by the local gas utility in accordance with their rules and regulations.

2. Painting of pipe, fittings, and valves.

1.02 REFERENCES:

A. Except as specified herein, the latest edition of the standards listed below form a part of this Specification to the extent referenced in this Section. Where earlier editions of standards are adopted as referenced in applicable codes, those shall govern. The publications are referred to within the text by the basic designation only.

B. In each of the standards referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. American National Standards Institute (ANSI):

1. B109.1: Diaphragm-Type Gas Displacement Meters (Under 500 Cubic Feet per Hour Capacity)

2. B109.2: Diaphragm Type Gas Displacement Meters (500 Cubic Feet per Hour Capacity and Over)

3. B109.3: Rotary Type Gas Displacement Meters

4. LC-1: Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing

5. LC-4: Press-Connect Metallic Fittings For Use in Fuel Gas Distribution Systems

6. Z21.24: Connectors for Gas Appliances

7. Z21.41: Quick-Disconnect Devices for Use with Gas Fuel Appliances

8. Z21.45: Flexible Connectors of Other Than All-Metal Construction for Gas Appliances

9. Z21.69: Connectors for Movable Gas Appliances

10. Z21.70: Earthquake Actuated Automatic Gas Shutoff Systems

11. Z21.80: Line Pressure Regulators

12. Z21.90: Gas Convenience Outlets and Optional Enclosures

D. American Society of Mechanical Engineers (ASME):

1. B1.1: Unified Inch Screw Threads (UN and UNR Thread Form)

2. B1.20.1: Pipe Threads, General Purpose, Inch

3. B2.1: Pipe Threads

4. B16.3: Malleable Iron Threaded Fittings Class 150 and 300.

5. B16.5: Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

6. B16.9: Factory-Made Wrought Steel Buttwelding Fittings

7. B16.11: Forged Fittings, Socket-Welding and Threaded

8. B16.38: Large Metallic Valves for Gas Distribution (Manually Operated, NPS 2 1/2 to 12, 125 psig Maximum)

9. B16.39: Malleable Iron Threaded Pipe Unions

10. B16.40: Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems

11. B18.2.1: Square and Hex Bolts and Screws, Inch Series

12. B18.2.2: Square and Hex Nuts

13. B31.8: Gas Transmission and Distribution Piping Systems

E. ASTM International (ASTM):

1. A36: Carbon Structural Steel

2. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

3. A182: Standard Specification for Forged or Rolled Alloy and Stainless-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

4. A194: Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service or Both

5. A403: Standard Specification for Wrought Austenitic Stainless-Steel Piping Fittings

6. B61: Standard Specification for Steam or Valve Bronze Castings

7. B88: Standard Specification for Seamless Copper Water Tube

8. D2513: Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

9. D2517: Reinforced Epoxy Resin Gas Pressure Pipe and Fittings

10. D2683: Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

11. F1973: Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems

F. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

1. SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Application, and Installation

G. Sheet Metal And Air Conditioning Contractors' National Association (SMACNA):

1. SMACNA Seismic Restraint Mnl: Seismic Restraint Manual: Guidelines for Mechanical Systems

H. U.S. National Archives And Records Administration (NARA):

1. 49 CFR 192: Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

I. National Fire Protection Association (NFPA):

1. NFPA 54: National Fuel Gas Code

J. Manufacturers' Standardization Society (MSS):

1. SP-43: Wrought Stainless Steel Butt-Welding Fittings

K. Fuel Gas Code 2015 of Utah (Adopts with Amendments the International Fuel Gas Code 2015 (IFGC 2015))

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Shop Drawings: Coordination Drawings - Prepare as specified in Paragraph "Cooperation and Coordination with Other Trades" of this Section.

C. Product Data: Annotate descriptive data to show the specific manufacturer, model, type, size capacity, curves, wiring diagrams, options, etc. of each item.

1. Pipe and fittings

2. Casings

3. Warning and identification tape

4. Valves

5. Valve boxes

6. Gas equipment connectors

7. Meters

8. Regulators

9. Pipe hangers and supports

10. Access panels

D. Certification: Submit documentation certifying completion of the following items in compliance with this Section.

1. Metal welding inspection

2. PE fusion welding inspection

3. Piping pressure tests

4. System purging

E. Certificates and Licenses: Prepare as specified in Part 1 of this Section.

1. Qualifications of Installer

2. Qualifications of Construction Supervisor

F. Manufacturer's Instructions: Submit manufacturer's installation instructions and manufacturer's visual joint appearance chart.

1. PE pipe and fittings

G. Operation and Maintenance Manuals: Prepare manuals in accordance with Section 01 78 23.

1. Valves

2. Meters

3. Regulators

H. Test Data: Submit piping system leakage test sheets as specified in Section 22 05 00.

I. Closeout Submittals:

1. Record Drawings: Prepare as specified in Part 1 of this Section.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Qualifications of Installer:

1. Prior to installation, submit data showing the name and license of the installing contractor and that he has successfully installed systems of the same type and design as specified herein. Data shall include names and locations of at least two installations of such systems. Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18 months. The installing contractor shall be licensed to perform applicable gas piping systems installation in the state in which the project is located.

C. Qualifications of Welder:

1. Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. The Authority Having Jurisdiction shall be notified 24 hours in advance of any required testing and the tests shall be performed at the work site. The welder or welding operator shall apply his

assigned symbol near each weld he makes as a permanent record. Prior to installation, submit data for acceptance showing the name and certification of each welder and welding operator to be used on the project. Submit each welder's identification symbols, assigned number, or letter, used to identify work of the welder. Welders making defective welds after passing a qualification test shall be given requalification test and, upon failing to pass this test, shall not be permitted to work on this Contract.

a. Steel Welder's Qualifications: Comply with ASME B31.8. Each steel welder shall have a copy of a certified ASME B31.8 qualification test report. Conduct a qualification test for each welder and submit results for acceptance.

b. PE Welder's Qualifications: Supervising and installing personnel shall be trained by a PE pipe manufacturer's sponsored course of not less than one week duration, or present proof satisfactory to the Engineer that personnel are currently working in the installation of PE gas distribution lines. Conduct a qualification test for each welder and submit results for acceptance.

c. Safety Standards: 49 CFR 192.

D. Qualifications of Construction Supervisor:

1. Provide a Construction Supervisor with a minimum of 5 years of experience in fuel gas piping construction supervision who shall be responsible for the installation of the Work of this Section of the Specifications. The Construction Supervisor shall be licensed to perform applicable fuel gas piping systems supervision in the state in which the project is located. Prior to installation, submit data for acceptance showing the name and license of the Construction Supervisor.

1.05 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Shipping:

1. All equipment, material and spare parts shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance. Equipment and material warranties shall not be voided by actions of the Contractor.

C. Receiving:

1. All equipment, material and spare parts shall be delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.

2. Inspect for damage and correctness, and inventory items, upon delivery to site.

3. Store and safeguard equipment, material and spare parts in accordance with manufacturer's recommendations.

1.06 SPECIAL REQUIREMENTS:

A. Refer to applicable sections of Division 1 with regard to providing the following:

1. Submittal of manufacturer's specifications, catalog data, descriptive matter, illustrations, diagrams, etc., including complete motor data for all equipment.

2. Nameplates

3. Foundations, installations, and grouting

4. Operating and maintenance instructions and parts lists

5. Lubricants

6. Special tools

7. Bolts, anchor bolts, and nuts

8. Concrete inserts

9. Sleeves

10. Electric motors

11. Voltage rating of motors

12. Equipment drive guards

1.07 COOPERATION AND COORDINATION WITH OTHER TRADES:

A. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow efficient completion of the project. Materials and equipment shall be installed as fast as conditions will permit, and installed promptly when and as directed.

B. Furnish to all other trades advance information on location and size of all concrete pads, chases, frames, boxes, sleeves, and openings needed for the Work, and also furnish layout information and shop drawings necessary to permit other trades affected by the Work to install their work properly coordinated and without delay.

C. Where there is evidence that Work installed interferes with the work of other Sections, assist in working out space conditions to make satisfactory adjustments.

D. With the acceptance of the Engineer and without extra cost to the Owner, make reasonable modifications in Work specified under this Section of the Specifications required to coordinate with normal structural interference's, or for proper execution of specified work.

E. If work is installed before coordinated with other trades so as to cause interference with the work of such trades, make all necessary changes in Work under this Section of the Specifications at no additional cost to the Owner.

F. Protect all materials and work of other trades from damage that may be caused by the Work required under this Section of the Specifications and be responsible for repairing any damages caused by such work without any additional cost to the Owner.

G. Follow Drawings in layout work. Check Drawings of, and coordinate with, other trades to verify special provisions, installation requirements and spaces in which Work provided under this Section of the Specifications will be installed. Maintain maximum headroom or space conditions at all points. Where headroom or space conditions appear inadequate, notify the Engineer before proceeding.

H. Prepare and submit for acceptance Coordination Drawings consisting of 3/8 inch = 1 foot-0 inches scale or larger working plans and sections, clearly showing how this Work is to be installed in relation to the work of other Sections. Coordination Drawings shall be based upon accepted equipment submittals.

I. Attend regular coordination and job progress meetings required.

1.08 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION:

A. All electrical apparatus and controls associated with equipment installed or modified under this Section but which are not integral with the equipment served, shall be furnished under Division 26. All mounting and wiring of non-integral electrical apparatus and controls, and interconnecting wiring to equipment served will be done under Division 26.

B. Access panels shall be furnished under this Section and installed by the trade responsible for the appropriate Section of the Specifications for the surface upon which the panels are mounted. Prepare a schedule showing location, size and function of all required access panels and deliver schedule to representatives of all installing trades.

C. Inserts and anchor bolts shall be furnished under this Section and installed under Section 03 30 00. Prepare a schedule showing location, size and function of all required inserts and anchor bolts and deliver schedule to representative of the installing trade.

D. Pipe sleeves shall be furnished under this Section and installed by the trade whose finished interior surfaces will be penetrated. Prepare a schedule showing location, size and function of all required pipe sleeves and deliver schedule to representatives of all installing trades.

1.09 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION:

A. Gas meters and regulators will be furnished by the Gas Utility.

1.10 REMOVAL WORK:

A. Particular care shall be taken to avoid creating hazards on the site or causing disruption of service in the adjoining buildings.

B. All existing equipment indicated to be removed shall be done in a neat and workmanlike manner. All existing equipment indicated to be turned over to the Owner shall be presented to the Owner in good condition at a location designated by the Owner. All other equipment shall be removed from the premises and disposed of at an approved disposal or recycling facility.

C. Remove all abandoned piping and equipment not built into building construction. Where ceilings or walls are removed all abandoned conduit and piping shall be removed and ends of live services capped. Abandoned elements built into walls or located above existing ceilings shall remain and ends capped and marked abandoned.

D. Should any asbestos and/or asbestos related products or materials be encountered during the performance of the Work, stop work immediately and inform the Engineer and the Owner of the presence of asbestos.

1.11 ELECTRICAL WORK:

A. All electrical apparatus and controls associated with equipment installed or modified under this Section but which are not integral with the equipment served, shall be furnished under Division 26. All mounting and wiring of non-integral electrical apparatus and controls, and interconnecting wiring to equipment served will be done under Division 26.

B. All equipment furnished under this Section requiring motors shall have motors factory furnished and installed by the manufacturer of the equipment served and shall be mounted and aligned so as to run free and true. Provide internal wiring and motors for mechanical equipment as an integral part of the equipment. Motor starters and contactors shall be factory-furnished and wired as an integral part of packaged mechanical equipment where indicated on the Drawings. Disconnect switches, and all other motor starters and contactors shall be furnished, installed and wired by Division 26.

C. When motors and other associated electrical apparatus furnished are larger than sizes indicated on the Drawings, the cost of additional electrical service and related work shall be included under the Section that furnished that motor.

1.12 CODES, PERMITS AND FEES:

A. Except for additional requirements as specified or indicated under the Work of this Section, materials, workmanship and equipment shall conform to the governing edition of the following regulations, and agency requirements. In the standards referred to herein, the advisory provisions shall be considered to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears.

1. State and Local Building Codes including, but not limited to, the Utah Fuel Gas Code and the 2018 International Building Code.

2. Local Fire Department.

3. Local Gas Utility.

4. Occupational Safety and Health Administration (OSHA).

5. Any other local codes or requirements of Authorities Having Jurisdiction.

B. Pay for all fees and give all notices, file all plans, obtain all permits and licenses, and obtain all necessary approvals from Authorities Having Jurisdiction. Deliver all certificates of inspection to the Authorities Having Jurisdiction. No work shall be covered before examination and approval by Authorities Having Jurisdiction. Replace imperfect or condemned work to conform to inspectional requirements, satisfactory to the Architect, Owner, Engineer and Authorities Having Jurisdiction without extra cost to the Owner. If Work is covered before inspection and acceptance, pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.

1.13 RECORD DRAWINGS:

A. Prepare and maintain Record Drawing to meet the requirements of this Section of the Contract Specifications.

B. As work progresses and for the duration of the Contract, maintain a complete and separate set of prints of Drawings at the job site at all times. On a daily basis, record work completed and all changes from original Drawings clearly and accurately, including work installed as a modification or addition to the original design such as change orders, instructions issued by the Engineer, or conditions encountered in the field. Record valve tags as they are installed. In addition, take photographs of all concealed equipment in gypsum board ceilings, shafts, underground (buried) piping routes and supports and other concealed, inaccessible work. At completion of work, make copies of photographs with written explanation on back. These shall become part of Record Drawings.

C. Record drawings shall show record condition of pipe routing and sizes, valve locations, details and sections, riser diagrams, and control changes. Schedules shall show actual manufacturer and make and model numbers of final equipment installation. Remove all

superseded data to show the completed work. Accurately indicate the location, size, type, and elevation of new buried piping and their relationship to existing buried piping.

D. The Record Drawings will be used as a guide for determining the progress of the Work installed. They shall be inspected on a regular basis and shall be corrected immediately if found inaccurate or incomplete. Requisitions for payment will not be accepted until the Record Drawings are accurate and up-to-date.

E. At completion of Work prepare a complete set of marked-up Record Drawings on bond paper showing all systems as actually installed. The Contract Drawing electronic CAD files will be made available for this Contractor's use to serve as backgrounds for the Record Drawings. Provide all drawings necessary to show the required record information. Submit marked-up prints to the Engineer for comments as to compliance with this Section. Make all modifications so noted by the Engineer.

F. Certify the accuracy of the Record Drawings. Record Drawings shall become the property of the Owner.

G. When required by jurisdiction, submit the Record Drawings for approval by the Authority Having Jurisdiction in a form acceptable to the jurisdiction.

PART 2 - PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS:

A. Coated Black Steel - Welded Joints: "Yellow Jacket" Schedule 40 mild black carbon steel, ASTM A53, Grade B, factory coated with yellow plastic, mill or site beveled, and complete with forged steel butt welding fittings and welded joints. All bare metal surfaces are to be cleaned and corrosion protected with a suitable Denso primer and tape corrosion protection system.

B. Polyethylene (Buried Piping): Safety yellow colored medium density polyethylene (MDPE) pipe shall be in accordance with ASTM D 2513, 100 psig working pressure, Standard Dimension Ratio (SDR), the ratio of pipe diameter to wall thickness, 11.5 maximum.

1. Manufacturers:

   a. Performance Pipe Driscoplex 6500 Series

   b. JM Eagle

   c. ENDOT Industries, Inc. Yellow Gas Pipe

2. Socket Fittings: Per ASTM D2683.

3. Butt-Fusion Fittings: Per ASTM D2513, molded.

4. Buried Utility Warning and Identification Tape:

   a. Provide detectable aluminum-foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3 inch minimum width, color-coded yellow for natural gas, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be "CAUTION BURIED GAS PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material. Refer to Section 31 23 33 for details.

   b. Manufacturer shall be:

      (1) Seton

      (2) Reef Industries, Inc.

      (3) Terra Tape Security Line Detectable

      (4) Christy's

      (5) Presco

5. Casing:

   a. Where indicated at railroad or other crossing, provide ASTM A53, galvanized pipe, Schedule 40, with extruded polyethylene coating.

C. Uncoated Black Steel – Screwed Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with malleable cast iron screwed fittings to ANSI B2.1, and screwed joints.

D. Uncoated Black Steel – Welded Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, mill or site beveled, complete with factory made forged steel butt welding fittings and welded joints.

E. Copper-Uncoated: Type "K" seamless copper tubing to ASTM B88, hard temper with wrought copper capillary brazed joint type fittings to ASTM B61, and brazed joints made with "Sil-Fos" or "Sil-Fos 5" brazing alloy, or, soft temper with flared brass fittings of a single 45 degree flare type, forged or with a machined long nut and copper to copper threaded connectors, and, where required, flared brass copper to NPS adapters.

F. Coated Copper: Type "K" soft temper as above but with a factory applied external yellow plastic coating approved by governing authorities.

G. Flexible Stainless Steel: Flexible, CGA certified, 125 psi rated, gas-tight, convoluted stainless steel tubing factory jacketed with a bright yellow PVC coating which is continuously identified. The tubing is to be supplied in coils and is to be complete with factory attached stainless steel end fittings, and adapter unions, protective plates, and steel clamps. Acceptable products are:

1. Flex Pression Ltd. (Westburne) "GAZFLEX"

2. Tru-Flex Metal Hose Corp. "Pro-Flex"

3. Titeflex Corp. "Gastite"

4. Omega Flex Canada "TracPipe"

H. Aboveground Fittings:

1. Pipe: Black steel, ASTM A 53, Type E or F, Grade A or B, Schedule 40, threaded ends or plain end socket welded for sizes 2 inches and smaller; otherwise, plain end beveled for butt welding.

2. Threaded Fittings: ASME B16.3, black malleable iron.

3. Socket-Welding Fittings: ASME B16.11, forged steel.

4. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.

5. Unions: ASME B16.39, black malleable iron.

6. Flanges and Flanged Fittings: ASME B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1. Flange faces shall have integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.

   a. Gaskets: Fluorinated elastomer, compatible with flange faces.

   b. Bolting: Stainless steel; ASTM A 193, Grade B8M or B8MA, Type 316, for bolts; and ASTM A 194, Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts shall conform with ASME B18.2.1 and ASME B18.2.2 with coarse threads conforming to ASME B1.1, with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts and bolt-studs shall extend through the nuts and may have reduced shanks of a diameter not less than the diameter at roof of threads. Bolts shall have American Standard regular square or heavy hexagon heads. Nuts shall be American Standard heavy semi-finished hexagon.

7. Pipe Thread Paste or Tape: Anti-seize and sealant paste or tape of polytetrafluoroethylene (PTFE).

8. Welding Filler Metal: ASME B31.8.

I. Risers:

1. Manufacturer's standard anodeless riser, transition from plastic to steel pipe with 7 to 12 mil thick epoxy coating meeting the requirements of ASTM F1973. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide remote bolt-on or bracket or wall-mounted riser supports as indicated.

a. Manufacturer shall be:

(1) GF Central Plastics

(2) Elster Perfection

J. Transition Fittings:

1. Steel to Plastic (PE): As specified for "riser" except designed for steel-to-plastic with tapping tee or sleeve. Coat or wrap exposed steel pipe with heavy plastic coating.

2. Plastic to Plastic: Manufacturer's standard bolt-on (PVC to PE) plastic tapping saddle tee, UL listed for gas service, rated for 100 psig, and O-ring seals. Manufacturer's standard slip-on PE mechanical coupling, molded, with stainless-steel ring support, O-ring seals, and rated for 150 psig gas service.

2.02 VALVES, BURIED:

A. Shutoff Valves:

1. Metallic ball valves, ANSI B16.33 corrosion-resisting steel, with threaded or flanged ends. Provide polytetrafluoroethylene (PTFE) seats.

2. PE ball or plug valves, ASME B16.40 and ASTM D 2513, Class C materials (PE 2306 or PE 3406), strength rating of Class 4 location with class factor of 0.20, and SDR matching PE pipe dimensions and working pressure.

a. Manufacturers:

(1) Poly-Valve

(2) Aqua-Fuse by CMF Global

(3) Lyall-Polytec

(4) GF Central Plastics

B. Valve Boxes:

1. Provide rectangular concrete valve box, sized large enough for removal of valve without removing box. Cast the word "Gas" into the box cover. Use valve box for areas as follows:

a. Roads and Traffic Areas: Heavy duty, cast iron cover.

b. Other Areas: Standard duty, concrete cover.

2.03 VALVES, ABOVEGROUND:

A. Provide lockable valves where located outdoors and where otherwise indicated. Valves shall be of only one of the types specified herein below.

B. Earthquake Automatic Gas Shutoff Valve:

1. ANSI Z21.70 and UL listed or AGA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed.

2. The valve shall provide automatic shut off when triggered by a magnitude 5.5 seismic event. Manually resettable on both sides of valve.

C. Ball Type (1/4-inch to 4-inch diameter): minimum 450 psi WOG rated, 1/4 turn, full port non-lubricated brass ball valves, each complete with a Teflon PTFE seat, chrome plated solid ball, removable lever handle, and screwed ends. Acceptable products are:

1. Neo Valves #525

2. Kitz Corp. Code 58

3. Toyo Valve Co. Fig. 5044A

4. MAS B-3

5. Nibco #T-FP-600

D. Plug Type (4-inch to 8-inch diameter): Plain face flanged, Class 125, 1380 kPa rated, 1/4 turn, cast iron lubricated plug valves, each wrench operated and complete with cylindrical plug with lubricant grooves, lubricant screw, and lubricant receptacle. Acceptable products are:

1. Neo Valves #1AS40114

2. Newman Hattersley #171M

3. KITZ 150 SCTAM-FS (flanged, 150 class, ball valve, 1/2-inch to 10 inches) CGA 3.16

2.04 NATURAL GAS CONVENIENCE OUTLET:

A. Neo Valves Model 3/375 quick-connect type outlets with interlocking safety cam to prevent release of the appliance connector until the valve is off, integral thermal protection to prevent gas flow if the outlet is exposed to temperatures exceeding 200 degrees F, and a wall enclosure box.

2.05 NATURAL GAS PRESSURE REDUCING VALVE:

A. Fisher (an Emerson Company) 1 inch x 1 inch Type S102C direct operating natural gas pressure reducing regulator with a cast iron body, 1 inch NPT connections, 9/16-inch orifice, and internal relief.

2.06 PRESSURE REDUCING REGULATORS:

A. Provide Fisher pressure reducing regulators as presented in Schedule 23 11 23-1. Also provide pressure reducing regulators to suit the building load complete with relief.

2.07 GAS EQUIPMENT CONNECTORS:

A. All gas equipment connectors shall be AGA-approved.

1. Flexible Connectors: ANSI Z21.45 or ANSI Z21.24 and approved for use in Utah, maximum length of the connector shall not exceed 36 inches.

2. Quick Disconnect Couplings: ANSI Z21.41.

3. Semi-Rigid Tubing and Fittings: ANSI Z21.69.

2.08 METERS:

A. ANSI B109.2 pipe mounted, diaphragm or bellow style, enamel coated steel case. Provide combined register totalizer reading in cubic feet, water escape hole in housing, and means for sealing against tampering. Meters shall have corrosion resistant factory painted finish.

2.09 REGULATORS:

A. AGA-approved, self-contained with spring-loaded diaphragm pressure regulating valve and atmospheric vent, corrosion resistant construction, pressure operating range as required for the pressure reduction indicated, volume capacity not less than indicated, threaded ends for sizes 2-inch and smaller, otherwise flanged. Regulators shall have corrosion resistant factory painted finish. Regulators shall be designed for the gas used.

2.10 PRESSURE GAUGES:

A. ASME B 40.1.

2.11 PIPE HANGERS AND SUPPORTS:

A. Provide MSS SP-58, Type 1, 7, and 41 hangers with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel with drilled hole on centerline and double nut and flat washer. Attach to wood framed structures using wood screws designed for use with threaded rod adapters, or through-bolted with double nut and flat washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Hangers, supports, rods and fasteners shall be hot-dipped galvanized steel. Hangers and supports in contact with bare copper tubing shall be PVC coated. Hangers and supports shall be Series 300 stainless steel. Rods and fasteners shall be Series 300 stainless steel.

2.12 SUPPLEMENTARY STEEL AND CHANNELS:

A. Unless otherwise indicated on the Structural Drawings, provide all supplementary steel and factory fabricated channels required for proper installation, mounting and support of all equipment and systems provided under this Section.

B. Supporting channels and supplementary steel shall be of sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for the specific loading on the system installed herein.

C. All supplementary steel shall be ASTM A36 factory-formed standard mill finished structural shapes, and shall be steel, field painted after fabrication . Channels shall be painted steel.

2.13 PIPE SLEEVES:

A. Sleeves in Masonry and Concrete Walls, Floors, Ceilings, and Flat Roofs: Schedule 40 hot dipped galvanized, standard weight ductile-iron or cast-iron pipe sleeves. Sleeves available from the manufacturer of mechanically adjustable segmented elastomeric seals shall be permitted subject to acceptance by the Engineer. Provide minimum 2 inch high waterstop for sleeves in exterior walls and floors.

B. Sleeves in Non-Masonry or Non-Concrete Walls, Floors, and Roofs: Hot-dip galvanized steel sheet, 26 gage minimum thickness.

C. Mechanically Adjustable Segmented Elastomeric Seals: Seals shall have low durometer EPDM seal elements and series 300 stainless steel hardware.

2.14 PIPE ESCUTCHEONS:

A. General: Provide pipe escutcheons at all pipe penetrations where penetration is exposed to view as specified herein with inside diameter closely fitting pipe outside diameter. Select outside diameter of escutcheon to completely cover pipe penetration hole in

floors, wall, or ceilings; and pipe sleeve extension, if any. Escutcheons shall be held in place by internal spring tension or set screws.

B. Provide pipe escutcheons in finished spaces. Pipe escutcheons shall be of stainless steel, anodized aluminum or chrome-plated brass, solid or split hinged.

2.15 ACCESS PANELS:

A. Access panels shall give access to each valve in concealed spaces above non removable (hard) suspended ceilings, and to all other concealed parts of the system. Access panels shall be located where indicated on the Drawings and/or where otherwise require accessibility for the proper inspection, operation and maintenance of the system.

B. Access panels shall be Milcor Type M, 16 inch by 16 inch minimum, as manufactured by Inryco, Inc. Door shall be constructed of 18 gage galvanized steel with frame constructed of 16 gage galvanized steel. Casing bead shall be galvanized steel. Hinge shall be continuous steel with stainless steel pin. Locks shall be flush-screwdriver operated, with metal cam. Galvanized steel sleeve shall be welded to panel for access to cam lock control. Prime coat shall be factory applied rust-inhibitive light grey paint.

PART 3 - EXECUTION

3.01 NATURAL GAS SERVICE:

A. Make all required arrangements with Dominion Energy on behalf of the Owner for installation of natural gas service piping with gas pressure regulator and meter assembly where shown.

B. Arrange for permits, inspections, and tests, in accordance with applicable State and local codes, at the contractor's expense.

C. Verify all measurements at the Project Site.

D. Avoid interferences with other trades.

3.02 NATURAL GAS PIPING INSTALLATION REQUIREMENTS:

A. Installation, workmanship, inspection and testing shall be in accordance with the specified Fuel Gas Code with the additions specified herein. Install natural gas piping upstream of meter/regulators or upstream of building connections in accordance with ASME B31.8. Install piping straight and true to bear evenly on hangers and supports. Keep the interior and ends of new piping and existing piping affected by the Work thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs or other accepted methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter. Inspect piping before placing into position.

B. Natural Gas Piping shall not be permitted in Electrical Rooms and stairwells.

C. Piping and other apparatus shall not be installed in such a manner so as to interfere with the full swing of doors, movement of personnel and equipment, and access to other equipment.

D. Make provisions for pipe expansion and contraction with suitable anchors and offsets, expansion joints, or expansion loops. Make provisions in buried piping for differential settlement. Install piping to allow freedom of movement in all planes without imposing undue stress on any section of the main piping, branch piping, equipment and structure.

E. Piping: Cut pipe to actual dimensions and assemble to prevent residual stress. Provide supply connections entering the building as indicated. Within buildings, run piping parallel to structure lines and conceal in finished spaces. Fittings installed in concealed locations shall be limited to the following types: threaded elbows, tees, and couplings, brazed fittings, welded fittings, and fittings listed to ANSI LC-1 or ANSI LC-4. Terminate each vertical supply pipe to burner or appliance with tee, nipple and cap to form a sediment trap. To supply multiple items of gas-burning equipment, provide manifold with inlet connections at both ends.

1. Cleanliness:

a. Clean inside of pipe and fittings before installation. Blow lines clear using 80 to 100 psig clean dry compressed air. Rap steel lines sharply along entire pipe length before blowing clear.

2. Buried Polyethylene (PE) Piping:

a. Provide totally PE piping. Buried piping shall not be permitted under any building and/or structure. Terminate buried piping not more than 6 inches above grade. Prior to installation, obtain printed instructions and technical assistance in proper installation techniques from pipe manufacturer. When joining new PE pipe to existing pipe line, ascertain when procedural changes in the fusion process is necessary to attain optimum bonding.

(1) PE Piping: Provide fusion-welded joints except where transitions have been specified. Use electrically heated tools, thermostatically controlled and equipped with temperature indication. (Where connection must be made to existing plastic pipe, Contractor shall be responsible for determination of compatibility of materials and procedural changes in fusion process necessary to attain maximum integrity of bond.)

(2) Laying PE Pipe: Minimum cover over pipe shall be 30 inches below finish grade or 36 inches below any drainage ditches or deeper when indicated. Minimum cover for services lines to any building or structure shall be 18 inches. Maintain 6 inches of clearance between

natural gas piping and any other utility or structure. If minimum clearance cannot be maintained, the natural gas pipe shall be protected with a casing pipe. Service lines shall be sloped to drain back to the distribution pipe. Lay in accordance with manufacturer's printed instructions.

(3) Buried gas piping shall not penetrate building foundation walls at any point below grade per FGC of Utah Section 404.6. Gas piping shall enter buildings or structures at a point above grade and the annular space between the pipe and the wall shall be sealed.

b. Excavating and Backfilling: Pipe bedding and compacted backfill shall be provided under this Section of the Specifications in accordance with the requirements of Section 31 22 00. Pipe bedding shall be 6 inches deep. Compacted backfill shall be to a point 12 inches above the crown of buried pipe. Bedding and compacted backfill shall be non-corrosive material such as cleaned washed sand, and contain no stones, metal, rubbish of any kind, frozen material, organic matter, or any other material capable of damaging piping or coating, and/or of settling. Gas lines shall be buried in the trenches separate from all other utilities including other gas lines. Trenches shall be wide enough to permit at least 6 inches spacing between the sides and floor of the trench. Make provisions in buried piping for differential settlement, e.g. snaking the piping in the trench before backfilling. Coordinate provision of utility warning identification tape with backfill operation. Bury utility warning and identification tape with printed side up at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

c. PE Pipe Installation Guidelines:

(1) Acceptable plastic PE pipe is manufactured according to standard ASTM D2513 and is marked with “ASTM D2513”. The PE type designations recommended are PE 2406, and PE 3408.

(2) PE plastic pipe is unsuitable for aboveground installation. Plastic pipe must be buried or inserted.

(3) Make each joint in accordance with written procedures that have been proven by test to produce strong gas-tight joints. PE plastic pipe joining procedures can be obtained from qualified manufacturers. Do not purchase a product if the manufacturer or supplier does not certify it for qualified joining procedures.

(4) All pipe joining procedures must be conducted by qualified person following the written joining procedures for each type of pipe and fitting used. No person shall make a plastic pipe joint unless that person has been qualified under the applicable joining procedure by

making a specimen joint that passes inspection and test. The specimen joint must be visually examined during and after joining and found to have the same appearance as a joint or photograph of a joint that is acceptable under the procedure. In the case of heat fusion, the specimen must be cut into at least three longitudinal straps, each of which is:

(a) Visually examined and found not to contain voids or discontinuities on the cut surfaces of the joint area;

(b) Deformed by bending, torque, or impact, and if failure occurs, it must not initiate in the joint area.

(5) Install properly designed valves in a manner that will protect the plastic material. Protect the pipe from excessive twisting, shearing, or cutting loads when the valve is operated. Protect from any secondary stresses that might be induced through the valve or its enclosure.

(6) Prevent pullout and joint separation. Plastic pipe must be installed in such a manner that expansion and contraction of the pipe will not cause pullout or separation of the joint.

(7) When inserting plastic pipe in a metal pipe, make allowance for thermal expansion and contraction. Make an allowance at lateral and end connections on inserted plastic pipes, particularly those over 50 feet in length. End connections must be designed to prevent pullout caused by thermal contraction. Fittings must be able to restrain a force equal to or greater than the strength of the pipe. To minimize the stress caused by thermal contraction, pipes inserted in the summer should be allowed to cool to ground temperature before tie-ins are made. Inserted pipes, especially those pulled in, should be relaxed, mechanically compressed, or cooled to avoid initial tensile stress. Operators unfamiliar with proper insertion techniques must have a qualified person develop the procedures.

(8) Repair or replace imperfections or damages before placing the pipe in service.

(9) Install all plastic mains and service lines below ground level. Where the pipe is installed in a vault or other below-grade enclosure, it must be completely encased in gas-tight metal pipe with fittings that are protected from corrosion. Plastic pipe installation must minimize shear and other stresses. Plastic mains and service lines that are not encased must have an electrically conductive wire or other means of locating the pipe. Plastic lines must not be used to support external loads.

(10) A yellow insulated copper tracer wire shall be installed adjacent to underground PE pipe. Access shall be provided to the tracer wire of the tracer wire shall terminate above ground at each end of the PE piping. The tracer wire size shall not be less than 12 AWG solid copper and the insulation type shall be 30 to 45 mils polyethylene suitable for direct burial, Southwire Tracer Wire, or approved equal.

(11) Ensure that plastic PE pipe is continually supported along its entire length by properly tamped and compacted soil. To prevent any shear or other stress concentrations use external stiffeners at connections to main, valves, meter risers, and other places where compression fittings might be used.

(12) In laying of plastic PE pipe, ensure adequate slack (snaking) in the pipe to prevent pullout due to thermal contraction.

(13) Suitable bedding (sand) and backfill must be provided. Ensure backfill with material that does not contain any large or sharp rocks, broken glass, or other objects that could cut or puncture the pipe.

(14) Take special care to prevent coal tar type coatings or petroleum base tape from contacting the plastic pipe. It can cause plastic pipe to deteriorate.

(15) Static electricity can ignite a flammable gas-air atmosphere. When working with plastic pipe of any kind where there is (or there may be) the possibility of a flammable gas-air atmosphere, take the following precautions:

(a) Use a grounded wet tape conductor wound around, or laid in contact with, the entire section of the exposed piping.

(b) If gas is already present, wet the pipe starting from the ground end with a very dilute water and detergent solution. Apply tape immediately and leave it in place.

(c) Wet the tape occasionally with water. Where temperatures are below freezing (32 degrees F) add glycol to the water to maintain tape flexibility. Ground the tape with a metal pin driven into the ground.

(d) Do not vent gas using an ungrounded plastic pipe or tubing. Even with grounded metal piping, venting gas with high scale or dust content could generate an electric charge in the gas resulting in an arc from the dusty gas cloud back to the pipe which could ignite the gas. Vent gas only at a downwind location remote from people or flammable material.

i. Dissipating the static charge buildup with wet rags, a bare copper wire, or other similar techniques may not be as effective as the above procedure. In all cases, use appropriate safety equipment such as flame resistant and static free clothing, breathing apparatus, etc.

(16) In transition area where the plastic pipe is connected to a fitting, valve, or riser, the use of protective sleeves may be needed to distribute excessive stresses, along with attention to adequate backfill and support.

3. Aboveground Steel Piping:

a. Determine and establish measurements for piping at job site and accurately cut pipe lengths accordingly. For 2-inch diameter and smaller, use threaded or socket-welded joints. For 2 1/2-inch diameter and larger, use flanged or butt-welded joints.

(1) Threaded Joints: Where possible use pipe with factory-cut threads, otherwise cut pipe ends square, remove fins and burrs and cut taper pipe threads in accordance with ASME B1.20.1. Provide threads smooth, clean and full-cut. Anti-seize jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread paste, pipe cement and oil, or PTFE powder and oil. PTFE tape is also acceptable. Apply jointing compound to male threads only. Work piping into place without springing or forcing. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed. Use unions for connections to valves, meters, and regulators for which a mean of disconnection is not otherwise provided.

(2) Welded Joints: Weld by the shielded metal-arc process, using covered electrodes and in accordance with procedures established and qualified in accordance with ASME B31.8.

(3) Flanged Joints: Use flanged joints for connecting welded joint pipe and fittings to valves, meters and regulators to provide for disconnection. Install joints so that flange faces bear uniformly on gaskets. Engage bolts so that there is complete threading through the

nuts and tighten so that bolts are uniformly stressed and equally torqued.

(4) Pipe Size Changes: Use reducing fittings for changes in pipe size. Size changes made with bushings will not be accepted.

4. Connections to Existing Pipeline:

a. When making connections to live gas mains, use pressure tight installation equipment operated by workmen trained and experienced in making hot taps. For connections to existing underground pipeline or service branch, use transition fittings for dissimilar materials.

5. Wrapping:

a. Where connection to existing steel line is made underground, tape wrap new steel transition fittings and exposed existing pipe having damaged coating. Clean pipe to bare metal. Initially stretch first layer of tape to conform to the surface while spirally half-lapping. Apply a second layer, half-lapped and spiraled as the first layer, but with spirals perpendicular to first wrapping. Use 10 mil minimum thick polyethylene tape. In lieu of tape wrap, heat shrinkable 10 mil minimum thick polyethylene sleeve may be used.

F. Valves:

1. Install valves approximately at locations indicated. Orient stems vertically, with operators on top, or horizontally. Provide support for valves to resist operating torque applied to PE pipes.

2. Stop Valve and Shutoff Valve:

a. Provide stop valve on service branch at connection to main and shut-off valve on riser outside of each building. Provide shut-off valve at connection to each gas utilization appliance and where otherwise indicated.

G. Gas Regulators:

1. Provide plug cock shutoff valve on both sides of each regulator. Install regulators outside of buildings and 18 inches aboveground on riser., unless specifically detailed otherwise. Install gas meter in conjunction with pressure regulator. On outlet side of regulator or meter, provide a union and a 3/8 inch gage tap with plug.

H. Pipe Hangers and Supports:

1. Selection, application, and installation of piping hangers and supports shall conform with MSS SP-58, unless otherwise indicated.

2. Furnish and install safe and substantial means of support for all parts of the piping system. Attach all pipes securely to the structure in correct alignment and pitch, to prevent vibration and to effectively care for expansion and contraction.

3. All piping shall be hung to true alignment, using appropriate hanger arrangements. Wire and strap hangers shall not be permitted. Hangers shall be located so that piping and hangers will be clear of other piping, hangers, conduits, lighting fixtures, equipment, ceiling suspension systems, ductwork and other obstructions.

4. Supplementary steel and channels shall be firmly connected to the building construction in a manner accepted by the Engineer, or as otherwise shown on the Drawings. Equipment and piping shall not be supported from metal decking or plaster ceilings.

5. Rod sizes, MSS SP-58.

6. Maximum Spacing Between Supports:

   a. Support piping within one foot on either side of regulators, flanged valves, and changes in direction. Support within 2 feet of wall penetrations.

   b. Vertical Piping: Support piping at each floor, but at not more than 10 foot intervals, with pipe riser clamps or offset pipe clamps. Support within 2 feet of floor and roof penetrations.

   c. Horizontal Piping: Locate supports within one foot of each change of direction. Support straight runs of steel piping and copper tubing as follows:

Maximum Spacing Feet									
Nominal Pipe Size inches	**One and under**	**1-1/4**	**1-1/2**	**2**	**2-1/2**	**3**	**4**	**5**	**6**
Steel Pipe (Vapor)	8	9	12	13	14	15	17	19	21
Copper Tube (Vapor)	6	9	10	11	13	14	16	18	20

I. Seismic Bracing Requirements

1. Piping and equipment shall be supported and braced to resist seismic loads where required by the specified Building Code. Provide seismic restraints in accordance with SMACNA Seismic Restraint Mnl unless otherwise required by the specified building code.

J. Pipe Through-Penetrations:

1. Furnish pipe sleeves where pipe passes through walls, floors, ceilings, roofs, and partitions. Sleeves will be installed, secured in proper position and location during construction by the trade whose element will be penetrated. Such trades include concrete, masonry, steel siding in the case of a steel building, and dry wall in the case of framed construction. Core drilled holes in masonry and concrete may be provided by this Section in lieu of pipe sleeves, however cored drilled holes in masonry shall have cavities completely grouted. Furnish sleeves of sufficient length to pass through entire thickness of walls, floors, ceilings, roofs, and partitions.

2. Pipe Penetrations Through Building Interior Construction: Provide not less than 1/4 inch one inch space between exterior of piping and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. For non-fire rated assemblies, seal at both ends of the sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass or silicone. Seal both ends of penetrations through fire rated assemblies to maintain fire resistive integrity with UL listed fill, void, or cavity material.

3. Pipe Penetrations Through Building Exterior Construction: Provide a mechanically adjustable segmented elastomeric seal, with sleeve sized as recommended by seal manufacturer. Seals shall have EPDM seal elements and Series 300 stainless steel hardware.

4. Extend sleeves in floor slabs 2 inches above the finished floor.

5. Seismic-braced Pipe:

    a. Proper clearances between penetrating gas system piping and any barrier shall be provided. The penetration holes shall be sized such that the hole diameter is 2 inches larger for pipe diameters 1-inch nominal to 3-inch nominal, and 4 inches larger for 4 inch and larger nominal diameter pipe.

    b. All open space around seismically braced through-penetrations shall be protected by a Listed, flexible through-penetration seal system.

K. Final Connections: Make final connections to equipment and appliances using rigid pipe and fittings, except for the following:

1. Domestic Water Heaters:

    a. Connect with semi-rigid tubing and fittings.

2. Equipment:

   a. Install flexible connectors. Connectors shall be long enough to permit movement of equipment for cleaning and to afford access to coupling.

3. Generators and HVAC equipment.

4. Install flexible connectors. Connectors shall have sufficient slack to avoid all stresses associated with generator vibration.

L. Provide full pipe diameter 6-inch long drip pockets at the bottom of all vertical risers, at all piping low points, and wherever else shown and/or required.

M. Identify all natural gas piping with two coats of safety yellow enamel applied over primer, and SMS Ltd. coil type vinyl identification makers with arrows.

3.03 DIGESTER (METHANE) GAS PIPING INSTALLATION REQUIREMENTS:

A. Provide digester gas piping to connect the piping train integral with the digester gas burners of the boilers, and provide all required vent piping. Extend the piping from termination of methane gas yard piping as shown.

B. Pipe is to be Type 316L stainless steel with Type 316 stainless steel pipe hangers and supports.

C. Do all digester gas piping work and connect the burners in accordance with requirements of ANSI B149.6, Installation Code for Digester Gas Systems, and requirements of any other regulatory authority.

D. Slope digester gas piping in the direction of flow to low points, and equip all low points with accessible and easily seen sediment traps and drip traps in accordance with ANSI B149.6 requirements.

E. Where digester gas piping penetrates an exterior concrete or masonry wall, foundation, etc., coat the portion of pipe in the wall with proper tar epoxy or wrap with suitable Denso or approved equivalent protection tape overlapped 50 percent.

F. Identify all exposed digester gas piping with two coats of suitable yellow - orange enamel applied over primer, and SMS Ltd. coil type vinyl identification markers with flow arrows.

3.04 INSTALLATION OF SHUT-OFF VALVES:

A. Provide TSSA approved ball type or lubricated plug type shut-off valves to isolate equipment, and wherever else shown.

B. Ensure that valves are located for easy accessibility and maintenance.

3.05 INSTALLATION OF NATURAL GAS CONVENIENCE OUTLETS:

A. Provide natural gas convenience outlets and wall mount where shown.

B. Provide a shut-off valve in connecting piping, confirm exact location prior to roughing-in, and ensure that the outlet is rigidly secured in place.

3.06 FIELD QUALITY CONTROL:

A. Prior to initial operation, inspect systems for compliance with Drawings, Specifications and accepted submittals. As part of inspection, perform inspections, tests and purging in compliance with the specified requirements. Have systems accepted by the Engineer before concealing.

B. Test Procedures and Reports:

1. Prepare and submit procedures, material and equipment for all specified tests to the Engineer for acceptance prior to the planned tests. Material and equipment used in testing shall be subject to inspection by the Engineer.

2. Provide all material and labor required for testing. Instruments, test equipment, and test personnel required to properly conduct all tests shall be provided. Provide water, fuel, electricity. The Owner will furnish water, fuel and electricity for the tests.

3. Repair defects disclosed by tests or, if required by the Engineer, replace defective work with new work without additional cost. If any deficiencies are revealed during test, such deficiencies shall be corrected and the tests reconducted at no additional cost.

4. Test reports shall include accepted test procedures, test results, deficiencies identified, and recommended corrective actions. Provide a complete explanation including supporting documentation detailing the design deficiencies. State that no deficiencies are evident if that is the case. When tests have been completed and corrections made, submit signed and dated test reports.

C. Metal Welding Inspection:

1. Inspect for compliance with the specified Fuel Gas Code except natural gas piping upstream of meter/regulators shall be inspected for compliance with ASME B31.8. Replace, repair and then re-inspect defective welds.

D. PE Fusion Welding Inspection:

1. Visually inspect butt joints by comparing with, manufacturer's visual joint appearance chart. Inspect fusion joints for proper fused connection. Replace defective joints by cutting out defective joints or replacing fittings. Inspect 100 percent of all joints and reinspect all corrections. Arrange with the pipe

manufacturer's representative in the presence of the Engineer to make first time inspection.

E. Piping Pressure Tests:

1. Test system gas tight in accordance with the specified Fuel Gas Code with the additions specified herein. For natural gas piping upstream of meter/regulators, test system gas tight in accordance with ASME B31.8. Use test pressure of 1-1/2 times maximum working pressure, but in no case less than 50 psig. Do not test until every joint has set and cool at least 8 hours at temperatures above 50 degrees F. Use clean dry air or inert gas, such as nitrogen or carbon dioxide, for testing. Systems which may be contaminated by gas shall first be purged as specified. Make tests on entire system or on sections that can be isolated by valves. After pressurization, isolate entire piping system from sources of air during test period. Maintain test pressure for at least 8 hours between times of first and last reading of pressure and temperature. Take first reading at least one hour after test pressure has been applied. Do not take test readings during rapid weather changes.

   a. For buried piping, conduct testing before backfilling; however, place sufficient backfill material between fittings to hold pipe in place during tests. Provide gas temperature same as actual trench conditions.

2. There shall be no reduction in the applied test pressure other than that due to a change in ambient temperature. Allow for ambient temperature change in accordance with the relationship PF + 14.7 = (P1 + 14.7) (T2 +460) / T1 + 460), in which "T" and "P" represent Fahrenheit temperature and gage pressure, respectively, subscripts "1" and "2" denote initial and final readings, and "PF" is the calculated final pressure. If "PF" exceeds the measured final pressure (final gage reading) by 1/2 psi or more, isolate sections of the piping system, retest each section individually, and apply a solution of warm soapy water to joints of each section for which a reduction in pressure occurs after allowing for ambient temperature change. In performing tests, use a test gage calibrated in one psi increments and readable to 1/2 psi.

3. Correct defects in Work and repeat test until no reduction in pressure occurs.

F. System Purging: After completing pressure tests, and before testing a gas contaminated line, purge line with nitrogen at junction with main line to remove all air and gas. Clean completed line by attaching a test pilot fixture at capped stub-in line at building location and let gas flow until test pilot ignites. Procedures shall conform to the specified Fuel Gas Code and ASME B31.8, whichever is more stringent.

CAUTION

Failure to purge may result in explosion within line when air-to-gas is at correct mixture.

G. Functional Testing: All equipment, control devices and signaling devices shall be tested individually to demonstrate proper operation. Test all control panel functions to demonstrate proper operation. Test all control system functions to demonstrate proper operation in accordance with the specified control sequences. Monitoring signals to the facility Supervisory Control and Data Acquisition (SCADA) system shall be verified.

3.07 MANUFACTURER'S INSTRUCTIONS AND SERVICES:

A. Obtain instructions from the manufacturer for the proper method of installation and connection of the equipment that is to be installed. Obtain all information that is necessary to facilitate the Work and to complete the project.

B. Provide manufacturer's services in accordance with Section 01 78 25. Services shall be provided for the satisfactory completion of installation, start-up, testing and training for those equipment and systems described herein below.

1. Gas booster system

C. Upon completion of all Work, furnish, in duplicate, certificates of inspection from equipment manufacturers stating that authorized factory engineers have inspected and tested the operation of their respective equipment and found same to be in satisfactory operating condition.

3.08 PAINTING:

A. Field painting of above ground gas piping shall be provided under this Section in accordance with Section 09 90 00.

B. Field touch up all damaged factory or shop applied coatings for material and equipment furnished under this Section in accordance with the manufacturer's recommendation.

C. Provide shop painting system, under this Section, of the following. Color of finish coat shall be yellow.

1. Hangers and supports in exposed locations.

2. Pipe, fittings and valves in exposed locations.

D. Do not apply paint until piping tests have been completed and accepted by the Engineer.

3.09 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

3.10 SCHEDULES:

Schedule 23 11 23-1			
Building	**Projected Gas Load[1] S. Cubic feet/hr.**	**Regulator (Fisher) Model**	**Relief (Fisher) Model**
IPS	160	S202H 1-1/2-inch body 1/4-inch orifice	289A 1/4-inch
[1] Confirm gas load for each building prior to ordering the valves.			

END OF SECTION

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SECTION 23 13 25

FACILITY ABOVEGROUND DIESEL FUEL-OIL STORAGE TANKS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide Facility Aboveground Diesel Fuel-Oil Storage Tanks as indicated and in compliance with Contract Documents.

1. Concrete-vaulted, steel, fuel-oil ASTs

2. Leak Detection and Monitoring System

3. Fuel Polishing System

4. Master Control Panel

5. Fuel Transfer System

6. Return Pump System

7. Vehicle Fuel Dispensing Unit

B. These specifications are written based on the Oldcastle Convault tank. The Envirosafe Fireguard tank may be an acceptable alternate if the size and configuration will meet the intent of the design drawings.

C. The tank system must comply with all provisions of: 1) UFC 79-7, Appendix A-II-F, for both Vehicle Impact Protection and Projectile Resistance; 2) NFPA 30 and 30A; 3) IFC Chapter 22; and 4) IFC Chapter 34.

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 7: Minimum Design Loads for Buildings and Other Structures

B. ASTM International (ASTM):

1. D396: Standard Specification for Fuel Oils

2. D975: Standard Specification for Diesel Fuel Oils

C. American Welding Society (AWS):

1. D1.1: Structural Welding Code – Steel

D. The Society for Protective Coatings (SSPC):

1. SP-6: Commercial Blast Cleaning

2. SP-10: Near-White Metal Blast Cleaning

E. Underwriters' Laboratories, Inc. (UL):

1. 142: Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids

2. 1238: Standard for Safety Control Equipment for Use with Flammable Liquid Dispensing Devices2085: Standard for Safety Protected Aboveground Tanks for Flammable and Combustible Liquids

1.03 DEFINITIONS:

A. AST: Aboveground storage tank.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

3. Fuel-oil storage tank accessories.

C. Shop Drawings:

1. Include plans, elevations, sections, anchors, and lifting or supporting points.

2. Indicate dimensions, components, and location and size of each field connection.

3. Shop Drawing Scale: 1/4 inch per foot (1:50).

D. Site Survey: Plans, drawn to scale, on which fuel-oil storage tanks are shown and coordinated with other services and utilities.

E. Qualification Data: For qualified professional engineer.

F. Seismic Qualification Data: For ASTs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Brazing certificates.

H. Welding certificates.

I. Field quality-control reports.

J. Sample Warranty: For special warranty.

K. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. EPA Compliance: Comply with EPA and state and local authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks.

C. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.09 WARRANTY:

A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-oil storage tanks and components that fail in materials or workmanship within specified warranty period.

1. Storage Tanks:

a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 degrees F:

(1) Structural failures including cracking, breakup, and collapse.

b. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 43 00, to design restraint and anchors for fuel-oil ASTs, and equipment, including comprehensive engineering analysis, using performance requirements and design criteria indicated.

B. Seismic Performance: Factory-installed support attachments for AST shall withstand the effects of earthquake motions determined according to ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.02 CONCRETE-VAULTED, STEEL, FUEL-OIL AST:

A. Manufacturers:

1. Oldcastle Convault.

2. Envirosafe Fireguard (potential alternate tank)

B. Description: UL 142 and UL 2085; thermally insulated, fire-resistant and protected, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and insulation and with interstitial space.

C. Construction: Fabricated with welded, carbon steel and insulation and encased in concrete that will protect from bullets; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature according to UL 2085.

Secondary Containment and Corrosion Protection: The tank system shall include secondary containment consisting of an impervious barrier of 30 mil High-Density Polyethylene geomembrane enclosing the primary steel tank and insulation material to contain leaks from the primary tank and isolating the primary tank from the concrete to protect against corrosion. The secondary containment shall be impervious to corrosion, including damage or failure due to microbial infestation.

1. Secondary containment comprised of a steel jacket not encased with concrete will not be permitted.

D. Concrete Encasement: A vaulted concrete enclosure shall encase and protect both the primary steel tank and the secondary containment. The concrete encasement shall be 6 inches thick with a minimum design strength of 4000 psi. The concrete design shall include the following for long-term durability: air entrainment, water-reducing admixture, and steel reinforcement. Concrete placement shall be a visually verifiable monolithic (seamless) pour to ensure the absence of voids on all sides and beneath the steel tank.

E. The vault enclosure shall have concrete support legs of unitized monolithic construction raising the concrete enclosure a minimum of 3 inches above the ground to meet visual inspection requirements. A mid-level seam or other cold joint construction which could compromise the liquid tightness (secondary containment) and fire protection capability of the vault is not permitted.

F. Thermal Protection: The tank system construction shall include covering the outer surface of the primary steel tank with a minimum 1/4 inch of polystyrene foam panels and 6 inches thick reinforced concrete for thermal insulation to protect against temperature extremes.

G. Corrosion Protection: All steel outside the concrete encasement shall be anti-oxidant powder coated to inhibit corrosion and meet ASTM B117.

H. Ballistics Resistance: The tank system shall carry a listing under UL Ballistics Standard 752, Levels 5,6, and 8, signifying bullet-resisting protection against penetration, passage of fragments of projectiles, or fragmentation of the vault enclosure to the extent that any protected material, including the secondary containment and primary tank are not damaged.

I. Fire Resistance: The tank system shall be designed and tested to provide 2 hour fire protection for the primary tank as per UL 2085 2-hour furnace fire test and 2 hour simulated pool fire test. The average maximum rise in temperature of the primary tank during the test shall not exceed 260 degrees F and the maximum temperature of any single point on the primary tank shall not exceed 400 degrees F. No steel members shall penetrate the walls or floor of the concrete encasement to assure isolation from pool fire heat.

J. Leak Monitoring: A thru-tank leak detection monitoring tube terminating between the primary tank and the secondary containment shall be provided to monitor any leaks from the primary tank.

K. Spill/Overfill Containment: The tank system shall include a UL listed 7-gallon spill/overfill container manufactured as an integral part of the primary tank, surrounding the fill pipe, and protected by 2-hour fire rating of the enclosure. The spill/overfill container shall include a stick port and normally closed drain valve to release spilled product into the main tank. Exterior steel shall be anti-oxidant powder coated to inhibit rust. Overfill containment systems that are designed to release spilled product into the interstitial area will not be accepted.

L. Overfill Protection: Overfill protection shall be provided by the following methods: a) direct reading level gauge visible from fill pipe access; b) valve rated for pressurized delivery located within fill pipe to close automatically at 95 percent full level; and c) high level alarm.

M. Exterior Finish: The tank system exterior shall be a low maintenance architectural exterior concrete finish. Models with fiber clad or painted steel exterior tanks will not be accepted.

N. Capacities and Characteristics:

1. Capacity: 12,000 gallons

2. Width: 8 feet-0 inches

3. Length: 34 feet-1 inches

4. Height: 8 feet-3-1/4 inches

5. Connection Sizes:

    a. Fill Line: 4-inch diameter

    b. Other Ports: 6 x 4-inch diameter

    c. Emergency Vent: 8-inch diameter

    d. Return: 2-inch diameter

    e. Leak Detection Port: 2-inch diameter

    f. Communication Port: 1-inch diameter

6. Accessway:

    a. Number Required: 1

    b. Diameter: 24-inch

7. Fuel-Oil Grade Number: Diesel

2.03 FUEL-OIL AST ACCESSORIES:

A. Tank Manholes: 22-inch-minimum diameter; bolted, flanged, and gasketed; centered on top of tank.

B. Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.

C. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.

D. Lifting Lugs: For handling and installation.

E. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle (1:1 slope).

F. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle (1:1 slope).

G. Two-Level Float Switch: Each AST shall be provided with a two-level float switch. Fitting size and length shall be recommended by the AST manufacturer. Float switch fitting, stem, and float material shall be stainless steel. Level 1 shall be low level indication and Level 2 shall be high level indication.

2.04 LIQUID-LEVEL GAGE SYSTEM:

A. Manufacturer:

1. Veeder-Root Magnetostrictive (MAG) Plus Probe

B. Description: Calibrated liquid-level gage system complying with UL 1238 with probes or other sensors and remote annunciator panel. Maximum diameter 4-inch. Provide sensor riser cap and adapter kit, if re-quired, to match tank port.

C. Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in gallons (liters); and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.

D. Controls: Electrical, operating on 120-Vac.

2.05 INTERSTITIAL LEAK SENSOR:

A. Manufacturer:

1. Veeder-Root

B. Description: Provide interstitial leak sensor to detect the presence of liquid between the double walls of the tank. Sensor shall be compatible with diesel fuel. Maximum sensor

diameter 1.5-inch. Provide sensor riser cap and adapter kit, if required, to match tank port.

2.06 DISCRIMINTATING CONTAINMENT SUMP SENSOR:

A. Manufacturer:

1. Veeder-Root

B. Description: Provide discriminating containment sump sensor in the fill integral spill containment area of each storage tank.

2.07 DISPENSER PAN SENSOR:

A. Manufacturer:

1. Veeder-Root

B. Description: Provide discriminating sump sensor in the fuel dispenser pan.

2.08 PRESSURIZED LINE LEAK TRANSDUCER:

A. Manufacturer:

1. Veeder-Root

B. Description: Provide a digital pressurized line leak transducer at each pump to pipe connection in the system.

2.09 LEAK-DETECTION AND MONITORING SYSTEM:

A. Cable and Sensor System: Comply with UL 1238.

1. Manufacturers:

a. Veeder-Root TLS-450 Plus.

2. Calibrated leak-detection and monitoring system with probes and other sensors and remote alarm panel for the fuel storage tanks, belly tanks, dispenser, and relative electrical cabinets.

3. Include fittings and devices required for testing.

4. Controls: Electrical, operating on 120-Vac.

B. System Requirements

1. For the fuel storage tanks, provide alarms from Magnetostrictive level probes (high-level and low-level), interstitial liquid sensors, discriminating sump sensors, pressurized line leak transducers, and mag sensors to SCADA.

2. For the belly tanks, provide alarms from interstitial leak sensors to SCADA.

3. For the Supply FOP Cabinet, Return FOP Cabinet, and Fuel Polishing Cabinet, provide alarms from pressurized line leak detection, and liquid sensors to SCADA.

4. For the dispenser, provide alarms from a mag sensor, hook signal, and dispenser pan sensor to SCADA.

2.10 FUEL OIL:

A. Diesel Fuel Oil: ASTM D975, Grade Low Sulfur, high volatility.

2.11 SOURCE QUALITY CONTROL:

A. Affix standards organization's code stamp.

2.12 ANTI-SIPHON VALVE:

A. Provide an Anti-Siphon Valve on the fuel oil supply connection to the AST. Valve shall be in a 90 degree configuration and have a ductile iron body, stainless steel cap and spring, stainless steel plunger with Viton disc, stainless steel thermal expansion valve with Viton seal. Valve shall be normally closed and design for the site elevation.

B. Manufacturer:

1. Morrison Bros. Co. – Model 910

2.13 FUEL TRANSFER SYSTEM:

A. Provide a heavy-duty fuel transfer system that moves fuel to the requesting tank from the source tanks. System shall be a dual pump system suitable for servicing multiple tanks. System controller shall be designed to communicate with the Master Control Panel. The Fuel Transfer System shall include the following:

1. NEMA 4 rate enclosure, powder coated

2. Pumps: Continuous duty, 7 gpm, 3/4 HP spur gear pump, 120V, 1 phase, 60 Hertz

3. Strainers: 20 mesh wye-strainer

4. Mechanical water separator and water detection alarm module

5. Cabinet leak detector

6. System Controller with safety and alarm features including high vacuum, high pressure, and no flow

7. Cabinet heater

8. Miscellaneous Items as required for a complete system including, but not limited to, pressure relief port, pressure gauges, pressure switches, vacuum gauges, vacuum switches, check valves, wye strainers, flow switches, and ball valves.

B. Manufacturer:

1. AXI, International – FTS-2000

2.14 RETURN PUMP SYSTEM:

A. Provide a dual pump return fuel pump system for each generator belly tank designed to transfer fuel from the belly tank to the fuel-oil storage tanks and shall operate based on the fuel level in the belly tank. System shall be designed to communicate with the Master Control Panel. The Return Pump System shall include the following:

1. Return Pumps: 10 gpm, 1 HP, 120V, 1 Phase, 60 Hertz

2. Pump System Controller: Fully automated UL508a

3. NEMA 4 rated enclosure, powder coated

4. 4-Position Float

5. Cabinet leak detector

6. Miscellaneous Items as required for a complete system including, but not limited to, check valves, wye strainers, flow switches, and ball valves.

B. Manufacturer:

1. AXI, International – OPS 1016

2.15 FUEL POLISHING SYSTEM:

A. Provide a fuel polishing system for each fuel-oil storage tank. System shall be a programmable, fully-automated, fuel maintenance system that removes water, sludge, and other contaminants from the fuel-oil storage tank. The Fuel Polishing System shall include the following:

1. NEMA 4 rated enclosure, powder coated

2. 10 gpm/600 gph pump, 3/4 HP gear pump, 120V, 1 phase, 60 Hertz

3. Primary Filter: 10-micron particulate or 60-micron stainless steel screen with centrifugal water separator.

4. Secondary Filter: 3-micron particulate filter

5. Fuel Conditioner: Inline magnetic conditioner

6. System Controller with safety and alarm features

7. Water detection sensor and water detection alarm module

8. Cabinet leak detector

9. Miscellaneous items as required for a complete system including, but not limited to, vacuum gauge, vacuum switch, pressure gauges, pressure switch, ball valves, enclosure leak detector, and water drain valve.

B. Manufacturer:

1. AXI, International – STS 6010

2.16 MASTER CONTROL PANEL:

A. Provide a Master Control Panel (MCP) designed to communicate and operate with the Fuel Transfer System and the Return Pump System. The MCP shall also provide alarms and tank levels to the plant SCADA system. The MCP will monitor the generator day tanks' call for fuel and determine which tank and which pump(s) will be required to run to supply fuel to the day tanks. It will also control the valve selection to ensure fluid flow is to and from the proper storage tank.

B. MCP enclosure shall be stainless steel and NEMA 4X rated. Power supply shall be 1-phase, 115 VAC and provided with a UPS and backup battery. MCP shall include a 15-inch touch screen HMI. MCP shall be UL508A listed.

C. Manufacturer:

1. AXI, International

2.17 VEHICLE FUEL DISPENING UNIT:

A. Manufacturer:

1. Gasboy/Gilbarco Veeder-Root

2. Wayne Select

3. Bennett

B. Furnish and install a pedestal mounted diesel fuel dispenser unit suitable for use in outdoor, below freezing environment with the following components:

1. 2-inch inlet connection (maximum)

2. 1-inch outlet connection

3. Flow proportion valve to set maximum flow rate

4. Dispensing pump with maximum 26 gpm capacity and maximum 50 psi pressure

5. Hose hook with 20 feet of 1-inch diameter hose and fuel nozzle

6. Digital flow meter

7. Containment

8. Stainless steel top, sides and base

C. Electrical requirement – 120V, 60 Hz

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine roughing-in for aboveground fuel-oil storage tanks to verify actual locations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EARTHWORK:

A. Comply with requirements in Section 31 23 00 for excavating, trenching, and backfilling.

B. Allow for cast-in-place, concrete base.

3.03 FUEL-OIL AST INSTALLATION:

A. Install tank bases and supports.

B. Concrete Bases: Anchor AST to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Use 4,500-psi, 28-day, compressive-strength concrete and reinforcement as specified in Section 03 30 00.

C. Connect piping and vent fittings.

D. Install ground connections.

E. Install tank leak-detection and monitoring devices.

F. Install steel ASTs according to STI R912.

G. Install insulated and concrete-vaulted, steel ASTs according to STI R942.

H. Fill storage tanks with fuel oil.

3.04 LIQUID-LEVEL GAGE SYSTEM INSTALLATION:

A. Install liquid-level gage system. Install panel inside building where indicated.

3.05 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION:

A. Install leak-detection and monitoring system. Install alarm panel inside building where indicated.

1. Double-Wall, Fuel-Oil Storage Tanks: Install probes in interstitial space per the probe manufacturer’s written installation instructions.

2. Install liquid-level gage.

3. Install discriminating sump sensor

4. Install dispenser pan sensor

5. Install pressurized line leak detectors

3.06 VEHICLE FUEL DISPENSING UNIT INSTALLATION

A. Install the vehicle fuel dispensing unit in accordance with the manufacturer's written instructions.

3.07 LABELING AND IDENTIFYING:

A. Nameplates, pipe identification, and signs are specified in Section 23 05 53.

3.08 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:

a. Double-Wall Tanks:

(1) Inner Tanks: Minimum 3 psig and maximum 5 psig.

(2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-inches Hg vacuum.

2. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig , hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.

3. Maintain the test pressure for one hour.

C. ASTs will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.09 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide metal ducts as indicated and in compliance with Contract Documents.

1. Single-wall rectangular ducts and fittings.

2. Single-wall round ducts and fittings.

3. Sheet metal materials.

4. Sealants and gaskets.

5. Hangers and supports.

6. Seismic-restraint devices.

1.02 REFERENCES:

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 62.1: Ventilation for Acceptable Indoor Air Quality

2. 90.1: Energy Standard For Buildings Except Low-Rise Residential Buildings

B. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A480: Standard Specification for General Requirements for Flat-Rolled Stainless and Heat- Resisting Steel Plate, Sheet, and Strip

3. A492: Standard Specification for Stainless Steel Rope Wire

4. A603: Standard Specification for Zinc-Coated Steel Structural Wire Rope

5. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

6. A1008: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

7. B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

8. C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

9. C534: Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

10. C916: Standard Specification for Adhesives for Duct Thermal Insulation

11. C920: Standard Specification for Elastomeric Joint Sealants

12. C1071: Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)

13. D3363: Standard Test Method for Film Hardness by Pencil Test

14. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

15. E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

C. American Welding Society (AWS):

1. D1.1: Structural Welding Code – Steel

2. D1.2: Structural Welding Code – Aluminum

3. D1.3: Sheet Metal Welding Code

D. North American Die Casting Association (NADCA):

1. ACR: Assessment, Cleaning and Restoration of HVAC Systems," "Section 5 - Cleanliness Verification and Documentation

E. National Fire Protection Association (NFPA):

1. 45: Standard on Fire Protection for Laboratories Using Chemicals

2. 90A: Standards for the Installation of Air-Conditioning and Ventilating Systems

F. Sheet Metal and Air Conditioning Contractors National Association (SMANCA):

1. HVAC Air Duct Leakage Test Manual

2. HVAC Duct Construction Standards – Metal and Flexible

3. IAQ Guidelines for Occupied Buildings under Construction

4. Seismic Restraint Manual: Guidelines for Mechanical Systems

G. Underwriters' Laboratories, Inc. (UL):

1. 181: UL Standard for Safety Factory-Made Air Ducts and Connectors

2. 723: Standard for Safety Test for Surface Burning Characteristics of Building Materials

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of the following products:

1. Liners and adhesives

2. Sealants and gaskets

3. Seismic-restraint devices

C. Shop Drawings:

1. Factory- and shop-fabricated ducts and fittings

2. Fittings

3. Reinforcement and spacing

4. Seam and joint construction

5. Penetrations through fire-rated and other partitions

6. Equipment installation based on equipment being used on Project

7. Locations for duct accessories, including dampers, turning vanes, and access doors and panels

8. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation

D. Delegated-Design Submittal:

1. Sheet metal thicknesses

2. Joint and seam construction and sealing

3. Reinforcement details and spacing

4. Materials, fabrication, assembly, and spacing of hangers and supports.

5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation] for selecting hangers and supports and seismic restraints.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1, "Structural Welding Code - Steel," for hangers and supports

2. AWS D1.2, "Structural Welding Code - Aluminum," for aluminum supports

3. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. Seismically brace duct hangers and supports in accordance with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems.

1. Refer to the requirements in Section 01 41 20.

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.02 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS:

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

2. For ducts exposed to weather, construct of Type 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches , select joint types in accordance with Figure 2-1.

2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SINGLE-WALL ROUND DUCTS AND FITTINGS:

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

2. For ducts exposed to weather, construct of Type 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 48 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.04 SHEET METAL MATERIALS:

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653.

1. Galvanized Coating Designation: G90.

C. Stainless-Steel Sheets: Comply with ASTM A480, Type 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

D. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

E. Reinforcement Shapes and Plates: ASTM A36, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch-minimum diameter for lengths 36 inches or less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

2.05 DUCT LINER:

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers:

a. Knauf Fiberglass

b. Johns Manville

2. Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x degrees F at 75 degrees F mean temperature.

b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x degrees F at 75 degrees F mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

a. Adhesive shall have a VOC content of 80 g/L or less.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick galvanized steel aluminum or stainless steel to match duct construction; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.

2.06 SEALANT AND GASKETS:

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

2. Tape Width: 4 inches.

3. Sealant: Modified styrene acrylic.

4. Water resistant.

5. Mold and mildew resistant.

6. Maximum Static-Pressure Class: 10 inch wg, positive and negative.

7. Service: Indoor and outdoor.

8. Service Temperature: -40 to plus 200 degrees F.

9. Substrate: Compatible with galvanized sheet steel , stainless steel, or aluminum.

10. Sealant shall have a VOC content of 420 g/L or less.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Solids Content: Minimum 65 percent.

3. Shore A Hardness: Minimum 20.

4. Water resistant.

5. Mold and mildew resistant.

6. VOC: Maximum 75 g/L (less water).

7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.

8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.

10. Sealant shall have a VOC content of 420 g/L or less.

11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.

12. Service: Indoor or outdoor.

13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric

2. Type: S

3. Grade: NS

4. Class: 25

5. Use: O

6. Sealant shall have a VOC content of 420 g/L or less

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.

2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.07 HANGERS AND SUPPORTS:

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.08 SEISMIC-RESTRAINT DEVICES:

A. Refer to Sections 01 41 20 and 23 05 48 for requirements for restraint components and applications.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION:

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 23 33 00 for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.

2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

N. Branch Connections: Use lateral or conical branch connections.

3.02 INSTALLATION OF EXPOSED DUCTWORK:

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCTWORK EXPOSED TO WEATHER:

A. All external joints are to have secure watertight mechanical connections. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. Single Wall:

1. Ductwork shall be galvanized steel or Type 316 stainless steel as indicated.

2. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 23 07 13.

3.04 DUCT SEALING:

A. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Outdoor, Supply-Air Ducts: Seal Class A.

3. Outdoor, Exhaust Ducts: Seal Class C.

4. Outdoor, Return-Air Ducts: Seal Class C.

5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.

6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.

7. Unconditioned Space, Exhaust Ducts: Seal Class C.

8. Unconditioned Space, Return-Air Ducts: Seal Class B.

9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.

10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.

11. Conditioned Space, Exhaust Ducts: Seal Class B.

12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.05 HANGER AND SUPPORT INSTALLATION:

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet .

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.06 SEISMIC-RESTRAINT-DEVICE INSTALLATION:

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic

Restraint Manual: Guidelines for Mechanical Systems", Sections 01 41 20 and Section 23 05 48.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Set anchors to manufacturer's recommended torque, using a torque wrench.

5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.07 CONNECTIONS:

A. Make connections to equipment with flexible connectors complying with Section 23 33 00.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.08 FIELD QUALITY CONTROL:

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2. Test the following systems:

a. Supply Ducts with a Pressure Class of 2 Inch wg or Higher: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.

b. Return Ducts with a Pressure Class of 2 Inch wg or Higher: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.

c. Exhaust Ducts with a Pressure Class of 2 Inch wg or Higher: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.

d. Outdoor-Air Ducts with a Pressure Class of 2 Inch wg or Higher: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.

5. Test for leaks before applying external insulation.

6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

7. Give seven days' advance notice for testing.

3.09 DUCT CLEANING:

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use duct cleaning methodology as indicated in NADCA ACR.

C. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

D. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

E. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.

7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.10 STARTUP:

A. Air Balance: Comply with requirements in Section 23 05 93.

3.11 DUCT SCHEDULE:

Wet Wells 1& 2 Supply and Exhaust Fans (01-F-81430 & 81440)	Stainless Steel
Pump Rm 101 (01-MAU-81210)	Galvanized
Pump Rm 101 Supply and Exhaust Fans (01-F-81410 & 81420)	Galvanized
Medium Voltage Electrical Rm 101 (10-AHU-81310 / 81320)	Galvanized

A. Fabricate ducts with materials indicated above and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units and Terminal Units:

a. Pressure Class: Positive 2 inch wg.

b. Minimum SMACNA Seal Class: B.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Constant and Variable Volume Air-Handling Units and Makeup Air Units:

a. Pressure Class: Positive 3 inch wg.

b. Minimum SMACNA Seal Class: B.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units and Terminal Units:

a. Pressure Class: Positive or negative 2 inch wg.

b. Minimum SMACNA Seal Class: B.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Air-Handling Units and Makeup Air Units:

a. Pressure Class: Positive or negative 2 inch wg.

b. Minimum SMACNA Seal Class: B.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2 inch wg.

b. Minimum SMACNA Seal Class: B.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to High-Humidity or Corrosive Locations:

    a. Type 316, stainless-steel sheet.

    b. Exposed to View: No. 4 finish.

    c. Concealed: No. 2D finish.

    d. Welded longitudinal seams; welded or flanged transverse joints with water-tight EPDM gaskets.

    e. Pressure Class: Positive or negative 3 inch wg.

    f. Airtight/watertight.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units and Terminal Units:

    a. Pressure Class: Positive or negative 2 inch wg.

    b. Minimum SMACNA Seal Class: B.

    c. SMACNA Leakage Class for Rectangular: 12.

    d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Air-Handling Units and Makeup Air Units:

    a. Pressure Class: Positive or negative 2 inch wg.

    b. Minimum SMACNA Seal Class: B.

    c. SMACNA Leakage Class for Rectangular: 12.

    d. SMACNA Leakage Class for Round and Flat Oval: 6.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. Stainless-Steel Ducts:

    a. Exposed to Airstream: Match duct material.

    b. Not Exposed to Airstream: Match duct material.

G. Liner where indicated on plans:

1. Supply-Air Ducts: Fibrous glass, Type I 1 inch(es) thick.

2. Return-Air Ducts: Fibrous glass, Type I 1 inch(es) thick.

3. Supply Fan Plenums: Fibrous glass, Type I 1 inch(es) thick.

4. Return Plenums: Fibrous glass, Type I 1 inch(es) thick.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Velocity 1000 fpm or Lower:

      (1) Mitered Type RE 4 without vanes.

   b. Velocity 1000 or Higher:

      (1) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

      (1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.

(2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

(3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

3.12 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide backdraft and pressure relief dampers, barometric relief dampers, manual volume dampers, control dampers, fire dampers, turning vanes, remote damper operators, duct-mounted access doors, flexible connectors, duct accessory hardware]as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. Air Movement and Control Association International, Inc. (AMCA):

1. 500-D: Laboratory Methods of Testing Dampers for Rating

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 90.1: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

C. ASTM International (ASTM):

1. A480: Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

2. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

3. B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

4. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

5. E477: Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers

D. National Fire Protection Association (NFPA):

1. 90A: Standards for the Installation of Air-Conditioning and Ventilating Systems

E. Underwriters' Laboratories, Inc. (UL):

1. 181: Standard for Safety Factory-Made Air Ducts and Connectors

2. 555: Standard for Safety Fire Dampers

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.

b. Manual volume damper installations.

c. Control-damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

C. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

D. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION:

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems".

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 MATERIALS:

A. Galvanized Sheet Steel: Comply with ASTM A653.

1. Galvanized Coating Designation: G90.

B. Stainless-Steel Sheets: Comply with ASTM A480, Type 316, and having a No. 4 finish.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T5.

E. Hard Aluminum: Comply with ASTM B221, Alloy 6065 T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

2.03 BACKDRAFT DAMPERS:

A. Manufacturers:

1. Tamco

2. Ruskin

3. Nailor

B. Channel Frame Material: Minimum 0.06 inch extruded aluminum.

C. Frame Construction: Channel-shaped, with zinc-plated mechanical assembly and duct mounting flange.

D. Blades Material: Minimum 0.06 inch extruded aluminum.

E. Blades Construction: Multiple single-piece blades, off-center pivoted, maximum 5-inch width.

F. Blade Action: Linked parallel.

G. Bearings: Celcon on zinc-plated steel pivots.

H. Blade and Jamb Seals: Extruded silicone.

I. Crank Arms: Hard aluminum.

J. Linkage: Hard Aluminum 11/32 inch rod

K. Blade Axles: Zinc-plated steel.

L. Tie Bars and Brackets: Aluminum.

M. Bearings: Synthetic pivot bushings.

N. Operational Temperature Range: Minus 40 degrees F to 212 degrees F.

O. Air Leakage: Shall not exceed 4.32 cfm/ft² against 1 in. w.g. differential static pressure at standard air.

P. Operational Temperature Range: Minus 40 degrees F to 212 degrees F.

Q. Air Leakage: Shall not exceed 6.93 cfm/ft² against 1 inch w.g. differential static pressure at standard air for dampers greater than 24 inches in height or width and 11.38 cfm/ft² against 1 inch w.g. differential static pressure at standard air dampers less than 24 inches in height or width.

R. Standard of Acceptance: Tamco; Series 7000

2.04 BAROMETRIC RELIEF DAMPERS:

A. Manufacturers:

1. Tamco

2. Ruskin

3. Nailor

B. Suitable for horizontal or vertical mounting.

C. Channel Frame Material: Minimum 0.06 inch extruded aluminum.

D. Frame Construction: Channel-shaped, with zinc-plated mechanical assembly and duct mounting flange.

E. Blades Material: Minimum 0.06 inch extruded aluminum.

F. Blades Construction: Multiple single-piece blades, off-center pivoted, maximum 5-inch width.

G. Blade Action: Linked parallel.

H. Bearings: Celcon on zinc-plated steel pivots.

I. Blade and Jamb Seals: Mechanically fastened extruded silicone.

J. Crank Arms: Hard aluminum.

K. Linkage: Hard Aluminum 11/32 inch rod.

L. Blade Axles: Zinc-plated steel.

M. Tie Bars and Brackets: Aluminum.

N. Bearings: Synthetic pivot bushings.

O. Counter Balance Weights: Aluminum (6061-T6) mounted on each blade. Counter-weights shall be fully adjustable, such that they may be set to relieve air pressure differentials less than .01 inch w.g.

P. Operational Temperature Range: Minus 40 degrees F to 212 degrees F.

Q. Air Leakage: Shall not exceed 4.32 cfm/ft² against 1 in. w.g. differential static pressure at standard air on a 24 inch x 24 inch unit.

R. Standard of Acceptance: Tamco; Series 7000 CW

2.05 MANUAL VOLUME DAMPERS:

A. Single Blade Dampers:

1. Material: Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

2. Configuration: Size and configuration to recommendations of SMACNA, except maximum height 8 inches.

3. Control: Locking quadrant with shaft extension to accommodate insulation thickness.

4. Shaft: Continuous.

5. Bearings: Inside and outside bronze end bearings.

6. Frame: Channel frame of same material as adjacent duct, complete with angle stop.

B. Multi-Bladed Dampers:

1. Material: Factory manufactured of material compatible with duct. Metal thickness and construction to recommendations of SMACNA.

2. Blade Height: Maximum blade height: 8 inches.

3. Bearings: Bronze bushings.

4. Shaft: Continuous.

5. Configuration: Linkage with opposed blade operation.

6. Control: Shaft extension with locking quadrant.

7. Frame: Channel frame of same material as adjacent duct, complete with angle stop.

2.06 FIRE DAMPERS:

A. Manufacturers:

1. E H Price

2. Ruskin

3. Nailor

4. Greenheck

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Fire Rating: 1-1/2 and 3 hours to suite separation rating.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners. Provide stainless steel to match duct construction or in corrosive atmospheres.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: As indicated in manufacturer's instructions to meet code requirements, and of length to suit application.

F. Mounting Orientation: Vertical or horizontal as required.

G. Blades: Roll-formed, interlocking, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 165 degrees F rated, fusible links.

2.07 TURNING VANES:

A. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

B. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.08 DUCT-MOUNTED ACCESS DOORS:

A. Manufacturers:

1. Acudor

2. Ductmate

3. Duro Dyne

4. Ruskin

5. Nailor

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.

c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.

d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:

   a. Access Doors Less than 12 Inches Square: No hinges and two sash locks.

   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with handles.

   d. Access Doors Larger than 24 by 48 Inches: Four hinges and two compression latches with handles.

2.09 FLEXIBLE CONNECTORS:

A. Manufacturers:

   1. Duro Dyne

   2. Ductmate

   3. Ventfabrics

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip minimum 3 inches wide attached to two strips of 3-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

   1. Minimum Weight: 26 oz./sq. yd

   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling

   3. Service Temperature: Minus 40 to plus 200 degrees F

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

   1. Minimum Weight: 24 oz./sq. yd

   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling

   3. Service Temperature: Minus 50 to plus 250 degrees F

G. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz./sq. yd

2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling

3. Service Temperature: Minus 67 to plus 500 degrees F

2.10 DUCT ACCESSORY HARDWARE:

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Compliance with ASHRAE/IESNA 90.1-2004 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," restricts the use of backdraft dampers, and requires control dampers for certain applications. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

2. Install aluminum volume dampers in aluminum ducts.

3. Install 316 stainless steel volume dampers in stainless steel and FRP ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.

2. Upstream from duct filters.

3. At outdoor-air intakes and mixed-air plenums.

4. At drain pans and seals.

5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.

6. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.

7. At each change in direction and at maximum 50-foot spacing.

8. Upstream and downstream from turning vanes.

9. Control devices requiring inspection.

10. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches

2. Two-Hand Access: 12 by 6 inches

3. Head and Hand Access: 18 by 10 inches

4. Head and Shoulders Access: 21 by 14 inches

5. Body Access: 25 by 14 inches

6. Body plus Ladder Access: 25 by 17 inches

K. Label access doors according to Section 23 05 53 to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5-inch w.g. and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect diffusers to ducts directly.

O. Install duct test holes where required for testing and balancing purposes.

P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.02 FIELD QUALITY CONTROL:

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Operate fire dampers to verify full range of movement and verify that proper heat-response device is installed.

4. Inspect turning vanes for proper and secure installation.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 23 34 00

FANS AND ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide fans and accessories as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. Air Movement and Control Association Inc. (AMCA):

1. 210: Laboratory Methods of Testing Fans for Rating

2. 211: Certified Ratings Program – Product Rating Manual for Fan Air Performance

3. 300: Reverberant Room Method for Sound Testing of Fans

4. 311: Certified Sound Ratings Program for Air Moving Devices

B. American National Standards Institute (ANSI):

1. S2.19: Mechanical Vibration – Balance Quality Requirements for Rigid Rotors

C. ASTM International (ASTM):

1. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus

D. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. 519: Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

E. National Fire Protection Association (NFPA):

1. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Shop Drawings: Submit complete material, construction and performance shop drawings for fans and accessories. Include the following:

1. Certified fan performance curves.

2. For fans where sound data is scheduled, certified sound power data which conforms to specified levels.

3. Complete motor data, including manufacturer.

4. Complete accessories data, including drawings (i.e., disconnects, curbs, dampers, belts, bearings, sheave sizes, coatings, etc.).

C. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems and anchorage for equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

D. Shop Drawings must confirm that proposed fan equipment conforms to requirements of this Section of the Specification.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Incorporate any requirements not listed here for each individual fan as noted on the Equipment Schedules on the drawings.

2.02 MEDIUM PRESSURE TUBE AXIAL FANS:

A. Vaneaxial, AMCA air performance and sound certified, bearing the AMCA seal on the fan, vaneaxial fans as per the Drawing schedule, with performance rating certification in accordance with results of tests performed in accordance with AMCA Publication 211. Each fan is to be complete with the following:

1. Housing: Fan housing shall be constructed of continuously welded steel and include an integral punched inlet and outlet flange to prevent air leakage. Fans shall

incorporate universal a mounting system to allow for field transitions from horizontal base mount, horizontal ceiling hung, vertical base mount or vertical ceiling hung configurations. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings. Belts, bearings and drives shall be protected from the airstream by heavy gauge steel belt tubes bolted bearing covers.

2. Wheel: The fan propeller shall be fabricated steel available in two levels of construction and include "Low and High" pressure blade pitch angles. Airfoil blades shall be continuously welded to heavy duty hubs to ensure long life in the harshest commercial or industrial applications. A standard square key or tapered bushing shall lock to propeller to the fan shaft. Hubs shall be two piece aluminum castings that securely lock the blades in place. Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19. Aluminum propeller parts shall not require protective coatings. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

3. Bearings: Flanged mounted, grease lubricated, ball or roller type isolated from the air stream, sized for an AFBMA L-50 average life expectancy of 200,000 hours at maximum published fan RPM, and equipped with extended lubrication lines terminating on the fan housing in a grease nipple.

4. Fan Motors and Drive: Motors shall meet or exceed EPACT (Energy Policy ACT) efficiencies. Motors to be NEMA T-frame, 1800 or 3600 RPM, Open Drip Proof (ODP) with a 1.15 service factor. Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required. Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class. Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration. Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class {Average Life or (L-50) of 400,000 hours} for horizontal mount and a basic rating fatigue life L(10) of 40,000 hours at maximum operating speed {Average Life or (L-50) of 200,000 hours} for vertical mount. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed. Bearings shall have Zerk fittings to allow for lubrication.

5. Spring Hangers: Vibration isolation spring hangers sized to suit the fan, selected to operate at 2/3 solid load, and supplied loose.

6. Finish: After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Polyester Urethane, electrostatically applied and baked. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.

7. Disconnect switches: Factory supplied, mounted and wired with housing suitable to exposure.

B. Manufacturers:

1. Greenheck

2. Twin City Fan and Fan Blower Co.

3. New York Blower

2.03 CEILING MOUNT EXHAUST FANS

A. General Description

1. Base fan performance at standard conditions (density 0.075 Lb/ft3)

2. Ceiling mounted applications.

3. Maximum operating temperatures is 130 Fahrenheit (54.4 Celsius).

4. UL/cUL listed for above bathtub exhaust.

5. Fans are UL/cUL listed 507 - Electric Fans.

6. Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number.

7. Wheel:

a. Forward curved centrifugal wheel.

b. Constructed of calcium carbonate filled polypropylene.

c. Statically and dynamically balanced in accordance to AMCA Standard 204-05.

8. Motors:

a. Motor enclosures shall be open driproof (ODP), opening in the frame body and or end brackets.

b. Motors are permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase.

c. Motors shall be mounted on vibration isolators and be accessible for maintenance.

d. Compatible for use with speed controls.

e. Thermal overload protection.

9. Housing:

a. Constructed of heavy gauge galvanized steel.

10. Backdraft dampers.

a. Aluminum.

11. Flexible connections:

a. To Section 23 33 00 - Air Duct Accessories.

12. Resiliently mount direct driven fan and motor.

13. Motor shall be plug-in type with permanently lubricated bearings.

14. Provide one piece aluminum intake grille.

B. Manufacturers:

1. Greenheck

2. Broan

3. PennBarry

PART 3 - EXECUTION

3.01 GENERAL:

A. The installation of all fans is to meet the seismic restraint requirements as stated in Section 01 41 20 and Section 23 05 48.

3.02 INSTALLATION OF INLINE FANS:

A. Provide inline centrifugal fans where shown.

B. Provide flexible duct connectors.

C. Install with motor on the bottom or side for ease of servicing.

D. Install mounting brackets for each fan and secure in place with vibration isolators and hanger rods, independent of connecting ductwork.

3.03 INSTALLATION OF CEILING EXHAUST FANS:

A. Provide ceiling exhaust fans where shown.

B. Rigidly secure each fan housing in place in the ceiling space and coordinate installation with:

1. The air distribution work where duct connection are specified.

2. The electrical work of Division 26 where electrical power connection to the housing receptacle is specified.

C. Install fan-motor assemblies and plug into housing receptacles.

D. Install accessories supplied loose.

E. When installation is complete, check and test operation and adjust as required.

3.04 INSTALLATION OF VANEAXIAL FANS:

A. Provide vaneaxial fans where shown.

B. Unless otherwise indicated or specified, suspend each fan from the structure, independent of connecting ductwork, by means of hanger rods and vibration isolation spring hangers.

C. When installation is complete, check and test operation and adjust as required.

3.05 CONTROLS:

A. Coordinate with HVAC control contractor to ensure tie-in between BMS controllers and VFD hard-wired control circuit.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

3.07 SCHEDULES:

A. See Drawings.

END OF SECTION

SECTION 23 37 13.13

AIR DIFFUSERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide round ceiling diffusers, rectangular and square ceiling diffusers, perforated diffusers, louver face diffusers, linear bar diffusers, high-capacity drum louver diffusers, as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 70: Method of Testing the Performance of Air Outlets and Air Inlets

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 TYPE DL-1: HIGH-CAPACITY DRUM LOUVER DIFFUSERS:

A. Manufacturers:

1. Price

2. Titus

3. Nailor

B. Airflow Principle: Extended distance for high airflow rates

C. Material: Aluminum, heavy gage extruded

D. Finish: Powder Coat

E. Border: 1-1/4-inch width with countersunk screw holes

F. Gasket between drum and border

G. Body: Drum shaped; adjustable vertically

H. Blades: Individually adjustable horizontally

I. Mounting: Surface

J. Size: As scheduled or indicated on drawings

K. Accessories:

1. Opposed-blade steel damper

2.02 SOURCE QUALITY CONTROL:

A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Review the architectural reflected ceiling plan and confirm the indicated diffuser mounting style is compatible the ceiling type. Any conflicts are to be brought to the Engineer's attention for resolution.

D. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING:

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 23 37 13.23

REGISTERS AND GRILLES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide adjustable blade face registers and grilles, fixed face registers and grilles as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 70: Method of Testing the Performance of Air Outlets and Air Inlets

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 REGISTERS:

A. Type SR-1: Aluminum Adjustable Blade Face Supply Register:

1. Manufacturers:

a. Price

b. Titus

c. Nailor

2. Make/Model: Per Equipment Schedule

3. Material: Extruded Aluminum

4. Finish: Powder Coat

5. Face Blade Arrangement: Adjustable double deflection with front and rear blades spaced 1-1/2 inch on center

6. Frame: 1-1/4 inches wide

7. Mounting: Countersunk screw

8. Damper Type: Aluminum adjustable opposed blade

2.02 GRILLES:

A. Type RG-1: Aluminum Eggcrate Core Return Grille:

1. Manufacturers:

a. Price

b. Titus

c. Nailor

2. Make/Model: Per Equipment Schedule

3. Material: Aluminum

4. Finish: Powder Coat

5. Face Blade Arrangement: Fixed 1/2 inch x 1/2 inch x 1/2 inch deep aluminum grid.

6. Frame: 1-1/4 inches wide

7. Mounting: Countersunk screw for surface, lay-in no screw hole for T-bar

8. Damper Type: None

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING:

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 23 41 00

PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide flat panel filters, pleated panel filters, front- or back-access filter frames, side-access filter housings, filter gauges as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 52.2: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

B. National Fire Protection Association (NFPA):

1. 90A: Standards for the Installation of Air-Conditioning and Ventilating Systems

C. Underwriters' Laboratories, Inc. (UL):

1. 900: Standard for Safety Air Filter Units

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

C. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.

2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

D. Seismic Qualification Data: Certificates, for filters, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

F. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide one complete set(s) of filters for each filter bank.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver and store products in a clean, dry place.

C. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

D. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

E. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

3. Replace installed products damaged during construction.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: Filters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and criteria documented in Section 01 41 20.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Component Importance Factor: 1.5.

B. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."

2. Comply with ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

C. Comply with NFPA 90A.

D. Comply with UL 900.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 PLEATED PANEL FILTERS:

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

1. Manufacturers:

a. Camfil

b. AAF Flanders

B. Source Limitations: Obtain from single source from single manufacturer.

C. Capacities and Characteristics:

1. Face Size: As per equipment schedule

2. Depth: 2 inches nominal.

3. Initial Resistance: 0.1-inch wg at 350 fpm.

4. Recommended Final Resistance: 1.0 inches wg.

5. Minimum Efficiency Reporting Value: MERV 8, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.

6. Access: Side.

D. Media: Cotton and synthetic fibers or 100 percent synthetic fibers coated with non-flammable adhesive.

1. Separators shall be bonded to the media to maintain pleat configuration.

2. Welded-wire or expanded metal grid shall be on downstream side to maintain pleat.

3. Media shall be bonded to frame to prevent air bypass.

E. Filter-Media Frame: Moisture resistant two piece cardboard frame with diagonal supports sealed or bonded to the media.

2.03 SIDE-ACCESS FILTER HOUSINGS:

A. Description: Factory-assembled, side-service housings, constructed of to match duct material, with flanges to connect to duct or casing system.

1. Manufacturers:

a. Camfil

b. AAF Flanders

B. Source Limitations: Obtain from single source from single manufacturer.

C. Prefilters: Integral tracks to accommodate 2-inch thick, disposable filters.

D. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking devices, and arranged so filter cartridges can be loaded from either access door.

E. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

2.04 FILTER GAUGES:

A. Diaphragm-type gauge with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Manufacturers:

a. Dwyer – 2000 Magnehelic

B. Source Limitations: Obtain from single source from single manufacturer.

1. Diameter: 4-1/2 inches.

2. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg or Less: 0- to 1.0-inch wg.

C. Accessories: Static-pressure tips, tubing, gauge connections, and mounting bracket.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF FILTERS:

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Install filter gauge for each filter bank.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

E. Coordinate filter installations with duct and air-handling-unit installations.

3.03 INSTALLATION OF FILTER GAUGES:

A. Install filter gauge for each filter bank.

B. Install filter-gauge, static-pressure tips upstream and downstream from filters. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

3.04 CONTROL CONNECTIONS:

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between pressure sensors and control system.

3.05 CLEANING:

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 23 42 00

GAS-PHASE AIR FILTRATION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide gas-phase panel filters, side-access filter housings, filter gages as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 7: Seismic Loads: Guide to the Seismic Load Provision

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 52.2: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

2. 62.1: Ventilation for Acceptable Indoor Air Quality

C. ASTM International (ASTM):

1. D3467: Standard Test Method for Carbon Tetrachloride Activity of Activated Carbon

2. D3802: Standard Test Method for Ball-Pan Hardness of Activated Carbon

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

2. 90A: Standards for the Installation of Air-Conditioning and Ventilating Systems

E. Underwriters' Laboratories, Inc. (UL):

1. 900: Standard for Safety Air Filter Units

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop

at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

C. Shop Drawings: For gas-phase air filters. Include plans, elevations, sections, details, and attachments to other work.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.

D. Seismic Qualification Data: Certificates, for gas-phase filters, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Operation and Maintenance Data: For each type of gas-phase filter and rack to include in emergency, operation, and maintenance manuals.

F. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide one complete set(s) of filters for each filter or filter bank.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver and store products in a clean, dry place.

C. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

D. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

E. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

3. Replace installed products damaged during construction.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: Filters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Component Importance Factor: 1.5

B. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."

C. Comply with NFPA 90A.

2.02 GAS-PHASE PANEL FILTERS:

A. Description: Factory-fabricated panel or pleated adsorbent media filter.

B. Manufacturers:

1. Camfil

2. AAF Flanders

C. Filter Unit Class: UL 900, Class 2

D. Capacities and Characteristics:

1. Face Size: As per Equipment Schedule

2. Depth: 2 inches nominal

3. Maximum or Rated Face Velocity: 500 fpm

4. Service Access Location (Front, Back, Side): Side

5. Initial Resistance: 0.10-inch wg

E. Media:

1. Flat-panel or pleated, multilayer filter with an inlet layer of nonwoven polyester fibers, bonded or supported by a grid, to a layer of impregnated activated carbon and potassium permanganate suitable for the removal of corrosive and acidic gases like H_2S.

2. Housed in a self-supporting frame.

F. Maximum Continuous Operating Temperature: 150 degrees F.

G. Pre-installation Protection: Package each gas-phase filter in a sealed polyethylene bag to prevent unintentional adsorption prior to installation.

2.03 SIDE-ACCESS FILTER HOUSINGS:

A. Description: Factory-assembled, side-service housings, constructed to match duct material, with flanges to connect to duct or casing system.

1. Manufacturers:

a. Camfil.

b. AAF Flanders

B. Source Limitations: Obtain from single source from single manufacturer.

C. Prefilters: Integral tracks to accommodate 2-inch thick, disposable filters.

D. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking devices, and arranged so filter cartridges can be loaded from either access door.

E. Sealing: Incorporate positive-sealing gasket material on channels of filter cartridge frames to prevent bypass of unfiltered air.

2.04 FILTER GAUGES:

A. Diaphragm-type gauge with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Manufacturers:

a. Dwyer – 2000 Magnehelic

B. Source Limitations: Obtain from single source from single manufacturer.

1. Diameter: 4-1/2 inches

2. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-inch wg or Less: 0- to 1.0-inch wg.

C. Accessories: Static-pressure tips, tubing, gauge connections, and mounting bracket.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Position each filter unit with required clearance for service and maintenance. Anchor filter-mounting frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Do not operate fan system until particulate filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

D. Do not install gas-phase filters until fan system is clean and there is no risk of construction debris loading the filter.

E. Install filter-gauge, static-pressure taps upstream and downstream from each filter bank. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

F. Coordinate filter installations with duct and air-handling-unit installations.

G. Install all manufacturer-provided accessories in accordance with manufacturer's written installation instructions.

3.03 CONTROL CONNECTIONS:

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between pressure sensors and control system.

3.04 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test for leakage of unfiltered air while system is operating.

C. Air filters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.05 CLEANING:

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new particulate filter media.

3.06 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain filters.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 23 70 00

AIR CONDITIONING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide air conditioning equipment as indicated and in compliance with Contract Documents.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Shop Drawings: Submit shop drawings for all products specified in this Section.

C. Include certified power and control wiring schematics with each shop drawing.

D. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems and anchorage for equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

1.03 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Manufacturer's Quality System:

1. Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.

2. The control must be UL tested and certified.

1.04 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 WALL MOUNTED DUCTLESS AIR CONDITIONING UNITS AND CONDENSING UNITS:

A. General:

1. System consisting of an indoor evaporator unit, a remote air cooled condensing unit, and a wall mounting 12 volt DC electronic controller

B. Basis of Design:

1. Mitsubishi Electric air cooled inverter air-conditioning split system Model PUY/PKA series as scheduled:

2. Acceptable Manufacturers:

a. Mitsubishi Electric (MITS Air Conditioning Inc.)

b. Daikin AC (Americas), Inc.

c. Carrier

C. Evaporator Units: Each wall mounting evaporator unit is to be complete with:

1. A casing with air intake grille, supply air outlet with manually adjustable guide vanes for direction of vertical air flow, and swing-flow louvres to automatically change the direction of horizontal air flow.

2. A line flow fan with a multi speed single phase induction motor not to exceed 41 dBa on high speed.

3. An evaporator coil.

4. A high impact molded plastic casing in an off white finish.

5. A PP honeycomb long life washable filter.

6. A wired wall mounted remote controller with unit start/stop, room temperature set point adjustment and fan speed adjustment.

7. Condensate pumping package.

D. Condensing Units: Each remote condensing unit is to be of horizontal draw-through design and complete with:

1. A minimum 0.6 mm thick zinc coated alloy steel casing with an external acrylic polyester enamel finish, removable top and front panels, and grille type guards for the condenser coil and condenser fan.

2. A compressor.

3. A condensing coil and a condenser fan.

4. A linear inverter to modulate the capacity of the system in accordance with a microprocessor based control system and inverter system shall control the capacity and power consumption from 8 percent to 10 percent.

5. Unit shall be microprocessor controlled with full diagnostic features.

6. Noise level shall not exceed 58 dBa.

7. Factory installed low ambient controls to enable unit to operate to -40 degrees F.

8. High pressure protection, over current protection and DC bus current protection.

2.02 ELECTRICAL REQUIREMENTS:

A. *Dewatering* Outdoor Units:

1. Each outdoor unit will require a 208-230 VAC single-phase power supply. 60 amp breaker.

B. *Dewatering* Indoor Units:

1. Each indoor unit will require a 208-230 VAC single-phase power supply. 15 amp breaker

C. Power:

1. *Refer to equipment schedules on drawings.*

D. Control circuit (Transmission line):

1. Control will be via a 30vdc M-net fuzzy logic signal generated by the outdoor unit. This signal will be sent to the indoor units via a 2 core 16 g non-polar screened cable. All indoor units, outdoor units and Local Network controls will be coupled to this network in a daisy chain or star connection fashion. Network communication to remaining operating system components will not be effected in the case of an individual component failure such as indoor units or controllers.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS:

A. Some equipment will be shipped to the site with an operating charge of refrigerant. Some equipment will be dehydrated and shipped to the site. Provide all required

refrigerant, and, where equipment is not complete with a refrigerant charging valve, site install a charging valve in an accessible location.

3.02 AIR CONDITIONING UNITS AND CONDENSING UNITS:

A. Provide split system air conditioning systems.

B. Secure evaporator units to the wall where shown, approximately 2.3 m above the finished floor. Ensure that the units are level and plumb. Avoid installing above permanently located electrical or electronic equipment.

C. All refrigeration piping must be separately insulated.

D. Obtain final refrigerant piping and wiring diagrams from supplier.

E. Provide all required control wiring and power wiring required for a complete installation.

F. Hand a remote controller for each system to the electrical trade at the site for installation as part of the Work of Division 26. Supply certified control and power wiring schematics and hand to the electrical trade with the controllers.

G. The Refrigerant Distribution circuit and Piping shall be designed and selected according to the manufacturers specifications.

H. Plumb the condensate pump discharge to the nearest drain.

I. Manufacturer's agent shall commission the system.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 23 73 33.16

INDOOR, INDIRECT, GAS-FIRED HEATING AND VENTILATING UNITS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide indirect, gas-fired heating and ventilating units, including the following components as indicated and in compliance with Contract Documents.

1. Casings

2. Fans, drives, and motors

3. Air filtration

4. Dampers

5. Indirect, gas-fired burners

6. Unit control panel

7. Controls

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. A117.1: Accessible and Usable Buildings and Facilities.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 52.2: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

2. 62.1: Ventilation for Acceptable Indoor Air Quality

C. American Society of Mechanical Engineers (ASME):

1. B16.1: Pipe Flanges and Fittings

2. B16.5: Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

3. B16.10: Face-to-Face and End-to-End Dimensions of Valves

4. B16.34: Valves – Flanged, Threaded, and Welding End

5. B31.1: Power Piping

6. B31.9: Building Services Piping.

D. ASTM International (ASTM):

1. A126: Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

2. A153/A153M: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

3. A536: Standard Specification for Ductile Iron Castings

4. B209/B209M: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

E. American Welding Society (AWS):

1. D1.1/D1.1M: Structural Welding Code – Steel

F. American Water Works Association (AWWA):

1. C606: Grooved and Shouldered Joints

G. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

2. 90A: Standards for the Installation of Air-Conditioning and Ventilating Systems

3. 90B: Standard for the Installation of Warm Air Heating and Air-Conditioning Systems

H. Underwriters' Laboratories, Inc. (UL):

1. 900: Standard for Safety Air Filter Units

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each indoor, indirect, gas-fired heating and ventilating unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

3. Include unit dimensions and weight.

4. Include cabinet material, metal thickness, finishes, insulation, and accessories.

5. Fans:

   a. Include certified fan-performance curves with system operating conditions indicated.

   b. Include certified fan-sound power ratings.

   c. Include fan construction and accessories.

   d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include filters with performance characteristics.

7. Include direct, gas-fired burners with performance characteristics.

8. Include dampers, including housings, linkages, and operators.

C. Shop Drawings: For each type and configuration of indoor, indirect, gas-fired heating and ventilating unit.

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.

4. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems, anchorage and equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

E. Source quality-control reports.

F. Startup service reports.

G. Field quality-control reports.

H. Sample Warranty: For manufacturer's warranty.

I. Operation and Maintenance Data:

1. Operation and maintenance manuals shall be specific to equipment purchased and crossing out of non-applicable items is not acceptable.

a. For air-handling units to include in emergency, operation, and maintenance manuals.

2. Comply with requirements of Section 01 78 23.

J. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each air-handling unit.

2. Fan Belts: One set for each air-handling unit fan.

K. Informational Submittals:

1. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

2. Sample Warranty: For manufacturer's warranty.

3. Seismic Qualification Data: Certificates for indoor, indirect, gas-fired heating and ventilating units, accessories, and components, from manufacturer.

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

d. Restraint of internal components.

4. Startup service reports.

5. Field quality-control reports.

L. Closeout Submittals:

1. Operation and Maintenance Data: For indirect, gas-fired heating and ventilating units to include in emergency, operation, and maintenance manuals.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.07 WARRANTY:

A. Comply with the requirements specified in Section 01 78 36.

1. Warranty: Manufacturer agrees to repair or replace components of indirect, gas-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

a. Gas-Fired Heat Exchangers: One year from date of first beneficial use by buyer or any other user, within one year from date of resale by buyer in any unchanged condition, or within 18 months from date of shipment from seller, whichever occurs first.

b. Coil Heat Exchangers, Sheet Metal: One year from date of first beneficial use by buyer or any other user, within one year from date of resale by buyer in any unchanged condition, or within 18 months from date of shipment from seller, whichever occurs first.

c. All Other Parts: Two years from date of first beneficial use by buyer or any other user, within two years from date of resale by buyer in any unchanged condition, or within 30 months from date of shipment from seller, whichever occurs first.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00, to design vibration isolation and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Structural Performance: Casing panels shall be self-supporting and capable of withstanding positive/negative 10-inch wg of internal static pressure, without exceeding a midpoint deflection of 0.0042 inch/inch of panel span.

G. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 8 inch wg.

H. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

I. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

J. Design criteria: Refer to the requirements of Section 01 41 20.

2.02 CAPACITIES AND CHARACTERISTICS

A. Refer to equipment schedules on drawings for performance and physical characteristics.

2.03 MANUFACTURERS:

A. Modine

B. Carrier

C. Trane

D. Engineered Air

2.04 UNIT CASINGS:

A. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.

B. Base Rail:

1. Material: 14 Gauge galvanized steel, unless noted otherwise in the Equipment Schedule.

C. Casing Joints: Continuous gasketing.

D. Double-Wall Construction:

1. Outside Casing Wall:

a. Standard Material, Aluminized Steel: Minimum 18 gauge thick unless noted otherwise on the equipment schedule.

b. Alternate Material, Aluminum: Minimum 16 gauge thick when required per equipment schedule.

c. Alternate Material, Stainless Steel: Minimum 18 gauge thick when required per equipment schedule.

E. Casing Insulation:

1. Materials: 1 ½ lb density fiberglass with fire resistant acrylic coating .

2. Insulation Thickness: 1 inch .

3. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

F. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

G. Panels, Doors, and Windows:

1. Panels:

a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.

b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow

c. Gasket: Neoprene, applied around entire perimeters of panel frames.

d. Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components.

2. Doors:

    a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing complete with viewing window.

    b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.

    c. Gasket: Neoprene, applied around entire perimeters of panel frames.

    d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 18 inches wide by full height of unit casing up to a maximum height of 72 inches.

3. Windows:

    a. Construction: Fabricate windows in access panels and doors of double-glazed, safety glass with an airspace between panes and sealed with interior and exterior rubber seals.

    b. Size: Minimum 8 inches, square or round.

4. Locations and Applications:

    a. Fan Section: Doors, with windows.

    b. Coil Section: Panels.

    c. Access Sections Immediately Upstream and Downstream of Coil Sections: Doors, with windows.

    d. Damper Section: Doors, with viewing windows.

    e. Filter Section: Doors large enough to allow periodic removal and installation of filters.

    f. Access Sections Immediately Upstream and Downstream of Filter Sections: Doors, with windows.

5. Service Lights: 100 Watt equivalent LED vaporproof luminaire with individual switched junction box located outside, adjacent to each access door and panel.

    a. Locations: Each section accessed with door or panel.

6. Convenience Outlets: One 20-A duplex GFCI receptacle per location with junction box located on outside casing wall.

2.05 FAN, DRIVE, AND MOTOR:

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

B. Fans: Double inlet double width forward curved centrifugal, rated according to AMCA 210; galvanized steel; mounted on solid-steel shaft.

1. Shafts: With field-adjustable alignment.

2. Shaft Bearings: Heavy-duty, self-aligning, permanently lubricated ball bearings with an L50 rated life of 100,000 hours according to ABMA 9.

3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

4. Mounting: For internal vibration isolation and seismic control. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.

5. Shaft Lubrication Lines: Extended to a location outside the casing.

6. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch- wide by 0.028-inch thick, galvanized-steel sheet.

a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

C. Drive: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.

2. Belts: Oil resistant, non-sparking and non-static; in matched sets for multiple-belt drives.

3. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; diamond-mesh wire screen, welded to steel angle frame; prime coated.

D. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13.

2. Motor Sizes: Maximum sizes as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

3. Enclosure: Open Drip Proof.

4. Unusual Service Conditions:

   a. Altitude: 4226 feet above sea level.

5. Efficiency: Premium efficient as defined in NEMA MG 1.

6. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

7. Provide full voltage non-reversing motor starters.

2.06 AIR FILTRATION:

A. Particulate air filtration is specified in Section 23 41 00.

B. Gas-phase air filtration is specified in Section 23 42 00.

C. Side-Access Filter Mounting Frames:

1. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness.

   a. Prefilters: Incorporate an integral 2-inch thick track with same access as primary filter.

   b. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2. Gas-Phase Air Filter Frames:

   a. Frames: Matching inner casing and outer casing material, and insulation thickness.

   b. Prefilters: Incorporate an integral 2-inch thick track.

   c. Sealing: Incorporate positive-sealing gasket material on channels to seal filter cartridge frames to prevent bypass of unfiltered air.

2.07 DAMPERS:

A. Retain "Dampers" or "Outdoor- and Return-Air Dampers" Paragraph below. Retain "Dampers" Paragraph if dampers are specified in Section 23 09 23.12. Retain "Outdoor- and Return-Air Dampers" Paragraph if dampers are to be provided by unit manufacturer. Not all manufacturers offer this option; consult manufacturers.

B. Extruded aluminum (6063-T5) damper frame shall not be less than 8 inches in thickness. Damper frame shall be 4 inches deep x 1 inch, with duct mounting flanges on both sides of frame. Damper frame shall have a 2-inch mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame to be assembled using zinc-plated steel mounting fasteners.

C. Blades shall be maximum 6-inch deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 1/16 inch.

D. Blade seals shall be extruded EPDM, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.

E. Frame seals shall be extruded silicone, secured in an integral slot within the aluminum frame extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Metallic compression type jamb seals will not be approved.

F. Bearings shall be a dual bearing system composed of a Celcon inner bearing (fixed around 7/16 inch aluminum hexagon blade pivot pin, rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable.

G. Hexagonal control shaft shall be 7/16 inch. It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be zinc-plated steel.

H. Linkage hardware shall be aluminum and corrosion-resistant zinc-plated steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with cup-point trunnion screws to prevent linkage slippage. Linkage that consists of metal rubbing metal will not be approved.

I. Dampers shall be designed for operation in temperatures ranging from -40 degrees F to 212 degrees F.

J. Dampers shall be AMCA rated for Leakage Class 1A at 1-inch wg static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.

K. Dampers shall be custom made to required size, with blade stops not exceeding 1.25 inches in height.

L. Dampers shall be opposed blade action for modulating airflow control and parallel blade for two position open – close action.

M. Standard of Acceptance: TAMCO Series 1000 Air-Foil Control Damper.

N. Damper Operators: Comply with requirements in Section 23 09 23.12.

1. Operator Motors:

a. Provided by Building Control Contractor.

2. Controls:

a. Provided by Building Control Contractor.

2.08 INDIRECT-FIRED GAS BURNER:

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.

B. Approval: Designed and certified by and bearing label of UL.

C. Burners: Stainless steel.

1. Rated minimum turndown ratio: 30 to 1.

2. Fuel: Natural gas.

3. Ignition: Electronically controlled electric spark with flame sensor.

4. Gas Control Valve: Modulating.

5. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

6. High-Altitude Model: For project elevations more than 2000 feet above sea level.

D. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.

E. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.

F. Heat Exchanger: Stainless steel.

G. Heat-Exchanger Drain Pan: Stainless steel.

H. Safety Controls:

1. Gas Manifold: Safety switches and controls complying with ANSI standards.

2. Vent Flow Verification: Differential pressure switch to verify open vent.

3. High Limit: Thermal switch or fuse to stop burner.

4. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.

5. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.

6. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.

7. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

8. Control Transformer: 24 V ac.

2.09 UNIT CONTROL PANEL:

A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.

B. Control Panel: Surface-mounted, remote panel, with engraved plastic cover, and the following lights and switches:

1. On-off-auto fan switch.

2. Heat-vent-off switch.

3. Supply-fan operation indicating light.

4. Heating operation indicating light.

5. Thermostat.

6. Damper position potentiometer.

7. Dirty-filter indicating light operated by unit-mounted differential pressure switch.

8. Safety-lockout indicating light.

9. Enclosure: NEMA 250, Type 4.

2.10 CONTROLS:

A. Comply with requirements in Section 23 09 23 and Section 23 09 93.11 for control equipment and sequence of operation.

B. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.

C. Interface with BMS System for HVAC: Factory-installed hardware and software to enable the BMS system for HVAC to monitor, control, and display status and alarms of heating and ventilating unit.

1. Hardwired Points:

a. Room temperature.

b. Discharge-air temperature.

c. Burner operating.

2. ASHRAE 135.1 (BACnet) communication interface with the BMS system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the heating and ventilating unit from an operator workstation. Control features and monitoring points displayed locally at heating and ventilating unit control panel shall be available through the BMS system for HVAC.

2.11 MATERIALS:

A. Steel:

1. ASTM A36 for carbon structural steel.

2. ASTM A568 for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.

2. Manufacturer's standard type, ASTM A240 for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of indirect-fired heating and ventilating units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Equipment Mounting:

1. Install heating and ventilating units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 03 30 00.

2. Comply with requirements for vibration isolation and seismic control devices specified in Section 23 05 48.

3. Comply with requirements for vibration isolation devices specified in Section 23 05 48.

B. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in Section 23 05 48.

C. Install gas-fired units in accordance with NFPA 54.

D. Install controls and equipment shipped by manufacturer for field installation with indirect, gas-fired heating and ventilating units.

3.03 PIPING CONNECTIONS:

A. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Gas Piping: Comply with requirements in Section 23 11 23. Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless-

steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.

B. Drain: Comply with requirements in Section 22 13 16 for traps and accessories on piping connections to condensate drain pans under condensing heat exchangers.

C. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

3.04 DUCTWORK CONNECTIONS:

A. Connect supply and intake ducts to indirect, gas-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 23 33 00 for flexible duct connectors.

3.05 ELECTRICAL CONNECTIONS:

A. MAU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53.

2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.06 CONTROL CONNECTIONS:

A. Install control and electrical power wiring to field-mounted control devices.

3.07 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Inspect for visible damage to burner combustion chamber.

b. Inspect casing insulation for integrity, moisture content, and adhesion.

c. Verify that clearances have been provided for servicing.

d. Verify that controls are connected and operable.

e. Verify that filters are installed.

f. Purge gas line.

g. Inspect and adjust vibration isolators and seismic restraints.

h. Verify bearing lubrication.

i. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

j. Adjust fan belts to proper alignment and tension.

B. Start unit according to manufacturer's written instructions.

1. Complete startup sheets and attach copy with Contractor's startup report.

2. Inspect and record performance of interlocks and protective devices; verify sequences.

3. Operate unit for run-in period recommended by manufacturer.

4. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

a. Measure gas pressure at manifold.

b. Measure combustion-air temperature at inlet to combustion chamber.

c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

5. Calibrate thermostats.

6. Adjust and inspect high-temperature limits.

7. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.

8. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

9. Measure and record airflow. Plot fan volumes on fan curve.

10. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

    a. High-limit heat.

    b. Alarms.

11. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

12. Verify drain-pan performance.

13. Verify outdoor-air damper operation.

3.08 STARTUP AND TESTING:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Comply with requirements for checkout, startup, and testing in Section 01 78 25.

3. Physical Checkout and Field Testing (Functional Completion Testing): Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connections; certify proper installation:

    a. 1/2 person-day

4. Startup: Calibrate, check alignment and perform a functional test with water or process fluid. Tests to include all items specified.

    a. 1/2 person-day

5. Commissioning: Field performance test equipment specified.

    a. 1 person-day

3.09 TRAINING:

A. Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

B. Coordinate training time with the Engineer and Owner.

3.10 ADJUSTING:

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.11 CLEANING:

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.12 FIELD QUALITY CONTROL:

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.13 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

3.14 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 23 74 16.11

PACKAGED, DX AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide packaged, DX air-handling units with the following components as indicated and in compliance with Contract Documents.

1. Casings
2. Fans, drives, and motors
3. Coils
4. Refrigerant circuit components
5. Air filtration
6. Electric coils
7. Dampers
8. Electrical power connections
9. Controls
10. Accessories

1.02 REFERENCES:

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):

1. 340/360: Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
2. 410: Forced-Circulation Air-Cooling and Air-Heating Coils

B. American Society of Civil Engineers (ASCE):

1. 7: Wind Loads: Guide to the Wind Load Provisions

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 15: Safety Standard for Refrigeration Systems

2. 62.1: Ventilation for Acceptable Indoor Air Quality

3. 90.1: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

D. ASTM International (ASTM):

1. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus

2. C916: Standard Specification for Adhesives for Duct Thermal Insulation

3. C1071: Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)

4. D870: Standard Practice for Testing Water Resistance of Coatings Using Water Immersion

5. D2247: Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity

E. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

F. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

2. 90A: Standards for the Installation of Air-Conditioning and Ventilating Systems

3. 90B: Standard for the Installation of Warm Air Heating and Air-Conditioning Systems

G. Underwriters' Laboratories, Inc. (UL):

1. 1995: Standard for Safety Heating and Cooling Equipment

1.03 DEFINITIONS:

A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, small-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems, anchorage and equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

1. For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

    a. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

    b. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

    c. Wind and Seismic-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

C. Product Data: For each RTU:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Include rated capacities, dimensions, required clearances, characteristics, and furnished specialties and accessories.

3. Include unit dimensions and weight.

4. Include cabinet material, metal thickness, finishes, insulation, and accessories.

5. Fans:

    a. Include certified fan-performance curves with system operating conditions indicated.

    b. Include certified fan-sound power ratings.

    c. Include fan construction and accessories.

    d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.

7. Include filters with performance characteristics.

8. Include dampers, including housings, linkages, and operators.

D. Contractor Responsibility: Contractor is responsible for any costs due to adjustments/alterations to basis of design.

E. Shop Drawings: For each packaged, small-capacity, rooftop air-conditioning unit.

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

F. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

G. Sample Warranty: For manufacturer's warranty.

H. Seismic Qualification Data: Certificates, for RTUs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

4. Restraint of internal components.

I. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 23 05 48.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

J. Source quality-control reports.

K. System startup reports.

L. Field quality-control reports.

M. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1. Operation and maintenance manuals shall be specific to equipment purchased and crossing out of non-applicable items is not acceptable.

2. Comply with requirements of Section 01 78 23.

N. Maintenance Material Submittals:

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Filters: 2 set(s) of filters for each unit.

b. Fan Belts: One set for each belt-driven fan.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. 1 set of filters.

2. 1 set of belts, if required.

C. Provide a list of recommended spare parts for the first year of operation and for the first five years of operation, including a price list and location of the nearest facility from which all spare parts can be obtained.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.09 WARRANTY:

A. Comply with the requirements specified in Section 01 78 36.

B. Manufacturer agrees to repair or replace components of outdoor, semi-custom, air-handling unit that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, electric heaters and unit controls.

B. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.

C. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.

D. Unit components shall be labeled, including refrigeration system components and electrical and control components.

E. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.

F. Installation, Operation, and Maintenance manual shall be supplied within the unit.

G. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the of the control compartment's hinged access door.

H. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

2.02 MANUFACTURERS:

A. AAON

B. Engineered Air

C. Trane

2.03 PERFORMANCE/DESIGN CRITERIA:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE 15 Compliance: For refrigeration system safety.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. UL Compliance: Comply with UL 1995.

G. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00, to design mounting and restraints for RTUs, including comprehensive engineering analysis.

1. Design RTU supports to comply with seismic performance requirements.

H. Seismic Performance: RTUs, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.04 UNIT CASINGS:

A. General Fabrication Requirements for Casings: Formed, finished and reinforced galvanized steel double-wall with impact resistant, rigid polyurethane foam panels.

B. Double-Wall Construction:

1. Outside Casing Wall: G90 galvanized steel, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

2. Inside Casing Wall: G90 galvanized steel

3. Floor Plate: G90 galvanized steel

4. Casing Insulation:

a. Materials: Injected polyurethane foam insulation

b. Casing Panel R-Value: Minimum R-13

c. Insulation Density: Minimum 2 pounds/cubic foot per ASMD1929-11

d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. Leakage:

1. Cabinet leakage shall not exceed 1 percent of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360.

2. Panel deflection shall not exceed L/240 ratio at 125 percent of design pressure.

E. Access Doors:

1. Doors:

a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.

b. Fasteners: Quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges. Arrangement shall allow panels to be opened against air-pressure differential.

c. Gasket: Neoprene, applied around entire perimeters of panel frames.

d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

e. Gasket: Neoprene, applied around entire perimeters of panel frames.

f. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

2. Locations and Applications:

a. Fan Section

b. Access Section

c. Coil Section

d. Damper Section

e. Filter Section

f. Mixing Section

F. Casing Finish:

1. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117-95 test procedure.

G. Condensate Drain Pans:

1. Location: Each type of cooling coil.

2. Construction:

a. Single-wall, double sloped 304 stainless steel

3. Drain Connection:

a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple.

4. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.

5. Width: Entire width of water producing device.

6. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.05 FANS, DRIVES, AND MOTORS:

A. Fan and Drive Assemblies:

1. Configuration:

a. Direct dive, unhoused, backward inclined, plenum supply fans.

2. Vibration:

a. Dynamically balance

b. Rubber isolators

3. Motors:

a. Ball bearings rated for 200,000 hours service with external lubrication points.

4. VFDs:

a. Factory mounted and wired in the unit.

2.06 COILS:

A. General Requirements for Coils:

1. Comply with AHRI 410.

2. Fabricate coils section to allow for removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).

3. Coils shall not act as structural component of unit.

B. Supply-Air Refrigerant Coil:

1. Tubes: Copper

2. Fins:

a. Material: Aluminum

b. Mechanically bonded to tubes

c. Flexible, epoxy polymer e-coat over complete coil

(1) Humidity and water immersion resistance to a minimum of 1,000 hours per ASTM D2247-92 and ASTM D870-92.

(2) Corrosion durability confirmed through testing with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90.

(3) UV resistant polyurethane topcoat.

(4) 5 Year warranty on coatings.

C. Outdoor-Air Condenser Coil:

1. Tubes: Copper

2. Fins:

a. Material: Aluminum

b. Mechanically bonded to tubes.

c. Designed for a minimum of 10 degrees F of refrigerant sub-cooling.

d. Hydrogen or helium leak tested.

e. Flexible, epoxy polymer e-coat over complete coil:

(1) Humidity and water immersion resistance to a minimum of 1,000 hours per ASTM D2247-92 and ASTM D870-92.

(2) Corrosion durability confirmed through testing with coating capable of withstanding at least 10,000 hours of salt spray per ASTM B117-90.

(3) UV resistant polyurethane topcoat.

(4) 5 Year warranty on coatings

D. Condenser Fans:

1. High efficiency electrically commutated motor

2. Factory installed head pressure control module:

a. Modulate fan speed based on head pressure.

b. Cooling operation allowed down to 35 degrees F outdoor air temperature with adjustable compressor lockout.

E. Electric-Resistance Heating Coils: Comply with UL 1995.

1. Casing Assembly: Galvanized-steel frame.

2. Removable for replacement or service without further disassembly of the air handler.

3. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

4. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.

5. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

6. Control Panel: Unit mounted with disconnecting means and overcurrent protection.

a. Full modulation capacity controlled by SCR.

b. 0-10 VDC heating control signal.

c. Airflow proving switch.

2.07 REFRIGERANT CIRCUIT COMPONENTS:

A. Compressor: Hermetic, variable speed scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, and internal pressure relief.

B. Installation: Lockable isolated service compartment to allow access without affecting unit operation.

C. Refrigeration Specialties:

1. Refrigerant: R-410A

2. Expansion valve with replaceable thermostatic element.

3. Refrigerant filter/dryer.

4. Manual-reset high-pressure safety switch.

5. Automatic-reset low-pressure safety switch.

6. Minimum off-time relay.

7. Automatic-reset compressor motor thermal overload.

8. Brass service valves installed in compressor suction and liquid lines.

9. Low-ambient kit high-pressure sensor.

2.08 AIR FILTRATION:

A. Provide two stage filtration with first stage minimum MERV 8 particulate filtration and second stage gas-phase filtration.

B. Air filtration is specified in Section 23 41 00 and Section 23 42 00.

C. In addition to the BMS monitored filter pressure drop provide magnahelic pressure gages for visible monitoring.

2.09 OUTSIDE AIR/ECONOMIZER:

A. Unit shall include 0-100 percent economizer with motorized outside air and return air dampers and electric actuator.

1. Dampers:

a. Hollow core airfoil extruded aluminum blades

b. Gear driven

c. Rubber edge seals

d. Aluminum end seals

e. Maximum leakage 20 cfm per square foot at 4.0 in. wg. differential pressure

B. Damper Operators: Comply with requirements in Section 23 09 23.12.

C. Intake Hood: Complete with bird screen.

2.10 ELECTRICAL POWER CONNECTIONS:

A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.11 CONTROLS:

A. DDC equipment controller provided and installed by the BMS contractor.

B. Unit is to be provided with all control components required to interface with the BMS controller per the control schematic drawings to achieve the specified control sequences.

C. Control equipment and sequence of operation are specified in Section 23 09 93.11.

D. Interface Requirements for HVAC Instrumentation and Control System:

1. Interface relay to provide indication of fault to the BMS.

2. Provide compatible interface for BMS for the following:

a. Monitoring supply fan start, stop, and operation.

b. Inquiring data to include outdoor-air damper position.

c. Monitoring variable-frequency drive operation.

d. Monitoring cooling load.

e. Monitoring economizer cycles.

2.12 ROOF / GROUND MOUNTED TRANSITION CURBS:

A. Curbs with vibration isolators and wind or seismic restraints are specified in Section 23 05 48.

B. Curbs are to be factory made, coordinated and supplied by the air handler manufacturer.

C. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

a. Materials: ASTM C1071, Type I or II.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

a. Liner Adhesive: Comply with ASTM C916, Type I.

b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.

c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

d. Liner Adhesive: Comply with ASTM C916, Type I.

D. Curb Dimensions: Grade mounted curbs are to provide a minimum of 56” clearance to the underside of the RTU and 17” to the underside of the connecting ductwork in the case of a directional transition curb.

2.13 ACCESSORIES:

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

C. Remote potentiometer to adjust minimum economizer damper position.

D. Safeties:

1. Smoke detector

E. Coil guards of painted, galvanized-steel wire.

F. Door switches to disable heating or reset set point when open.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Coordinate any housekeeping pad requirements and location with other trades.

3.02 PREPARATION:

A. Curb: Install RTUs on curbs and coordinate roof or wall penetrations and sealing with metal building manufacturer. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

3.03 DUCT CONNECTIONS:

A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at roof curb.

2. Connect supply ducts to RTUs with flexible duct connectors specified in Section 23 33 00.

3. Duct connection configurations to curbs as shown on drawings are representative. Adjustments required by site conditions or non-base of design equipment are the responsibility of the contractor. The contractor will coordinate changes with all other trades.

3.04 ELECTRICAL CONNECTIONS:

A. Connect electrical wiring according to Section 26 05 20.

B. Ground equipment according to Section 26 05 26.

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs as specified in Section 26 05 53.

2. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2 inch high.

3. Locate nameplate where easily visible.

3.05 CONTROL CONNECTIONS:

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 26 05 20.

3.06 STARTUP AND TESTING:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Comply with requirements for checkout, startup, and testing in Section 01 78 25.

3. Physical Checkout and Field Testing (Functional Completion Testing): Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connections; certify proper installation:

a. 1/2 person-day

4. Startup: Calibrate, check alignment and perform a functional test with water or process fluid. Tests to include all items specified.

a. 1/2 person-day

5. Commissioning: Field performance test equipment specified.

    a. 1 person-day

B. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Inspect for visible damage to unit casing.

3. Inspect for visible damage to compressor, coils, and fans.

4. Inspect internal insulation.

5. Verify that labels are clearly visible.

6. Verify that clearances have been provided for servicing.

7. Verify that controls are connected and operable.

8. Verify that filters are installed.

9. Clean condenser coil and inspect for construction debris.

10. Remove packing from vibration isolators.

11. Verify lubrication on fan and motor bearings.

12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

13. Start unit according to manufacturer's written instructions.

    a. Start refrigeration system.

    b. Do not operate below recommended low-ambient temperature.

    c. Complete startup sheets and attach copy with Contractor's startup report.

14. Inspect and record performance of interlocks and protective devices; verify sequences.

15. Operate unit for an initial period as recommended or required by manufacturer.

16. Adjust and inspect high-temperature limits.

17. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.

18. Start refrigeration system and measure and record the following when ambient is a minimum of 15 degrees F above return-air temperature:

    a. Coil leaving-air, dry- and wet-bulb temperatures.

    b. Coil entering-air, dry- and wet-bulb temperatures.

    c. Outdoor-air, dry-bulb temperature.

    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

19. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

20. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume

    b. Return-air volume

    c. Relief-air volume

    d. Outdoor-air intake volume

21. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures

    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake

22. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-temperature limit on gas-fired heat exchanger

    b. Low-temperature safety operation

    c. Filter high-pressure differential alarm

    d. Economizer to minimum outdoor-air changeover

    e. Relief-air fan operation

    f. Smoke and firestat alarms

23. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.07 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.

2. Inspect for and remove shipping bolts, blocks, and tie-down straps.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. RTU will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.08 TRAINING:

A. Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

B. Coordinate training time with the Engineer and Owner.

3.09 ADJUSTING:

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 23 05 93 for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 CLEANING:

A. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.11 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

DIVISION 26

ELECTRICAL

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SECTION 26 05 10

ELECTRICAL WORK – GENERAL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide complete and operational systems for both normal and standby electric power systems, normal and emergency lighting systems, grounding systems and other specified systems, including the installation and wiring of miscellaneous equipment and devices. Perform all work and testing as indicated and specified.

1. Provide conduit, wiring and connections for power, control, lighting, instrumentation and alarms for equipment furnished by others unless otherwise specified and indicated.

2. Provide temporary circuits, overcurrent devices, conduit and wiring, and other equipment required during construction and change-over from existing to proposed electric system. Perform work at the convenience of the Owner.

3. Provide electrical system studies including a short circuit and protective device coordination study and an arc-flash study for the electrical distribution system constructed under this contract.

4. Install all raceways and equipment to meet the seismic design criteria of Section 01 41 20. Raceways supports and equipment anchoring shall be provided as specified in the Division 26 sections which form a part of the Contract Documents.

5. The equipment enclosure classification of the plant areas are indicated on the corresponding Drawings, not limited to Electrical discipline drawings. Provide all equipment, devices and material meeting the requirements for these area classifications unless otherwise noted or specified.

6. Review the electrical underground system and the civil yard piping. Install the electrical underground system in a manner that avoids conflicts with maintenance holes, catch basins, etc. provided under other Divisions of the specifications.

1.02 REFERENCES:

A. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

2. 70E: Standard for Electrical Safety in the Workplace

B. Occupational Health and Safety Administration (OSHA):

1. 1910.7: Definition and Requirements for a Nationally Recognized Testing Laboratory

1.03 SEQUENCING AND SCHEDULING:

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots and openings in the building structures during the progress of construction to allow for the electrical installation.

C. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Sequence, coordinate and integrate the installation of electrical materials and equipment for efficient flow of the work.

E. Coordinate the installation of large equipment prior to closing in the building.

F. Sequencing and scheduling work at existing facilities:

1. Coordinate electrical power outages to the electrical systems and equipment with the Owner. Where duration of proposed outage cannot be allowed by the Owner, phase the work to allow the system or equipment to be re-connected to the electrical power system within the time frame allowed by the Owner or provide temporary power connections as required to maintain service to the systems or equipment. The temporary power can be from a generator or another part of the facility not affected by the outage provided there is sufficient spare capacity.

a. The above requirement includes, but is not limited to, maintaining power and signal continuity to 3 existing flow meters, as identified on site plans.

2. Coordinate power change-overs and outages with Client, and obtain advance written approval.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Install electrical work in conformance with latest rules and requirements of National Fire Protection Association Standard No. 70 (National Electrical Code) and in accordance with requirements of State and Local Codes.

1.05 QUALIFICATIONS OF ELECTRICAL SUBCONTRACTOR:

A. The Electrical Subcontractor shall have been engaged in work of a similar nature to this contract for the past 5 years.

B. The Electrical Subcontractor shall have a minimum of five projects of equal or greater size with the type of equipment specified under this project.

1.06 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. The following defines a minimum for all Division 26 shop drawing and data submittals:

a. Submit shop drawings delineated by specification number with all information for one piece of equipment provided as one package.

b. Partial submittals will be returned without action.

c. Submit bills of material: Include a numbered list of all components, with manufacturer's name, catalog number, rating, and other identification. Place item number or similar identification on all other drawings where item appears.

d. Submittal shall include:

(1) Manufacturer’s drawings

(2) Panel layout

(3) Equipment layout

(4) Schematic diagram

(5) One line diagram

(6) Control sequence diagrams

(7) Interconnection diagrams

(8) Wiring diagrams

(9) Catalog data

(10) Acceptable wire size range for wire termination hardware.

e. Submit only completed drawings showing all local and remote devices associated with each item.

f. Mark shop drawings and data submitted showing only items applicable to specific contract.

g. Where additions and modifications are made to existing equipment, provide drawings which include both retained existing equipment and new work.

h. Submit time-current characteristic curves for all submitted protection devices such as circuit breakers and fuses.

i. Submit other documentary or descriptive information as required for each assembly to demonstrate compliance with the applicable contract documents.

2. Shop drawings and data are required for the following list:

a. Starting Equipment Data List -Submit blank list initially to verify acceptable format. Submit final list at completion of the project.

b. Short Circuit and Coordination Studies Arc-Flash Studies

c. Harmonic Analysis

d. Conduit and Fittings

e. Wire and Cable

f. Wiring Devices

g. Transformers

h. Medium Voltage Switchgear and Load Switches

i. Maintenance Holes, Handholes, and Associated Equipment and Devices

j. Panelboards

k. Grounding Equipment and Devices

l. Neutral Grounding Resistor, Neutral Grounding Resistor Assemblies

m. Lighting Fixtures and Accessories

n. Light Poles

o. Lighting Control Panels

p. Lightning Protection System

q. Fire Alarm System

r. Card Access System

s. Telephone System

t. Surveillance System

u. Electric Heat Tracing

v. Control Stations

w. Enclosures

x. Control Panels

y. Safety Switches

z. Electric Heating Units and Accessories

aa. 600 Volt Motor Control Centers and Motor Controls

bb. Engine Generators, Enclosures, and Accessories

cc. Paralleling Switchgear and Accessories

dd. Generator System Master Controller and Accessories

ee. Variable Frequency Motor Controllers, including Medium Voltage

ff. VFD-Controlled Electric Motors, including Medium Voltage

gg. Field Acceptance Test Reports

hh. Record Drawings

3. Submit instruction manuals for installation, operation, and maintenance of equipment, and parts list for equipment listed below. Specifically mark standard publications forming a part of this contract. Cross out, blank out, or otherwise delete non-applicable items. Submittals which do not clearly indicate items and features provided shall be rejected.

   a. Lighting Controls

   b. Medium Voltage Switchgear and Load Switches

   c. Medium Voltage Variable Frequency Motor Controllers

   d. Medium Voltage Motors

   e. Generator Paralleling Gear and Accessories

   f. Protective Relay Systems

g. Relay Panels

h. Control Panels

i. Unit Substation

j. Lightning Protection System

k. Security System

l. Fire Alarm System

m. Card Access System

n. Telephone System

o. Surveillance System

p. 600 Volt Motor Control Centers

q. Switchboards

1.07 NAMEPLATES AND LABELING:

A. Provide nameplates and labels as specified in Section 26 05 53.

1.08 INTERFERENCE AND ERRONEOUS LOCATIONS:

A. Locations of electrical equipment, devices, outlets, and similar items, as indicated, are approximate only. Exact locations shall be determined during construction.

B. Verify in field, all data and final locations of work installed under other sections of specifications, required for placing of electrical work.

C. In case of interference with other work or erroneous locations with respect to equipment or structures, furnish all labor and materials to complete the work.

1.09 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20 and in Division 26.

1.10 APPROVAL AND MARKING EQUIPMENT:

A. Provide only devices and materials that are listed and/or labeled by UL, wherever standards have been established by that organization. Where a UL listing is not available for equipment, submit certified test reports of a Nationally Recognized Testing Laboratory (NRTL), approved by the local inspecting authority, indicating that

equipment is in conformance with local code requirements or any other applicable requirements. Tests and inspections for approval of equipment shall be performed at no additional cost to Owner.

B. Clearly mark equipment, devices and material with name or trademark of manufacturer and rating in volts and amperes and other pertinent information on a nameplate.

1.11 EQUIPMENT SPECIFIED ELSEWHERE:

A. Certain items of control equipment and other equipment are indicated on electrical drawings for connection, but are specified in other sections pertaining to plumbing, heating, ventilating and air conditioning, mechanical process, instrumentation, etc. Such items are not furnished as part of electrical work.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 WORK IN EXISTING STRUCTURES:

A. In general, any or all existing electrical equipment and services are to remain in operation and shall not be disturbed unless otherwise noted in these Specifications and/or on the drawings or as required for the proper execution of the work. Provide at least two workdays written advance notice to Owner of intended disruption of equipment and services, and coordinate with Owner for approval to proceed.

B. In each area of the work, disconnect and carefully remove the existing electrical equipment and devices so noted. With the exception of items indicated as having to be re-used, all such existing equipment and devices shall be disposed of as specified herein. If not required by the Owner, remove them from the premises and site. All existing electrical equipment and devices indicated as not removed or abandoned are to be maintained in operation and any circuits disturbed by the construction shall be restored.

C. Maintain existing electrical services and systems to and in the buildings throughout the project and all “down-time” shall be scheduled at least two weeks in advance with the permission of the Engineer and such scheduling shall be rigidly adhered to.

3.02 PROTECTION OF ELECTRICAL EQUIPMENT:

A. Store equipment in compliance with manufacturer’s recommendations and as specified herein.

B. Protect electrical equipment from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction.

C. Do not store equipment outdoors.

D. Where equipment is installed or stored in moist areas, or unheated buildings, provide acceptable means to prevent moisture damage. Provide uniformly distributed source of heat in electrical equipment to prevent condensation and damage to electrical insulation systems.

3.03 DEFECTIVE OR DAMAGED EQUIPMENT:

A. Damaged equipment shall not be used. Equipment damaged in shipment, storage, installation or through other means shall be replaced without additional cost to the Owner.

B. All equipment showing signs of water damage shall be rejected regardless of dielectric test results.

C. All electrical equipment is considered "in storage" regardless of location until first energized. Manufacturer's recommendations for storage precautions, conditions and care shall be followed.

3.04 STARTING EQUIPMENT DATA LIST:

A. Obtain data from the equipment supplier shop drawing submittals or equipment nameplates, and prepare a complete tabulation of all motors over 1/3 hp, electric heaters over 3 kW, and starting equipment for both, to be furnished on the project. Indicate building or facility from which the motor or heater is powered in the tabulation.

1. Include in tabulation firm the following information:

a. Name and identification of equipment

b. Manufacturer

c. Horsepower or kilowatt rating

d. Voltage

e. Phase

f. Speed

g. Full load current

h. Locked rotor current or code letter

i. Type of enclosure (open drip-proof, totally enclosed, fan cooled, etc.)

j. NEMA size of starter or contactor

k. Overload heater size

l. Type of starter (full-voltage, reduced-voltage, autotransformer, etc.)

m. Breaker trip setting or fuse size

n. Voltage of starter operating coil

o. If starter is at a motor control center, list motor control center number.

2. Final acceptance of the electrical system is contingent upon submittal of the complete motor and electric heater tabulation.

3. Arrange tabulation in groups by MCC or building location.

4. Furnish six copies of the tabulation to the Engineer when a submission is made.

3.05 DRAWINGS AND SPECIFICATIONS:

A. Drawings and specifications are typical of work to be done and of the arrangement desired. Provide accessories and appurtenances which the Engineer deems functionally necessary for a complete installation, whether or not explicitly indicated or described.

3.06 RECORD DRAWINGS:

A. The Contractor shall maintain a master set of record drawings showing the changes and deviations from the contract drawings.

B. A minimum of 30 days prior to application for Final Payment, submit two sets of drawings for approval that are marked to show the as-installed equipment, devices, raceway locations and wiring. The markings on the drawings are to be neat, clean and legible.

C. Provide electric power systems as-built record drawings, including submission to Owner within 90 days of system acceptance, or as required by other parts of these Specifications, or as per paragraph above, whichever is earlier. (Per 2018IECC C408.2.5.1).

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 05 13

MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide medium voltage cables, and accessories for systems rated above 2001 volts to 15,000 volts.

1.02 REFERENCES:

A. Association of Edison Illuminating Companies (AEIC):

1. CS8-00: Specification for Extruded Dielectric Shielded Power Cables rated 5 through 46 Kv

B. American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE):

1. C2: National Electrical Safety Code

2. 386: Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

3. 404: Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5000V Through 46,000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500V Through 500,000V

C. ASTM International (ASTM):

1. B3: Standard Specification for Soft or Annealed Copper Wire

2. B8: Standard Specification for Concentric Lay Stranded Copper Conductors, Hard, Medium Hard, or Soft

D. Institute of Electrical and Electronics Engineers (IEEE):

1. 48: Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations

2. 592: Standard for Exposed Semi conducting Shields on High Voltage Cable Joints and Separable Insulated Connectors

3. Std. 400.2: Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)

E. Insulated Cable Engineers Association (ICEA):

1. S-93-639/NEMA WC74: 5-46KV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

2. S-97-682: Utility Shielded Power Cable rated 5-46kV

3. T-25-425: Guide for Establishing Stability of Volume Resistivity for Conducting Polymeric Components of Power Cables

F. National Fire Protection Association (NFPA):

1. 70: National Electrical Code

G. Underwriters Laboratories, Inc. (UL).

1. 1072: Medium-Voltage Solid Dielectric

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 00.

C. Test Reports:

1. Certified copies of production sampling and completed cable test reports described in Paragraph 1.04 of this Specification shall be submitted prior to shipping cable in a legible and coherent format. This data should include the X-Y plot of the partial discharge test per ICEA.

2. Test reports shall be in a legible and coherent format and reported in accordance with AEIC CS8.

D. Catalogue Data: Submit catalogue data showing physical information, specifications used for manufacturing and materials used to manufacture cable.

E. Submittal Data Shall Include:

1. Letter stating cable meets specification and the date of cable manufacture.

2. Conductor size.

3. Conductor shield materials.

4. Insulation material.

5. Insulation thickness.

6. Diameter over insulation.

7. Insulation semi-conductor thickness.

8. Jacket material.

9. Jacket thickness.

10. Diameter of cable.

11. Weight per unit length of cable.

12. Cable pulling calculations including direction of pull.

13. Proof of NRTL listing and manufacturer's cutsheet indicating material meets criteria for purposes intended.

F. Certification of the Qualifications of Medium-Voltage Cable Installers: The certification shall be accompanied by satisfactory proof of the training and experience of persons listed by the Contractor as cable installers.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Cable furnished under this specification shall conform to the latest edition of Insulated Cable Engineers Association (ICEA S-93-639) or its successors, except as specifically modified herein.

C. The completed cable shall meet or exceed all Insulated Cable Engineer's Association (ICEA), and Association of Edison Illuminating Companies (AEIC) physical and electrical tests. Tests shall be performed and frequency of sampling shall be in accordance with the latest edition of ICEA S-93-639 except as modified herein. All tests required by this specification, AEIC and ICEA shall be performed.

D. Cable shall be manufactured and tested using good care and workmanship.

E. EPR insulated cable shall be manufactured by a dry or steam curing process.

F. The conductor shield, the insulation, and the semiconducting insulation shield extrude in a triple tandem, dual tandem, or true triple process.

G. Production sampling tests shall be in accordance with ICEA S-93-639, ICEA S-97-682, and AEIC CS8.

H. AC Voltage Tests: Each factory reel length shall withstand AC voltage tests by the manufacturer at the factory in accordance with ICEA S-93-639.

1.05 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. The cable shall be placed on the shipping reel with both ends of cable accessible for proof testing. Ends of cable shall be sealed with weatherproof material prior to shipment.

C. Each end of each length of cable shall be hermetically sealed and securely attached to the reel.

D. Minimum reel drum diameter shall be 14 times the overall diameter of the cable.

E. A pulling eye shall be installed by the manufacturer for each length of cable supplied for installation in ducts, manholes, and utility tunnels.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Medium voltage cables as manufactured by:

1. Okonite

2. Prysmian Cables & Systems

3. Southwire

B. The cable manufacturer shall have a minimum of 10 years proven and successful experience with the manufacturing of EPR insulated cables.

C. All cable furnished shall be installed within 12 months of manufacture date. Labeling of cable shall be per NEMA and shall contain no less than the following information:

1. Name of Manufacturer

2. NEC Designation

D. Cable shall be operated at 60 Hertz, single or three phase at system voltage of 5 kV or 15 kV. Suitable installations include in conduit for wet or dry location and in open air in sunlight.

2.02 CONDUCTOR:

A. The conductor shall be Class B concentric lay stranding, uncoated copper in accordance with ASTM B3 and B8 and ICEA S-93-639 with the minimum number of wires noted below:

Conductor Size Range	Number of Strands
8 - 2	7
1 - 4/0	19
250 - 500	37
501 – 1,000	61

B. Conductor shall be free from moisture, corrosion and excessive drawing lubricant before conductor shielding is applied.

2.03 CONDUCTOR SHIELD (STRAND SCREEN):

A. The strand screen shall consist of an extruded semiconducting thermosetting compound applied over the conductor. It shall be of a material compatible with the thermal characteristics of this conductor metal and insulation, shall be uniformly and firmly bonded to the overlying insulation, and shall be free stripping from the conductor. A semiconducting tape may be applied between the conductor and the extruded conductor screen. Okonite EPR based semiconductor is an approved exception.

B. The D-C volume resistivity of the extruded conductor shield shall not exceed 1000 meter-ohms at the maximum normal operating and emergency operating temperature accordance with ICEA Publication T-25-425.

C. The extruded strand shield shall have a minimum elongation of 100 percent after an air oven test at 250 degrees F for seven days and a brittleness temperature not warmer than 14 degrees F.

D. The contact area between the insulation and conductor shield shall not exhibit projections or irregularities which extend from the cylindrical surface of the conductor shield by more than 5 mils toward the insulation or 10 mils away from the insulation.

2.04 INSULATION:

A. Insulation shall conform to ICEA S-93-639 except as modified herein and shall be the following, or a prior acceptable equivalent product:

1. The insulation shall be a high quality heat, moisture, ozone, and corona resistant high dielectric strength ethylene propylene rubber compound. It shall be contrasting in color from the extruded strand and insulation screens. It shall contain less than 5 percent polyethylene, and the ethylene content of the elastomer

shall not exceed 72.5 percent by weight of ethylene to limit susceptibility to treeing.

2. Insulation shall be for use in wet or dry locations at conductor temperatures not exceeding 220 degrees F for continuous operation, 285 degrees F emergency overload conditions, and 480 degrees F short circuit conditions.

B. The insulation shall have a minimum and maximum thickness for a 133 percent insulation level as specified in Table II below:

TABLE II

Rated Circuit Voltage (kV) Phase to Phase	Conductor Size (AWG or kcmil)	Minimum Insulation Thickness (mils)	Maximum Insulation Thickness (mils)
5	8 – 1,000	85	120
8	6 – 1,000	115	170
15	2 – 1,000	210	250

C. Insulation shall be homogeneous and free of gels or discolorations larger than 10 mils.

D. The insulation shall meet or exceed the requirements of all tests specified in ICEA S-93-639.

E. The interface between the insulation and insulation shield shall be free of contaminants larger than 4 mils. The insulation shall be free from contaminants, gels and agglomerates larger than 10 mils.

2.05 INSULATION SHIELD (INSULATION SCREEN):

A. Insulation shield shall conform to ICEA S-93-639, except as modified herein.

B. The insulation screen shall consist of an extruded, semiconducting thermosetting compound applied over and compatible with the insulation. It shall be of a material compatible with the thermal and chemical characteristics of the insulation and the overlaying metallic shield. Okonite EPR based semiconductor is an approved exception.

C. The thickness with corresponding minimum and maximum points shall be as specified in Table III:

TABLE III		
Calculated Minimum Diameter over Insulation Inches	**Insulation Shield Minimum Point Thickness, mils**	**Insulation Shield Maximum Point Thickness mils**
0 - 1.000	24	60
1.001 - 1.500	32	60
1.501 - 2.000	40	75
2.001 & Larger	40	90

D. The insulation shield shall not alter its physical or electrical properties from exposure to sunlight or the elements.

1. The extruded insulation shield shall have a minimum elongation of 100 percent after an air oven test at 250 degrees F for 7 days and a brittleness temperature not warmer than minus 22 degrees F.

E. The D-C volume resistivity of the extruded insulation shield shall not exceed 75 meter-ohms at 194 degrees F when tested in accordance with ICEA Publication T-25-425.

F. The insulation shield shall be free stripping from the insulation, and the tension necessary to remove the extruded insulation shield shall be 3 to 24 pounds at room temperature when tested in accordance with ICEA S-93-639.

G. The contact area between the insulation and insulation shield shall not exhibit projections or irregularities, which into the insulation from the insulation shield more than 5 mils and into the insulation shield from the insulation more than 7 mils.

2.06 METAL TAPE SHIELD:

A. Cable shall have a metal tape or metal tape with wire shield.

B. A copper tape with nominal thickness of 0.005 inches shall be applied directly over the insulation shield. The tape shall be of suitable width and shall lap at least 12.5 percent of its width. The tape shall be free from burrs and, where jointed, shall be made electrically continuous. (If wire shield is used, it shall be mechanically and electrically comparable).

C. Application of tape shield or wire shield shall not deform the insulation.

2.07 JACKET:

A. The jacket shall be black polyvinyl chloride compound meeting the requirements of ICEA S-93-639.

B. The average thickness of the jacket shall be not less than the values specified in the following table. The minimum thickness of the jacket at any point shall be not less than 80 percent of the specified minimum average thickness.

TABLE IV	
Calculated Diameter of Cable under Jacket, inches	**Min. Thickness of Jacket, mils**
0.700 and Smaller	55
0.701 - 1.500	70
1.501 - 2.500	100
2.501 and Larger	125

C. Linear shrinkage of the jacket shall not exceed the linear shrinkage of the insulation.

D. The jacket shall be sunlight resistant in accordance with the requirements of UL 1072.

2.08 CABLE DIMENSION:

A. Cable dimensions shall be in accordance with ICEA S-97-682

B. Diameters over insulation shall be in accordance with ICEA S-97-682.

2.09 CABLE TERMINATIONS:

A. Outdoor: See Splices and Taps paragraphs for connections below-grade.

B. Indoor: Terminations that are inside equipment or weatherproof compartments of outdoor equipment, such as transformers and switchgear.

1. Terminations of shielded power cables rated 15 kV or less shall be done with an IEEE Standard 48 Class 1 termination. It shall either be a one-piece design, where high-dielectric constant stress control is integrated within a skirted insulator made of silicone rubber, gray in color or provide for positive placement of the stress control with the installation of a stress patch. The termination shall not require heat or flame for installation. The terminations shall be 3M Brand 5630 K Series Quick Term II cold shrink Termination Kits or Raychem TFT-E-SG. Only a NEMA 2-hole, long-barrel terminal connector shall be used. The connector shall be listed for copper/aluminum applications.

2. Where connecting inside of electric motors, provide terminations per connecting equipment manufacturer requirements, including spring-tension bonding of conductor shield(s) at both ends. It is not acceptable to only bond power connection grounding features at only one end.

C. Cable terminations shall have voltage ratings of not less than 15,000 volts (ungrounded neutral). The standard withstand test voltage of the completed terminations shall conform to IEEE Standard No. 48.

2.10 SPLICES AND TAPS:

A. Unless specified otherwise, all splices and taps shall be as per items B & C below. Only where hand-made splices are called out on the contract documents shall Item D apply.

B. In manholes and maintenance holes, splices for feeders shall only be 600 Amp non-loadbreak power distribution connectors. Acceptable manufacturers are ABB/Elastimold Catalog #K655BLR or equals from 3M, Eaton/Cooper, Hubbell, or approved equal. Provide manufacturer's corresponding cable adapter and compression connector sized per phase conductor. Elastimold or Cooper insulating plug, basic insulating plug and/or connecting plug shall be required for assembly. The only acceptable tape shield adaptors are Elastimold 20MA or 3M 8460/8460 ground shield adapter kit. Cooper tape shield adapters are not to be used.

1. Splices other than those in (B), above, are prohibited.

2.11 CABLE IDENTIFICATION TAGS:

A. The cables shall have identification tags in manholes (at conduit entrances and splices) and at equipment terminations indicating feeder number and routing (Example: Routing: "To MH-36", "To 01-TR-99110A". Feeder: "F01TR99110A"). The tags shall be 1 inch polypropylene plastic (Almetek EZH9) affixed to cables with plastic or nylon ties.

B. At underground riser poles where feeders make a transition from underground to overhead, the feeder number will be 2 inch x 2 inch black letters on yellow background adhesive-backed numbers. These numbers shall be attached to an aluminum strip nailed to wood or banded to steel pole above the cable terminator bracket.

2.12 FIREPROOFING:

A. Cables in manholes shall be fireproofed with one layer of one half-lapped 3M 77 tape applied and held in place with 3M 69 tape. The fireproofing tape shall completely cover each cable and hand-taped splice from duct entrance to duct exit. All three-phase cables shall be fireproofed together ending a minimum of 6 feet from the T-splice, and then individually wrapped up to the T-splice. Extend the fireproofing 1 inch into duct. The fireproofing tape shall extend 1 inch (minimum) onto the splice/T-connector body.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. All work on primary conductors shall be done only when such conductors and equipment are de-energized.

1. Written request for outages shall be submitted twenty-one (21) calendar days in advance of the outage date. This request will delineate the particular circuit or service interrupted and the approximate hours the utility shall be off.

2. The work to be performed during an interruption of electrical utilities will be preceded by all possible preparation and will be carefully coordinated to minimize the duration of the interruption and work will proceed continuously until the system is restored to normal.

3. Phasing of reconnected feeders shall be identical to the existing phasing.

B. Install and terminate primary cables in accordance with the manufacturer's approved recommendations and tools suggestions. The conductors shall be free of kinks and twists, and all bends shall be formed with smooth radius not smaller than twelve times the diameter of the cable nor smaller than the minimum radius recommended by the manufacturer, whichever is greater. All 600 amp and 200 amp terminations shall be mounted to avoid any stress on the terminations.

C. The two-hole cable connectors shall be crimped with only the manufacturer's approved tool recommendations.

D. All cables in one conduit shall be pulled in together using a suitable patented grip on the conductors with a basket weave grip over the insulation, arranged so the stress of pulling is applied to the conductor and not the insulation.

E. Use a swivel between the cable grip and pulling rope.

F. Lubricate cables with Cable lube or Minnearallac cable pulling compound or the type approved by the cable manufacturer.

G. Maximum pull tensions shall not exceed values recommended by the cable manufacturer or as specified on the drawings. Pulls shall be made in the directions shown in the submitted cable pulling calculations.

H. Install cables in manholes along wall as specified on drawing providing proper support. In manhole, route cables a minimum of 3/4 of manhole perimeter.

I. Cable shield shall be grounded with #6 bare copper to manhole ground at all terminations to provide permanent, low-resistance bond.

J. After cables have been terminated or spliced and fireproofing tape applied, each cable shall have a spiral wrap of colored 1/2-inch wide tape 3M #35 vinyl plastic applied over the fireproofing tape. Spiral wrap of colored tape shall be over the total length of cable, with maximum of 5-inch separation between spirals. The color coding is as follows:

1. 2400 volt - No Colored Tape Required

2. 4160 volt - Red Tape (3M #10224)

3. 12470 to 13,800 volt - Blue Tape (3M #10240)

K. Seal all duct runs in manholes going inside buildings with a water-tight seal.

L. Cables of the same circuit shall be identified by tags in manholes (at conduit entrances and T-splice) and entrances into equipment. Information on tags shall include: circuit number and routing (circuit number will be confirmed at the outage coordination meeting). Tags shall be installed on each cable after fireproofing (see Part 2.12).

M. Cables of the same circuit shall have the phasing identified with color tape in manhole. Phase A with one wrap, Phase B with two wraps, Phase C with three wraps.

3.02 CABLE ENDS:

A. After cutting, if cable ends are not to be terminated in same working day cut, immediately protect cable ends from damage or moisture by sealing with cable caps and silicone sealant. Provide stress relief at all terminations. Provide correct phasing of the conductors of each circuit at all terminations. Provide proper connections of tape shield or tape shield and drain wire to ground.

3.03 TEST PREPARATION:

A. Prior to energizing the cable, testing of the cable shall be performed in the presence of the Engineer.

B. Exposed ends of cable shall be prepared and cleaned prior to testing in order to minimize any leakage current.

C. Cable circuit ends must be cleaned and guarded for personnel safety during cable testing. Circuits not under test in the immediate vicinity shall be grounded.

3.04 FIELD TESTING AND RECORDS:

A. Each power cable shall first be given a full dielectric-absorption test with 5000-volt insulation-resistance test set.

1. Test shall be applied for a long enough time to fully charge the cable.

2. Readings shall be recorded every 15 seconds during the first 3 minutes of test and at 1 minute intervals thereafter.

3. Test shall continue until three equal readings, 1 minute apart, are obtained.

4. Minimum reading shall be 200 megohms at an ambient temperature of 68 degrees F.

5. Readings taken at other than 68 degrees F ambient temperatures shall be corrected accordingly.

B. Upon successful completion of the dielectric adsorption tests, the cable shall be subjected to a direct-current high-potential test for 5 minutes with test voltages applied in accordance with AEIC CS8 and IEEE Std. 400.2 for cross-linked, polyethylene-

insulated cable; and AEIC CS8 and IEEE Std. 400.2 for ethylene propylene rubber-insulated cable.

1. Leakage current readings shall be recorded every 30 seconds during the first 2 minutes and every minute thereafter for the remainder of the test.

2. When the leakage current continues to increase after the first minute, the test shall be immediately terminated and steps taken to find and correct the fault. When a second test becomes necessary, this test procedure shall be repeated.

C. Upon satisfactory completion of the high-potential test, the cable shall be given a second dielectric adsorption test as before.

D. Results of the second dielectric-adsorption test shall agree with the first test and shall indicate no evidence of permanent injury to the cable caused by the high-potential test.

E. Test data shall be recorded and shall include identification of cable and location, megohm readings versus time, leakage current readings versus time, and cable temperature versus time.

F. Final acceptance shall depend upon the satisfactory performance of the cable under test.

G. Exposed circuit ends under test require a minimum separation from all elements not subjected to a test of 1 inch per 10 kV of test potential. After testing, cables shall be grounded for a minimum of 4 times (4X) as long as the test voltage was applied during the hi-potential tests to assure complete discharge.

H. When all cable, splices and terminations have been tested and test results have been accepted by the Engineer, the cable system may be placed in service.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 20

ELECTRIC WIRES AND CABLES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide wires and cables for complete electrical systems as indicated and specified.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. B3: Soft or Annealed Copper Wire.

2. B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

3. B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.

B. Insulated Cables Engineers Association, Inc. (ICEA)/National Electrical Mfg's Association (NEMA):

1. S-61-4021/WC 5: Thermoplastic Insulated Wire & Cable.

2. S-66-524/NEMA WC 7: Cross-Linked-Thermosetting-Polyethylene Insulated Wire and Cable.

3. S-68-516/WC 8: Ethylene-Propylene-Rubber-Insulated Wire & Cable.

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

D. Underwriters Laboratories, Inc. (UL):

1. 44: Thermoset-Insulated Wires and Cables.

2. 83: Thermoplastic-Insulated Wires and Cables.

3. 854: Service Entrance Cables.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 26 05 10.

1.04 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver wire and cables in full reels protected against injury. Deliver reels with factory attached UL approved tags showing the manufacturers name and the type of insulation, size, and length of wire in each coil or reel.

C. Accept wire and cable on site in manufacturer's packaging. Inspect for damage.

D. Store and protect in accordance with manufacturer's instructions.

E. Protect from weather. Provide adequate ventilation to prevent condensation.

1.05 DESIGN CRITERIA:

A. Wire for lighting, single phase circuits shall be Type XHHW or THWN-THHN.

B. Wire for three phase circuits shall be Type XHHW.

C. Service conductors are not anticipated. Contact Engineer for clarification if required.

D. Single conductor wire for control, indication and metering shall be Type THWN-THHN No. 12 or 14 AWG, stranded.

E. Multi-conductor control cable shall be used for the underground system and shall be No. 12 or 14 AWG, stranded with overall jacket.

F. Wire for process instrumentation shall be twisted shielded pairs No. 16 AWG, stranded with overall jacket, unless noted otherwise. Reference Instrumentation Loop Diagrams for additional requirements.

G. Ground wires shall be Type THW, green. Bare ground wires shall be soft drawn copper, 98 percent conductivity.

H. Wire for power circuits installed in duct banks shall be type RHW.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. 600V Cable:

1. Okonite.

2. Southwire.

3. American Insulated Wire.

B. Control and Metering Wire:

1. Belden Wire and Cable.

2. Alpha Wire.

3. Coleman Cable.

C. Cable Fireproofing Tape:

1. MAC Products, Inc.

2. 3M Electrical Products.

2.02 MATERIALS AND COMPONENTS:

A. Furnish copper conductors. Material and stranding of conductors to conform to ASTM B3, ASTM B33, and to ASTM B8, for the appropriate class.

B. Uncoated, soft or annealed copper wire conforming to ASTM B3.

C. Superseding the following paragraphs, where connecting between a Variable Frequency Motor Controller (VFMC) and a motor, unless a suitable filter is required and provided, then provide multi-conductor cable, with:

1. 2kV-insulation system.

2. Identification for use on the load side of a VFMC or VFD

3. XHHW or other polyethylene insulation over phase conductors

4. 3-conductor parallel symmetric equipment grounding conductors

5. Overall foil shield

6. Overall insulated jacket, with cable ratings for the intended purpose.

7. Acceptable manufacturers are Belden, Southwire, and General Cable, and pre-approved equals.

8. Include cable manufacturer's recommended VFD termination kit that maintains contstant spring tension against the overall shield, at both ends of the cable.

D. Wires and Cables for Maximum 600-Volt Power Circuits: Where used in lighting or receptacle branch circuits provide No. 12 AWG gauge and No. 10 AWG gauge as solid conductor. Provide other wire with Class C stranding. Provide No. 6 AWG gauge and larger with Class B stranding. Provide wires and cable conforming to UL 83.

E. Wires and Cables for Maximum 600-Volt Power Circuits: For No. 8 AWG gauge and smaller provide type THWN/THHN or RHW, except for three-phase circuits which shall be XHHW-2 per Paragraph 1.05.B.

F. Wires and Cables for Control, Indicating, Metering, or Alarm Circuits: Single and multi-conductor control cable, copper conductors, Class B or C stranding. Insulation; 600-volt polyethylene, polyvinylchloride, or EPR. Continuous rating of 90C dry and 75C wet. Color coding conforming to Table K-2, ICEA/NEMA S-61-4021/WC 5.

G. Shielded Cable for Instrumentation Wiring: 7-strand copper conductors, size No. 16 AWG. Insulate conductors individually with color coded polyethylene or polyvinylchloride. Twist pairs with varying lay (if more than one pair) and cover with cable tape and copper or aluminum coated Mylar shielding tape and tinned copper drain wire. Jacket: Polyvinylchloride.

H. Cables: Rated 600 volts and 90 degrees C, using ampere rating of 75 degrees C if so limited by equipment terminal temperature ratings.

I. Category 6 Cable: Reference Section 27 15 13 for requirements.

PART 3 - EXECUTION

3.01 GENERAL:

A. Perform work in accordance with the National Electrical Code.

B. Provide power cable identification as follows:

System Voltage	Neutral	Phase A	Phase B	Phase C
208/120V	White	Black	Red	Blue
240/120V	White	Black	Red	None
480/277V	Gray	Brown	Orange	Yellow

C. Use green to identify insulated ground conductors.

NOTE: Colored insulation, tapes or sleeves may be used to provide color coding where permitted by the NEC. Insulated ground conductors must have green covering.

D. Permanently post means of identification of grounded and ungrounded conductors for each nominal voltage system at each panelboard and motor control center.

E. In power and multiconductor cables manufactured without a grounding conductor identify one of the multi-conductors as the equipment grounding conductor at each cable end and at every point where the conductors are accessible.

3.02 INSTALLATION OF WIRING:

A. Unless otherwise indicated, use no conductor smaller than No. 12 AWG for power, No. 14 AWG for control, and No. 16 AWG for shielded applications.

B. Install conductors continuous from outlet to outlet and make no splices except within outlet or junction boxes.

C. Install cable in underground raceway system without splices. There shall be no splices between connection points unless otherwise indicated.

D. Draw all conductors contained within a single conduit at the same time.

E. Apply wire pulling compound to conductors being drawn through conduits. Use pulling compound, Minerallac No. 100, Y-er-Eas, Yellow 77, High Performance Polywater Cable Lubricant.

F. Use no cable bend with radius of less than eight times its diameter.

G. Wires and cables installed without prior submittal review are subject to removal at no additional expense.

H. Where cable is furnished with an overall shield:

1. Power applications – Bond shield to equipment ground bus at both ends of the system.

2. Signal applications, such as 4-20mA analog, thermocouple extension wire, and Current Transformer (CT) wire – Bond shield to equipment ground bus at central equipment, and not at the end termination equipment, unless otherwise noted. Clip and tape shield to avoid creation of inadvertent ground loops, unless otherwise noted. See Process Specifications and Drawings for additional requirements.

3.03 CONDUCTOR IDENTIFICATION:

A. Label each wire at both termination points. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification clearly stamped on terminal boards and printed on directory cards in distribution cabinets and panelboards. Also label every cable in each maintenance hole. Provide imprinted or engraved stainless steel label where lableling inside maintenance holes.

B. Identify each wire in junction boxes, cabinets, and terminal boxes where total number of control, indicating, and metering wires is three or more and no terminal board is provided, including all power wire. Where no termination is made use a plastic-coated, self-adhesive, wire marker and where termination is made use a, plastic, pre-printed sleeve wire marker.

C. In cases similar to above where terminal boards are provided for the control, indicating, and metering wires, identify all wires including motor leads and other power wires too large for connection to terminal boards, by sleeve wire markers as specified above.

D. In maintenance holes and handholes, identify each power wire by laminated plastic tag located so it is easily seen. Control wires to be bundled and marked as listed in conduit and wire schedule.

3.04 CONNECTORS, TERMINAL LUGS AND BOARDS:

A. For wiring of circuits consisting of No. 10 or No. 12 AWG solid wires, such as for lighting branch circuits, use self-insulated pressure type connectors for all splices or joints.

B. Terminate all wires connected to terminal boards, terminal blocks, or to other similar terminals by means of ring or tongue, nylon self-insulated, tin-plated copper pressure terminals.

C. Terminal boards shall be 600 volts and rated for 125 percent of the ampacity of the connected circuit. They shall have screw terminals, with white marking strips for wire identification, of the 4-, 6-, 8-, or 12-pole type, as necessary.

D. Wire connections for which terminals are not supplied, for example, at solenoids or motor terminal junction boxes:

1. 10 AWG and smaller: Use self-insulated pressure-type connectors.

2. 8 AWG and larger: Use insulated, mechanical type with set screw or follower bearing directly on the wire. Split bolt connectors are not acceptable.

E. Clearly and permanently mark terminal strips with ink or indelible pencil. Mark each wire consistently throughout entire system, using notation of wires given on manufacturer's wiring diagrams wherever possible.

3.05 FIELD TESTING:

A. Submit results of all cable tests on forms indicating cable size, voltage, and date with name of tester and witness.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide a single, complete, integrated grounding system, including conductors, raceways, and connections, indicated and specified, and in accordance with the National Electrical Code Article 250 and the National Electrical Safety Code.

B. Include grounding of switchgear, substations, motor control centers, electric equipment enclosures etc., outdoor substations, transformers, switch structures, etc.; ground grid systems with ground rod and water pipe connections; structural steel, and lightning protection system.

C. Include grounding conductors completely inter-connecting water supply pipe, ground rods, ground grid, substation, switchgear and motor control center ground buses, other distribution equipment, and other groundable equipment.

1.02 REFERENCES:

A. American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE):

1. ANSI/IEEE C2: National Electrical Safety Code.

B. ASTM International (ASTM):

1. B3: Standard Specification for Soft or Annealed Copper Wire.

2. B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

3. B33: Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

C. Institute of Electrical and Electronics Engineers (IEEE):

1. Standard 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potential of a Ground System.

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code

2. 780: Lightning Protection Code

E. Underwriters Laboratories (UL):

1. 467: Standard for Grounding and Bonding Equipment.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

B. Submit shop drawings and manufacturers' product data in accordance with requirements of Section 26 05 10.

C. Submit catalog and dimensional data for the following:

1. Ground rods

2. Conductors

3. Exothermic welding

4. Connecting hardware

D. Submit grounding system test results.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S COMPLIANCE:

A. Manufacturer's acceptance contingent upon products' compliance with the specifications.

2.02 MANUFACTURERS:

A. Ground Rods:

1. ERICO Products Inc.

2. Galvan Electrical Products

3. Nehring Electrical Works

B. Conductors:

1. Southwire

2. General Cable

3. Republic Wire

C. Exothermic Welding:

1. ERICO Products, Inc.

2. American Brass Mfg. Co.

3. Orgo-Thermit, Inc.

D. Connecting Hardware:

1. American Brass Mfg. Co.

2. Thomas and Betts

3. Anderson Electric Corp.

2.03 MATERIALS AND COMPONENTS:

A. Conductors:

1. Provide copper grounding conductors bare or insulated, sized as indicated. When not indicated on the drawing provide in accordance with the NEC. Provide protection of conductors in locations where physical damage would result from direct exposure.

2. Ground and bond wires for substations, main panels and distribution points, and ground rod connections shall be annealed bare copper conforming to ASTM B3, stranded, with 98 percent conductivity.

3. Equipment ground conductors run with circuit conductors and grounding electrode conductor shall be 600 volt with green insulation, unless noted otherwise on the Contract documents.

4. Unless noted otherwise, all conductors No. 8 AWG and larger shall be stranded, Class B in accordance with ASTM B8.

a. Uninsulated conductors shall be bare copper in accordance with ASTM B3, tinned in accordance with ASTM B33.

b. Use tinned-coated in corrosive environments including when buried in earth or embedded in concrete.

B. Ground Bus:

1. Provide a 4 by 1/4 inch copper bar complete with bolted type connectors as indicated.

2. Bus bar shall have 18 pre-drilled holes, two standoff insulators, two stainless steel mounting brackets and four stainless steel assembly bolts and lock washer.

C. Connectors and Fasteners:

1. Provide ground clamps which are UL listed for use on copper or brass pipes.

2. Provide ground clamps, for use on iron pipes, of galvanized or malleable iron, or of standard noncorrosive material for use on iron pipes.

3. Provide ground clamps, for use on pipes, with rigid metal base providing good contact by proper seating on the pipe. Do not use strap type clamps.

D. Ground Rods:

1. Ground rods shall conform to the requirements of NFPA 70 and UL Standard 467.

2. Ground rods shall be copper-clad steel rods not less than 3/4 inch in diameter and not less than 10 feet long per section.

3. Ground rods shall be clean and smooth with the following characteristics:

a. Cone-shaped point on the first section.

b. Die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in millimeters or feet.

PART 3 - EXECUTION

3.01 EXOTHERMIC WELDING:

A. Welding shall be by the exothermic process.

B. Within the welding procedure, include the proper mold and powder charge and conform to the manufacturer's recommendations.

C. Welding processes shall be the exothermic fusion type that will make a connection without corroding or loosening.

D. The welding process shall join all strands and not cause the parts to be damaged or weakened.

E. Completed connection or joint shall be equal or larger in size than the conductors joined and have the same current-carrying capacity as the largest conductor.

F. Paint buried ground connection with a bitumastic paint.

3.02 INSTALLATION OF GROUNDING CONDUCTORS:

A. Install grounding conductors so that they will not be exposed to physical damage. Install connections firm and tight. Arrange conductors and connectors so no strain on connections.

B. Run grounding conductors associated with direct burial cables in common trenches above cables except as indicated otherwise.

C. Bury equipment grounding conductors 30 inches deep. Bring loops or taps up for connection to equipment or other items to be grounded.

D. Where raceways are used to contain and protect grounding conductors, install in accordance with Sections 26 05 33 and Section 26 05 43.

E. Where bare grounding conductors are contained within metallic raceways, bond ends of raceways to conductors.

F. Install loop type, low impedance, grounding system interconnecting all components so at least two grounding connections are provided for each major item of electrical equipment. Ensure that severing of any single grounding conductor in this system does not remove grounding protection on any major item. Locate loop conductor at least 36 inches below finished grade, or at least 2 inches below depth of frozen soil observed during excavation, whichever is deeper.

G. Bond steel columns, steel arches, and other vertical/near-vertical structural steel to both lighting protection system and to the ground ring, near the top and bottom of the steel vertical.

H. Connect structural steel to the external perimeter loop of grounding conductors installed around all sides of building foundation. Connect to each vertical column by loop or tap. Connect two opposite points on external loop to two different points on grounding system.

I. Buried and concealed ground connections shall use exothermic welding.

J. Make accessible connections to structural members by exothermic welding process or by bolted connector. Connections to equipment or ground bus by bolted connectors.

3.03 INSTALLATION OF GROUND RODS:

A. Install ground rods in maintenance holes in accordance with requirements specified under the section Underground Distribution Systems. Connect each grounding conductor entering a maintenance hole to ground rod by exothermic weld.

B. Install ground rods where indicated. Install the top of the rod 12 inch below the ground surface.

C. Make connection to overall grounding system as indicated.

D. Ensure that final resistance of interconnected ground system is 5 ohms or less. Measure ground resistance in normally dry conditions, and not less than 48 hours after rainfall.

3.04 EQUIPMENT GROUNDING:

A. Ground each piece of electrical equipment by means of a grounding conductor installed in raceway feeding that piece of equipment. Grounding conductors installed in conduit with insulated conductors to be furnished with green, 600 volt insulation. Ground conductors are in addition to and not to be considered as the neutral wire of the system.

B. Connect power transformer cases and neutrals to grounding system. Connect neutral ground connection at transformer terminal. Provide two separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other.

C. Connect two separate ground connections from ground grid to ground bus of switchgear assemblies, motor control centers, switchboards and all outdoor substation and transformer equipment. Ensure that each connection for item of equipment is from different section of ground grid.

D. Connect a grounding conductor between panelboard and grounding system. Where a grounding bar is furnished with panelboard, connect grounding conductor to bar.

E. Conduits entering metal enclosures shall utilize bonding type locknuts and grounding bushings. Locknuts that gouge into the metal enclosures are not acceptable.

F. Where conduits are not effectively grounded by firm contact with a grounded enclosure, apply grounding bushings on at least one end of conduit run. Conduit connections shall be wrench tight.

G. Connect grounding conductors from equipment in area where ground bus is required to ground bus. Connect ground bus to grounding system. Mount ground bus on 600 volt pedestal insulators.

H. Connect lightning arresters to ground system by suitable conductors. Where lightning arresters are furnished with electrical equipment and grounding connections are not inherently provided, ensure that suitable separate grounding conductor connects lightning arresters with system ground.

I. Ground transformers, lightning arresters, insulators and other appurtenances, installed on timber or metal structure. Run grounding conductors between structure and ground rods. Protect grounding conductor by molding applied for at least 8 feet above ground, with both molding and conductor stapled. Install ground rod where indicated and driven until top of rod is 1 foot below ground.

J. Connect individual ground rods to the grounding loop using the direct burial grounding cable (ground ring).

K. Bond individual cable tray sections with bonding jumpers.

3.05 SIGNAL GROUNDING:

A. Ground signal surge protection and shields of twisted, shielded cable using a signal bonding conductor. The signal bonding conductor shall be a continuous path from the instrument surge protection or shield to the grounding electrode conductor. The signal bonding conductor shall be isolated from the equipment grounding conductor for its entire path.

B. Where convenient, several signal bonding conductors may be combined, providing that all the following conditions are met:

1. The combined signal bonding conductor shall have the equivalent cross section of the conductors that it was combined from or three times the cross section of the largest conductor that it was combined from, whichever is less.

2. The combined signal bonding conductor shall be isolated from the equipment grounding conductor.

3. Where two signal bonding conductors are combined use a three port insulated splice.

4. Where three or more signal bonding conductors are combined, use a copper bus mounted on 600 volt insulators. Attach each conductor to the bus using an insulated ring tongue lug and screw terminal.

C. Isolate shields at non-bonded end to avoid current flowing from point-to-point over the shield from stray currents commonly present is the equipment grounding system.

3.06 FIELD TESTING:

A. Test grounding systems for ground resistance. Total resistance from any point on the ground network to the building counterpoise must not exceed 50 milliohms.

B. Ground resistance and counterpoise tests must be made during dry weather and no sooner than 48 hours after rainfall. Conditions of soil and weather shall be documented on test forms.

C. Conduct tests using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with IEEE Standard 81.

D. Indicating instrument must be self-contained and include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-

reading ohmmeter, series resistors, and range-selector switch. Calibrate direct-reading ohmmeter for ranges of 0 to 20 ohms and 0 to 200 ohms.

E. Place auxiliary grounding electrodes in accordance with instrument manufacturer's recommendations but not less than 50 feet apart, in accordance with IEEE Standard 81.

F. Perform continuity test on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.

G. Furnish copies of test reports on ground system.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide supports from building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

2. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

3. A924: Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

4. E84: Standard Test Method for Surface Burning Characteristics of Building Materials.

5. E119: Standard Method for Fire Tests of Building Construction and Materials.

B. FM Global (FM):

1. Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

D. Underwriters Laboratories, (UL): Applicable listings.

1. FRD: Fire Resistance Directory.

2. 263: Fire Tests of Building Construction and Materials.

3. 723: Test for Surface Burning Characteristics of Building Materials.

4. 1479: Fire Tests of Through-Penetration Firestops.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Steel or malleable iron.

B. Aluminum where indicated.

C. Stainless steel where indicated.

2.02 COATINGS:

A. Protect steel and malleable iron supports, support hardware, and fasteners with zinc coating.

B. Provide products identified for both use in sunlight and use outdoors.

C. Use PVC coating where indicated on Drawings.

2.03 MANUFACTURED SUPPORTING DEVICES:

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type. Anchors containing lead are not acceptable.

2. Toggle Bolts: All steel springhead type.

3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for intended service.

4. Nuts, Washers, and Bolts: Stainless steel.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. U-Channel Systems: Channels, with 9/16 inch diameter holes, at minimum of 8 inch on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacturer.

2.04 U-CHANNEL SYSTEMS:

A. Manufacturers, Stainless Steel/Galvanized Steel Channel.

1. Unistrut Corp.

2. Power-Strut.

3. B-Line Systems, Inc.

B. Manufacturers, Fiberglass Channel.

1. Omnistrut, Champion Fiberglass.

2. Durostrut, Enduro Composite Systems.

3. Struttech, Entrum Industries.

C. Provide Type 316 stainless steel channel or fiberglass channel with corresponding accessories.

D. Channels, with 9/16 inch diameter holes, at minimum of 8 inch on center, in top surface.

E. Provide fittings and accessories that mate and match with U-channel and are of same manufacture.

F. Provide hot-dipped galvanized after fabrication for steel channel and accessories.

G. Provide channel of the proper material to match equipment classifications.

2.05 FIRE RESISTANT JOINT SEALERS:

A. Manufacturers:

1. “Dow Corning Fire Stop Foam;” Dow Corning Corp.

2. “Pensil 851;” General Electric Co.

B. Two part, foamed-in-place, silicone sealant formulated for use in through penetration fire stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.

C. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E814, by Underwriters’

Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with structural system and with other electrical installation.

C. Raceway Supports: Comply with NEC and following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.

2. Strength of each support shall be adequate to carry present and future load multiplied by safety factor of at least 4. Where this determination results in safety allowance of less than 200 pounds, provide additional strength until there is minimum of 200 pounds safety allowance in strength of each support.

3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Support parallel runs of horizontal raceways together on trapeze-type hangers.

5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

6. In vertical runs, arrange support so load produced by weight of raceway and enclosed conductors is carried entirely by conduit supports with no weight load on raceway terminals.

D. Vertical Conductor Supports: Install simultaneously with installation of conductors.

E. Sleeves: Install in concrete slabs and walls and other fire-rated floors and walls for raceways and cable installations. For sleeves through fire rated wall or floor construction, apply UL listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.

F. Conduit Seals: Install seals for conduit penetrations of slabs below grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

G. Conduit extending through roof shall pass through ceiling box at roof line.

1. Provide 14 gage minimum copper box complete with watertight soldered seams and flanged to serve as pitch pocket for each conduit.

2. Install conduit and pitch pocket in advance of roofing work.

H. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with following:

1. Fasten by means of wood screws or screw type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring tension clamps on steel. Threaded studs driven by powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws. (Applies to Early Work Package 2 only.)

2. Fasten by means of toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring tension clamps on steel. Threaded studs driven by powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

3. Holes cut in concrete shall not cut main reinforcing bars. Fill holes that are not used.

4. Load applied to any fastener shall not exceed 25 percent of proof test load. Use vibration and shock resistant fasteners for attachments to concrete slabs.

3.02 CHANNELS:

A. Support electrical components as required to produce same structural safety factors as specified for raceway supports.

B. Install metal U-channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

C. Install Type 316 stainless steel for mounting of electrical equipment in outdoor areas and on below grade, outside building and structure walls.

D. Install galvanized steel channels for interior building mounting of electrical equipment except for those locations listed above and unless otherwise indicated.

E. Install fiberglass channel in chemical areas with NEMA 4X enclosures.

3.03 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide complete raceway systems, with matching accessories, fittings, boxes, and other hardware, as indicated and specified. When non-metallic raceway systems are specified, provide green insulated grounding conductor sized per National Electrical Code (NEC) requirements.

B. All raceway runs are indicated diagrammatically to outline general routing of raceway. Unless specifically identified for installation in concrete walls or slabs, raceways shall be run exposed with raceway supporting systems. Avoid interfering with pipes, ducts, structural members, or other equipment. Any installation deviations from the contract requirements shall be corrected at no cost to Owner.

C. Provide raceway systems in accordance with the following:

1. In precedence to the following, provide rigid aluminum conduit for all instrumentation and controls raceways, except for those in duct banks, or otherwise identified in plans and details. For other conduits:

a. In non-corrosive areas that are either NEMA 12 or NEMA 1 areas, use EMT (above lay-in ceilings or in stud walls) or galvanized rigid steel raceway systems (exposed or subject to damage).

b. In NEMA 4 areas, and where subject to wetting or wash down, use PVC Coated RMC or galvanized rigid steel conduit. Use copper-free aluminum RMC conduit where indicated on plans.

c. In areas subject to corrosion, or areas otherwise identified for NEMA4X construction, use PVC coated galvanized rigid steel or rigid aluminum conduit.

d. In exterior building applications, use galvanized rigid steel conduit.

e. Inside concrete slabs or walls, use PVC Schedule 40 raceway systems. Except use PVC-coated Steel RMC where identified in plans and details, and for elbows and stubs through concrete.

f. Review Architectural schedules for additional data regarding the corrosiveness of an area, and additional requirements.

D. All raceway systems shall be installed in accordance with the criteria described in this section. Any proposed deviations from these requirements shall be submitted to the Engineer in writing for review and disposition.

1. Use Type 304 stainless steel support systems for exterior application and in NEMA 4 and NEMA 4X areas.

2. All NEMA 1 and NEMA 12 areas shall use hot dipped galvanized steel support systems.

E. Rigid aluminum conduit and boxes can be used in place of PVC coated rigid steel in outdoor NEMA4 and similar areas. Install per manufacturer's requirements. Not allowed in direct contact with concrete. Rigid aluminum conduit is prohibited in underground locations.

F. All raceways shall be supported to NEC requirements and to meet all applicable seismic criteria. Raceways 2 inch outside diameter or greater shall be independently supported in a manner to meet the criteria to resist failure during earthquake events. All hardware supports shall be specifically designed for the magnitude of the earthquake event as defined in Section 26 05 10.

1.02 REFERENCES:

A. National Electrical Manufacturers Association (NEMA):

1. TC-2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

2. TC-3: Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

B. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

C. Occupational Safety & Health Act (OSHA).

1. Regulation 1910.7

D. Underwriter's Laboratories, Inc. (UL):

1. 1: Electrical Flexible Metal Conduit

2. 6: Rigid Metal Electrical Conduit

3. 6A: Rigid Aluminum Conduit.

4. 94: UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

5. 360: Electrical Liquid-Tight Flexible Steel

6. 651: Schedule 40 and 80 PVC Conduit

7. 797: Electrical Metallic Tubing

8. 1242: Intermediate Metal Conduit

9. 1684: UL Standard for Safety Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

C. Submit shop drawings for review in advance of contruction with labels of feeders to be included within the conduit.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing laboratory (NRTL).

1. Term “NRTL” shall be as defined in OSHA Regulation 1910.7.

2. Terms “listed” and “labeled” shall be as defined in NFPA 70, National Electrical Code, Article 100.

C. Regulatory requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

1.05 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements specified in Section 01 41 20.

B. It shall be the responsibility of manufacturer and supplier along with the Electrical Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

C. Install supports for raceway systems greater than 2 inches in diameter to meet the seismic requirements indicated and specified.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Electrical Metallic Tubing (EMT):

1. Triangle/PWC, Inc.
2. Perma-Cote Industries
3. Republic Steel Corporation.
4. Robroy Industries.
5. Allied Tube and Conduit.

B. Rigid Metal Conduit and polyvinylchloride-coated (PVC-coated) rigid steel conduit .

1. Triangle/PWC, Inc.
2. Perma-Cote Industries.
3. Republic Steel Corporation.
4. Robroy Industries.
5. Allied Tube and Conduit / Atcore Calbond
6. (Fittings) ABB / Thomas And Betts Ocal

C. Rigid Aluminum Conduit:

1. Allied Tube and Conduit
2. Wheatland

D. Polyvinylchloride (PVC) Conduit:

1. Triangle/PWC, Inc.
2. Robroy Industries.
3. Carlon Electrical Sciences, Inc.

E. Flexible Conduit:

1. American Flexible Conduit Company.
2. Anamet, Inc.

3. Electri-Flex Company.

4. International Metal Hose Company.

F. Boxes and Fittings:

1. O.Z./Gedney Company.

2. Crouse-Hinds Electrical Construction Materials.

3. Appleton Electric Company.

G. Fiberglass-Reinforced Polyester Boxes:

1. Crouse-Hinds Electrical Construction Materials.

2. Fibox.

3. Hoffman Engineering Company.

4. Vynckier Enclosure Systems.

H. Support Systems:

1. Michigan Hanger Co., (O-Strut).

2. Thomas & Betts (Superstrut).

3. Unistrut Corp.

2.02 MATERIALS AND COMPONENTS:

A. Electrical Metallic Tubing:

1. Provide electrical metallic tubing conforming to NEMA Standard FB-1 and UL-797.

2. Fittings and Conduit Bodies: NEMA FB-1 as recommended by the conduit manufacturer.

3. Provide EMT with rain-tight couplings where:

a. Appropriate per Code

b. Where in the same room as pumping or process equipment.

c. Where circuit is supplying or supplied by Uninterruptable Power Supply units.

B. Rigid Metal Conduit, including PVC-Coated:

1. Provide galvanized rigid metal conduit, each with a coupling on one end and thread protector on other end.

2. Hot-dip galvanize rigid steel conduit over entire length, along interior and exterior surfaces, including threads. Conduit shall conform to UL 6.

3. Provide PVC-Coated conduit where indicated, and where:

   a. Providing a conduit stub from within a slab/foundation or under a slab/foundation.

   b. Where bending upwards into a conduit stub, or where changing direction by more than 22.5 degrees in any direction.

C. Where within 2 feet of a deflection jointFlexible-Metal Conduit:

1. Provide flexible-metal conduit for use in dry areas and match fittings, size, and material to rigid conduit to which it is connected. Flexible-metal conduit shall conform to UL 1.

2. Provide liquid-tight flexible-metal conduit for use in damp areas consisting of flexible-metal conduit, with liquid-tight, sunlight-resistant jacket extruded over the conduit. Provide stainless steel, braided flexible conduit in NEMA 4X, corrosive areas. On larger than 1-1/4 inch, furnish separate external ground wire. Liquid-Tight flexible-metal conduit shall conform to UL 360.

D. Polyvinylchloride (PVC) Conduit:

1. Provide PVC conduit, Schedule 40 and Schedule 80 conforming to NEMA Standard TC-2 and UL-651.

2. Fittings and Conduit Bodies: NEMA TC 3 as recommended by the conduit manufacturer.

E. Boxes:

1. In NEMA and NEMA 12 areas, provide standard, sheet-metal, outlet and junction boxes constructed of code-gauge, galvanized sheet steel. Size each box as required by the NEC.

2. Provide boxes containing fixture studs for hanging fixtures. Use concrete-tight boxes for installation in concrete. Do not use shallow boxes unless building construction is such that it is impossible to use standard-depth boxes.

3. Provide outlet boxes and fittings for hazardous locations conforming to UL 886 for class, group, and division indicated.

4. Provide cast boxes with covers or device plates suitable for the area classification. Provide same fittings in PVC-coated format where subject to corrosion. Use cover screws of stainless steel or high brass for iron boxes. Provide seal-offs in accordance with NEC Chapter 5, even if not explicitly required on plans. Review plans and details for additional requirements. Coordinate conduit routing for instrumentation and controls per the plans and schedules of all project disciplines. Review Typical Instrument Wiring Schedule for additional requirements.

5. Provide polyvinylchloride boxes for use as junction boxes and provide high impact strength fiberglass-reinforced polyester boxes for use as device boxes, pull boxes, and terminal boxes for use with polyvinylchloride conduit. Size each box as required by the NEC.

F. Fittings:

1. Provide cast-iron fittings of malleable iron or a mixture of gray iron and cast steel.

2. Provide suitable expansion fittings where conduits cross expansion joints, and above where conduit stubs from below-grade to above-grade.. Equip these fittings with grounding straps, clamps, and copper bonding jumpers. Provide fittings with minimum of 8 inches of axial expansion or contraction.

3. Provide suitable PVC-Coated deflection joints where between 0 and 2 feet outside of structural foundation, with additional as identified in Specifications or in Plans; Salient features include:

a. Identified as corrosion-resistant.

b. Minimum tolerable axial expansion or contraction of up to 3/4”.

c. Minimum tolerable angular misalignment of the axes of the coupled conduit runs in any direction to 30°.

d. Minimum tolerable parallel misalignment of the axes of coupled conduit runs in any direction to 3/4”.

e. Provide PVC-coated joint where located below-grade.

f. Provide PVC-coated adapter to convert from PVC to PVC-coated joint where connecting to PVC below-grade.

4. Also provide PVC-Coated suitable deflection joints where conduit approaches duct bank.

G. PVC-Coating is to be factory-applied. Ensure patching and installation compounds and methods are strictly as recommended by the PVC-coated raceway / fitting manufacturer.

H. Provide fittings and conduits from a single manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Perform all work in accordance with the NEC.

B. Use no conduit less than 3/4-inch in diameter, unless otherwise indicated.

C. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's printed instructions.

3.02 SEISMIC RESTRAINTS:

A. For conduits and other raceways installed in open areas, not adjacent to and secured to structural elements, and 2 inch outside diameter or greater, support such raceways using seismic restraints rated for the applicable project earthquake criteria.

B. Methods of Restraining Raceways:

1. Utilize threaded rod with rod stiffeners and transverse channel braces at approximately 45 degrees angle, at 15 feet on center, maximum, and on one side of rod support.

2. Utilize longitudinal bracing with channel braces at 30 feet on center, maximum.

3. Strap raceways directly to transverse channel braces, using pipe strap with both ends of strap bolted into the channel brace.

4. Do not rigidly brace raceways to different parts of a building that may respond differently during an earthquake. Seismic restraints shall not limit expansion and contraction of the raceway support system.

5. Provide flexible connections for conduits 2 inch outside diameter or greater than when terminating to fixed equipment to prevent loss of raceway integrity in the event of an earthquake.

3.03 INSTALLATION OF FITTINGS:

A. Install expansion fittings wherever conduits cross structural expansion joints and where indicated on Plans. Keep the fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.

B. Do not install fittings to replace elbows and pull boxes, unless space or other problems make use of fittings necessary. Use oversize fittings whenever large cable is installed, in order to maintain proper bending radius.

C. Terminate ends of all floor conduits installed for future use with couplings and readily removable plugs set flush with finished floor surface. Cap spare wall conduits at wall where they enter building.

D. Equip ends of all conduits with conduit fittings. Fit conduits terminating at motor control center or power distribution equipment, or in box above or below, with grounding type bushings, or solidly ground by locknuts or other acceptable fittings. Connect each grounding bushing to ground bus by a bare or green-covered copper wire. Do not use ground wire smaller than 12 AWG. Install ground wire larger than 12 AWG when required by NEC. Where conduits terminate in unprotected areas or where bonding is required over expansion joint, flexible conduit or equivalent; use ground wires 6 AWG. copper or larger.

E. Terminate conduits entering gasketed sheet-metal boxes or gasketed sheet-metal equipment enclosures with gasketed hubs.

F. Terminate conduits entering non-gasketed sheet-metal boxes or enclosures with double locknuts and insulated bushings, or with acceptable equivalent.

G. Join raceways with fittings listed for the purpose. Make joints tight. Use raceway fittings compatible with raceway and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, except as otherwise indicated.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

2. Use insulating bushings to protect conductors.

3. Tighten set screws of threadless fittings with suitable tool.

H. Install PVC-coated fittings with tools and methods as required by the manufacturer. Conduits underneath the IPS building require additional scruitiny and inspection, including photographs of final work, assuring complete coating was made, so as to maximize the life of the electrical system underneath the IPS foundation.

3.04 INSTALLATION OF RACEWAYS:

A. Install exposed raceways parallel or at right angles to walls and ceiling beams. Make all changes in directions with listed bends, elbows, and pull boxes. Space parallel runs uniformly throughout. Secure in place by hangers and fasteners. Ground raceways by connection to properly grounded enclosures, bonding, or other means, to obtain permanent low resistance path to ground throughout installation. Ensure that raceway sections in single run and in parallel runs are of same type and finish.

1. Run parallel or banked raceways together, on common supports where practical.

2. Install raceways level and square and at proper elevations. Provide minimum 7 feet headroom. Locate so as to avoid tripping near walkways or other pathway obstructions.

B. Support raceways concealed above suspended ceilings from slab above ceiling in same manner as exposed raceways. Do not support raceways from ceiling supports.

C. Provide cast-in-place inserts in concrete to support all runs, unless otherwise permitted. Use stainless steel sleeve type concrete anchors for installing boxes, and conduit supports. Provide Type 316 stainless steel nut, bolts, and washers, for use with concrete anchors.

D. Support conduits by hangers or pipe straps spaced according to NEC, but in no case more than 10 feet on centers.

E. Comply with NECA 102 for aluminum conduits.

F. Provide hot-dipped galvanized supports for galvanized conduit.

G. Stub-Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit. Flexible metal conduit may be used 6 inches above the floor, provide stanchions as required to secure and support per Code. Where equipment connections are not made under this Contract, terminate ends of floor conduits installed for future use with couplings and readily removable plugs 8 inch above finished floor surface. Cap spare wall conduits at wall entrance to building.

H. Do not use dissimilar metals in conjunction with each other. Use an insulation between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. Maintain electrical continuity of system. Use bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials as insulation.

I. Install fittings to match raceway being used.

J. Install expansion fittings wherever conduits cross structural expansion joints at connections between buildings. Keep fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.

K. Provide separate raceways for all low voltage instrumentation raceways (50 volts and below) from control and power raceways.

L. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box; use two locknuts, one inside and one outside the box.

M. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

N. Install pull wires in all empty raceways. Use 14 AWG zinc-coated steel or monofilament plastic line having not less than 200 pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

O. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

P. Complete raceway installation before beginning conductor installation.

Q. Use temporary closures to prevent foreign matter from entering raceway.

R. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

S. Where metal conduits rise through floor slabs in wet areas, coat conduits for a distance of 6 inches above and below slab grade with brush coat of waterproof bituminous cement.

T. Install PVC-coated conduit with tools and methods as required by the manufacturer. Conduits underneath the IPS building require additional scruitiny and inspection, including photographs of final work, assuring complete coating was made, so as to maximize the life of the electrical system underneath the IPS foundation.

U. Identify raceways with engraved or imprinted stainless steel labels that include feeder desigations of enclosed feeders. Where enclosing circuits without a feeder name, then provide supplying panel abbreviation and circuit numbers.

3.05 BENDS:

A. Make all bends carefully to prevent distortion of circular cross section. Field bend conduit shall have an inside radius of not less than nine diameters.

B. Where bends of less than nine diameters are necessary, use standard factory elbows. Size conduit to permit cable-bending radius within the factory elbow of at least eight times cable diameter.

C. Allow no conduit greater than 50 feet to have more than two 90 degree bends or equivalent thereof between pulling points. For conduits less than 50 feet in length, allow only three 90 degree bends between pulling points.

3.06 CUTTING, THREADING AND CONNECTING:

A. Make all field cuts in conduits squarely, file cut ends, ream to remove rough edges and thread in accordance with NEC. No running thread permitted. Make all connections mechanically strong and tight, and with acceptable connectors. Where conduit surface coating is damaged or removed in the cutting, threading or reaming process, restore the surface to its original condition.

3.07 CONDUIT CLEANING:

A. Clean all conduit carefully before and after installation, ream ends free of burrs, and free inside surfaces from all imperfections likely to injure cable.

B. After installation of each complete new conduit run, snake the run with band to which is attached a tube cleaner with cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of conduit. Remove and replace all conduit through which mandrel will not pass.

C. Use a sponge with steel brush to clean steel conduit and use a sponge with nylon brush to clean PVC conduits.

D. After cleaning, protect ends of all conduit with standard caps to prevent entrance of water, concrete, debris, or other foreign substance.

3.08 CONDUIT DRAINAGE:

A. Where practicable, pitch conduit to drain to outlet boxes, or install so as to avoid trapping moisture. Where dips are unavoidable in exposed conduits, install fitting with drain hole at low point.

3.09 INSTALLATION OF BOXES:

A. Unless otherwise indicated, install sheet metal boxes only in dry, accessible locations. Install cast-metal boxes in exterior concrete or masonry walls, in floor slabs, in basements, all other below grade locations and elsewhere as indicated. Cast metal boxes shall be used (unless otherwise indicated) where vapor-tight fixtures are required, for all surface mounting of wall switches and receptacles and for all outdoor use. Install pull boxes for motor control centers and large ceiling hung boxes where indicated.

B. Install boxes in conformance with all the requirements of NEC. Install boxes designed for type of construction involved. Support boxes in same manner as required for conduit. Size boxes to provide bending radius for wire or cable of at least eight times diameter or in accordance with NEC, whichever is larger.

C. Center all outlets in panels, or spaces and adjust to structural finish. Where specific locations are not indicated, locate outlets with respect to equipment served.

D. Place all outlet boxes, junction boxes and pull boxes, in accessible locations when they are installed above or behind plastered ceilings, furred spaces, or suspended ceilings. Install access panels of suitable size. Mark all access panels for all boxes so panels can be readily located in future. Mark, using metal tabs or plastic buttons which cannot mark ceilings or walls, appropriate for type of construction being used.

E. Assemble cast-metal boxes with threaded conduit hubs in such manner that conduit connections and gasketed covers are watertight. Close all unused threaded openings with pipe plugs and compound.

F. Provide cast boxes with covers and device plates suitable for the area classification. Install screws of stainless steel or high brass for iron boxes.

3.10 FLEXIBLE CONNECTIONS TO MOTORS AND EQUIPMENT:

A. At all motors and electrically operated equipment to which conduit connections are made, install with a complete connection between end of conduit and terminal box of motor or other equipment.

B. Install the conduits in locations permitting direct connection to motors.

C. Make connections between rigid raceway and motor or equipment subject to vibration and adjustment using flexible conduit. Make each connection with at least one quarter bend so that no vibration can be transmitted beyond flexible connection. Provide stanchion or other support as required to secure non-vibrating end of the flexible conduit per Code.

D. Install flexible metal conduit, fittings, and accessories in dry areas in accordance with requirements of NEC.

E. Install liquid-tight flexible metal conduit in damp and corrosive areas. Locate conduit to reduce the possibility of damage to the exterior coating. Use fittings that screw into flexible conduit and provide gaskets.

F. Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures and; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid tight flexible conduit in wet or damp locations. Install liquid-tight flexible metal conduit in areas subject to wetting due to fire protection sprinklers or broken or ruptured water line. Locate conduit to reduce the possibility of damage to the exterior flexible conduit jacket. Use fittings that screw into flexible conduit and provide gaskets. Install separate ground conductor across flexible connections.

3.11 PROTECTION:

A. Provide protection and install in accordance with manufacturer printed instructions. The conduit and raceway equipment manufacturers, to ensure that coatings, finishes, and enclosures are without damage or deterioration at completion of project.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touch-up coating recommended by the manufacturer.

3.12 FINAL SYSTEM ACCEPTANCE:

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions and at no additional cost to the Owner.

B. Label all raceways and boxes in accordance with the requirements of Section 26 05 10.

3.13 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide complete underground distribution system as indicated and specified.

B. Conform to lines, grades, elevations, and dimensions. Resolve interferences with other underground conduit, piping or equipment, either new or existing with the Engineer. Match components suitable for proper installation.

C. Provide red-dyed concrete encasement of duct system where indicated. Include forms and reinforcing in installation. Perform work in accordance with Section 26 05 10.

D. Provide maintenance holes (MHs) and handholes (HHs) complete with ground rods, windows, ladders, frames, covers, cable racks, supports, pulling irons, and other inserts. Use reinforced concrete. Perform work in accordance with Section 26 05 10.

E. Provide Schedule 40 polyvinylchloride (PVC) conduit or HDPE conduit for power and control circuits (as indicated on drawings or specified herein) and furnish and install rigid galvanized steel conduits for instrumentation, communication and fire circuits.

F. Specification in Division 01, 02, and 03 are incorporated by reference, especially the following sections. Note that mid-execution coordination is required to accommodate existing conditions. Sections of particular importance to existing utilities include:

1. 01 31 13, "Coordination"

2. 02 10 20, "Protecting Existing Underground Utilities"

1.02 REFERENCES:

A. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with requirements of Section 26 05 10.

C. Provide "Record" drawings.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S COMPLIANCE:

A. Manufacturer's acceptance contingent upon products' compliance with specifications.

2.02 MANUFACTURERS:

A. Polyvinylchloride (PVC) Conduit:

1. Specified in Section 26 05 33

B. High Density Polyethylene (HDPE) Conduit is not an acceptable duct conduit material.

C. Rigid Steel Conduit, Galvanized:

1. Specified in Section 26 05 33

D. Rigid Steel Conduit, Galvanized, including portion PVC-Coated:

1. Specified in Section 26 05 33

E. Rigid Steel Conduit, Aluminum:

1. Specified in Section 26 05 33

F. Fiber, Conduit, Type I is not an acceptable duct conduit material.

G. Maintenance Hole Waterproofing Material:

1. Heavy Duty Black, No. 46-449, by Tnemec Company, Inc., No. Kansas City MO

2. Hi-Build Bituminous Coating, No. 64-J-5, by Valspar Corporation, Baltimore, MD

3. Bitumastic Super Service Black, by Kop-Coat, Inc., Pittsburg, PA

2.03 MATERIALS AND COMPONENTS:

A. Conduit Spacers: Furnish conduit spacers made of plastic to maintain spacing between conduits.

B. Concrete: Minimum compressive strength, 3,000 psi.

C. Hot-dipped galvanized steel conduit used underground to be painted with bituminous paint.

D. PVC-Coated galvanized steel conduit where indicated in plans and details.

E. PVC-Coated galvanized steel condit deflection joints where indicated in plans and details.

F. Maintenance Hole Frames and Covers:

1. Heavy duty gray cast iron

2. Conform to details indicated on the drawings and as specified

3. Provide machine-finished seat

4. Mark "ELECTRICAL-15kV", "ELECTRICAL-5kV", “Comunications”, or “Electrical-480V” on cover of maintenance hole as appropriate for system.

2.04 PROVISIONS FOR TRACING IN THE PUBLIC WAY

A. Provide 3-terminal Switchable tracing accesspoint, CopperHead Lite Duty SnakePit, or equal, within an HS-20-rated round 12-inch-diameter meter box with steel lid (box to be at least 12 inches tall.) Provide integral ground rod with accesspoint. Install per manufacturer instructions. Color lid for fiber optic as orange, lid for power as red. Maintain at least 24 inches of slack below accesspoint for maintenance over lifetime of system.

B. Provide detectable tape centered above duct bank, with color and text to match utility marked. Provide insulated #14 detectable tape, minimum.

PART 3 - EXECUTION

3.01 INSTALLATION OF CONDUITS:

A. Requirements shown on drawings and plans take precedence over Specification requirements for buried conduits and ductbanks.

B. Lay conduits, indicated to be direct buried in the ground, in trench on 3 inch bed of sand and cover with an equivalent 3 inch bed of sand. Ensure that no rocks come in contact with conduit during backfilling. Dig trenches to depth and location indicated.

C. Provide minimum separation for groups of power and control conduits of 7.5 inches center-to-center for conduits with conductors rated 2.4kV and above. Provide minimum spacing between outer diameter of conduits of at least 3 inches for conduits of all volage levels, both vertically and horizontally. Build ductbank layer by layer, backfill and compact each layer (for direct buried applications) to provide support for next layer.

D. Separate power and control ducts from instrument ducts by a minimum of 12 inches, and ductbanks by 12 inches minimum, concrete-to-concrete.

E. Backfill ductbank in layers and tamp or "puddle" as directed by the CM. Provide yellow ductbank marker tapes, reading "Caution - Electrical Lines Below", over entire length of ductline. Locate tapes 12 inches below grade. Provide a tape for every 12 inches of width of ductline.

F. Install conduit, indicated to be encased in concrete with spacers and reinforcing, as specified and as indicated. Rigid galvanized steel conduits to be painted with bituminous paint.

G. Install conduit runs following routing on drawing and running in straight lines. Where deviation from a straight line becomes necessary, install bends of radius which allow for rodding and installation of cable.

H. Accomplish changes in direction of runs exceeding total of 10 degrees, either vertical or horizontal, by long sweep bends having minimum radius of curvature of 25 feet Manufactured bends can be used at ends of short runs of 100 feet or less, with less than 270 degrees of bends, and then only at or close to the end of run. Provide long sweep bends made up of one or more curved or straight sections and/or combinations thereof. Install manufactured bends with minimum radius of 36 inch where larger radius cannot be used. Provide lubrication and/or cable feeding into conduit as required

I. Lay ductlines to minimum slope of 3 inches per 100 feet and slope to maintenance holes and handholes, as indicated. Ductlines are to slope away from buildings.

J. Install spacers at intervals of approximately 4 feet and stagger between tiers of ducts to provide not less than 12 inches of longitudinal separation. Install base spacers to provide at least 3 inches between bottom of trench and underside of bottom conduits. Completely fill space with concrete. Firmly wire conduits and spacers together before concrete is placed.

K. Ductbanks are to be formed, unless trench conditions allow for neat placement of concrete with specified clearances.

L. Prior to placing of concrete, remove all dirt, sand, and any other debris from between conduits and from trench bottoms. Hold conduits in place to prevent floating or accidental movement.

M. Stagger joints in conduits at least 6 inches. Do not allow couplings to rest on bottom of trench. Install couplings for plastic conduit in accordance with manufacturer's recommendations.

N. Install concrete encasements so minimum clearance of 12 inches from concrete to parallel pipes, lines, structures, etc., is maintained. Where ducts cross, minimum clearance of 6 inches is required. Do not allow the top of concrete to be less than 30 inches below finished grade or paving. Submit special conditions which may require lesser clearances or special conditions which may require greater than 30 inches depth to Engineer for acceptance.

O. Where a connection is made to existing ductline, bond or dowel concrete encasement to existing encasement. Use waterstop between ductpours and between maintenance holes or buildings and ductwork as indicated.

P. Do not use power-driven vibrators for spading of concrete around ducts.

Q. Roll and grade backfill, and restore surface to condition equal to the site finish grade, or as otherwise indicated.

R. Locate ductbank markers at ends of all ductbanks except at maintenance holes or handholes, at approximately every 200 feet along duct run, and at each change in direction of duct run. Place markers approximately on ductbank. Install markers 6 inches square or round section by 3 feet long made of Class B concrete. Imprint the letter "D" or cast it on top of the marker. Install top of duct markers flush in paved areas, protruding no more 2-inches above finished grade in unpaved areas. In finished lawns, allow marker to protrude 1/2-inch.

S. Keep conduits clean of concrete, dirt, and other substances during the course of construction. After the ductlines have been completed, pull a standard flexible mandrel not less than 12 inches long, having a diameter approximately 1/4-inch less than the inside diameter of the conduit, through each conduit, after which pull a brush with stiff bristles through each conduit to make certain that no particles of earth, sand, or gravel have been left in the line. Replace conduit runs that do not allow the passage of the mandrel at no additional cost to the Owner. Pneumatic rodding may be used to draw in the lead wire. Install in spare conduits a pull wire or rope, and plug and seal spare conduits after cleaning.

T. Reference Specification 26 05 33, Plans and Details for fittings and conduit requirements in at end of ductbanks, bends, stubs, deflection and/or expansion fittings, and additional requirements.

3.02 MAINTENANCE HOLES AND HANDHOLES:

A. Construct maintenance holes and handholes of cast-in-place 3,000 psi red-dyed concrete, as indicated.

B. Install maintenance holes with cable racks, hooks, insulators, and other features, as indicated.

C. Place a 12 inch crushed-stone base under each maintenance hole and handhole. See plans for additional requirements.

D. Construct cast-in-place maintenance holes and handholes with forms, complete with centering cores and molds, to conform to shape, form, line, and grade required and maintain sufficiently rigid to prevent deformation under load. Make all joints leakproof and arrange horizontally or vertically. Place forms on successive units for continuous

surfaces and fit to accurate alignment, assuring a smooth completed surface, free from irregularities.

E. At convenient point close to wall, drive a ground rod into earth as indicated. Extend ground rod approximately 6 inches above finished maintenance hole floor. After completion of maintenance hole or handhole, connect 6 foot length of No. 4 bare copper ground wire to ground rod and coil it within maintenance hole or handhole for connection to steel supports and cover.

F. Size, space, and place reinforcing bars as indicated and as specified.

G. Set maintenance hole and handhole frames to the required grade, in full bed of concrete mortar to make watertight connection.

H. Install tops of maintenance hole and handhole covers in unpaved areas approximately 1/2-inch above finished grade, and in paved areas install flush with finished surface of paving.

I. Install galvanized corrosion-resistant channel support, with continuous slot and required fittings designed for concrete encasement.

J. Install inserts in the maintenance holes as indicated.

K. Install two cable pulling irons in wall opposite each ductbank entrance into maintenance hole, one 6 inch above floor and one 6 inch below the roof of maintenance hole. Where indicated on drawings, install additional features such as openings in maintenance hole walls for future conduit entrances. Seal future entrances with required courses of brick.

L. Where ductlines enter maintenance holes, terminate conduits in end bells. Terminate steel conduit entering maintenance holes and handholes in grounding bushing.

3.03 PROVISIONS FOR TRACING IN THE PUBLIC WAY

A. Locate tracing accesspoint at the southernmost extent of the public way, located 1 foot outside of the fence that bounds the public way, and 5 feet north of every maintenance hole.

B. Provide connection to separate terminals from tracing wire.

C. Bond ground terminal of tracing access point to embedded ground rod.

D. Ensure conductivity of tracing wire from terminal boxes prior to burial.

E. Install top of tracing accesspoint 2” below cover, and centered within, valve box.

F. Install tracing accesspoint in accordance with manufacturer instructions.

G. Install valve box in accordance with manufacturer instructions, and locate flush with grade.

3.04 MAINTENANCE HOLEAND HANDHOLE WATERPROOFING:

A. Apply two coats of bituminous waterproofing material to exterior surfaces of maintenance holes and handholes. Apply by brush or spray, in accordance with manufacturer's printed instructions. Allow time between coats to permit drying to bitumastic manufacturer’s recommendations for the purpose.

1. Two coats applied with a minimum dry film thickness of 12 to 14 mils per coat.

3.05 RECORD DRAWINGS OF UNDERGROUND WORK:

A. Furnish one set of marked copies of contract drawings, showing exact routing and depths of all underground conduit, duct handholes and maintenance holes. Furnish scaled plot plans, showing principal outline of buildings and structures. Reference conduits, ducts, and maintenance holes, and all bends deviating from straight line, dimensionally from fixed objects or structures.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 05 50

SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section describes the requirements for furnishing and installing seismic restraint devices for electrical equipment as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 7: Minimum Design Loads for Buildings and Other Structures - Includes Supplement No. 1

1.03 SUBMITTALS:

A. Submit the following shop drawings and submittal data in accordance with Section 01 33 00.

B. Reference Specification 01 41 20, Seismic and Wind Requirements, for additional requirements, which are incorporated into these requirements by reference.

C. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 00 and specific directives within Specifications Division 26.

D. Submit shop drawings in accordance with the General Provisions, Conditions and Section 01 33 00.

E. Delegated Design Submittals: Provide seismic-resistant installation with design and written certification from Professional Engineer licensed in the State of Utah stating that supports systems and anchorage for equipment have been designed according to the requirements of:

1. Section 1613 of the Building Code of Utah

2. Section 1613 of the International Building Code (IBC)

3. Salt Lake City specific codes and ordinances

4. ASCE/SEI 7, including design and construction to resist the effects of earthquake motions in accordance with Chapters 11, 12, 13, 15, 17 and 18 of ASCE/SEI 7, as applicable.

5. In accordance with Specification 01 41 20.

F. Provide "Delegated Design Submittals" including associated installation for the following:

1. Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments

2. This includes, but is not limited to permanently affixing all switchgear, conduits, electrical enclosures, control enclosures, pullboxes, battery cabinets, and all other items identified by the National Electrical Code to be secured.

G. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems (including raceways) and anchorage for wind, seismic, and all other pertinent loads.

H. At a minimum, seismic design shall be the most resilient of the following:

1. As required in the Structural Contract Documents.

2. Design Ground Motions shall be determined on a site-specific basis and not by use of a zip code. For specific acceleration values for a particular project please go to the Applied Technology Council to use their free "ATC Hazards by Location" tool: https://hazards.atcouncil.org/, or an approved equivalent that is acceptable to the Salt Lake City Authority Having Jurisdiction.

3. Seismic Design Category is site specific (per Section 1613.2.5 of the IBC).

I. Submit equipment anchoring methods. Include anchoring locations, anchor types, and minimum anchor embedment depths. Anchors shall have ICC-approved anchorage values.

PART 2 - PRODUCTS

2.01 SEISMIC DESIGN OF EQUIPMENT:

A. Equipment fabricated or assembled at manufacturers' premises shall be designed and constructed in such a manner that all portions, elements, subassemblies, and/or parts of said equipment and the equipment as a whole, including their attachments, shall have the capability of withstanding seismic forces specified under "Seismic Anchoring and Restraints" below.

B. Construction in an outside state, prior to shipment to site, does not relieve the Contractor of providing a Utah-compliant installation, with review and certification of a Utah-licensed Professional Engineer.

2.02 SEISMIC ANCHORING AND RESTRAINTS:

A. Equipment Anchors: Electrical equipment shall be securely anchored. Anchoring shall have the capability of withstanding seismic forces per Sections 13.3 and 13.4 of ASCE 7. Use Ip = 1.5, Site Class E.

B. Raceway Supports:

1. Seismically support raceway (conduit, cable tray, busway, etc.) of 2.5-inch inside diameter and larger and suspend 12 inches or more from the top of the raceway to the bottom of the support for the hanger. Raceway supports shall have the capability of withstanding seismic forces per Sections 13.3 and 13.4 of ASCE 7. Use Ip = 1.5, Site Class E.

2. Provide Kin-Line seismic bracing system, Midland Ross superstrut seismic restraint system, Cooper B-Line Seismic Bracing System, or equal. Install per manufacturer's requirements.

PART 3 - EXECUTION

3.01 EQUIPMENT AND RACEWAYS:

A. Install equipment anchors and raceway supports in accordance with the final shop drawing and manufacturer's recommendations. Properly torque all bolts to the required values.

3.02 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY:

A. Section Includes:

1. Identification of electrical materials, equipment, and installations.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. A13.1: Scheme for the Identification of Piping Systems

B. Institute of Electrical and Electronics Engineers (IEEE):

1. ANSI/IEEE C2: National Electrical Safety Code.

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

B. Product Data:

C. Submit for each type of product specified.

D. Samples: Submit for each color, lettering style, and or graphic representation required for identification materials; samples of labels and signs.

E. Miscellaneous: Schedule of identification nomenclature to be used for identification signs and labels.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

PART 2 - PRODUCTS

2.01 RACEWAY AND CABLE LABELS:

A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ASME A13.1, NFPA 70, or as specified elsewhere.

B. Components and installation shall comply with NFPA 70.

C. Conform to ASME A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.

1. Color: Black legend on orange field.

2. Legend: Indicates voltage.

D. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl. Legend is over-laminated with clear, wear and chemical resistant coating.

E. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color coded, acrylic bands sized to suit diameter of line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.

F. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inch wide.

G. Underground Line Warning Tape: Permanent, bright colored, continuous printed, vinyl tape with following features:

1. Size: Not less than 6 inch wide by 4 mils thick.

2. Compounded for permanent direct burial service.

3. Embedded continuous metallic strip or core.

4. Printed Legend: Indicates type of underground line.

H. Tape Markers: Vinyl or vinyl cloth, self-adhesive, wraparound type with preprinted numbers and letters.

I. Aluminum, Wraparound Marker Bands: Bands cut from 0.014 inch thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

J. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.

K. Aluminum Faced Card Stock Tags: Wear resistant, 18 point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch thick, laminated with moisture resistant acrylic adhesive, and punched for fastener. Preprinted legends suit each application.

L. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 by 2 inch by 0.05 inch.

2.02 FUSED EQUIPMENT LABELS

A. Provide UV-resistant engraved plastic or stainless steel label on equipment exterior. Provide label with 3/8-inch height text. If plastic, coloration is black legend on orange field.

B. Record fuse make and model for replacement fuses on label legend. Append "PER ARC FLASH / COORDINATION STUDY". Match fuse make and model to fuse determining Arc Flash boundaries and PPE in the required Electrical System Studies. Reference Specification 26 05 70, Electrical System Studies, and its deliverables for additional information.

2.03 ENGRAVED NAMEPLATES AND SIGNS:

A. Conform with Specification 22 05 53 requirements for Warning Signs and Labels, except:

1. Do not rivet nor screw into explosion-proof enclosures/equipment. Where labelling explosion-proof equipment, submit proposed adhesive and adhesion technique. Alternately, submit proposed material and technique to use stainless steel hardware to permanently affix labels to equipment, in accordance with explosion-proof enclosure/equipment manufacturer's instructions. Adhere labels to equipment with approved method.

2. Alternate Fasteners for Plastic Laminated and Metal Signs: Self tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts, flat washers and lock washers. (Or per Specification 22 05 53.)

B. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ASME A13.1, NFPA 70, or as specified elsewhere.

C. Engraving stock, melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, 1/8 inch thick for larger sizes.

D. Exterior signs are to be Metal Backed, Butyrate Signs: Wear resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396 inch, galvanized steel backing, with colors, legend, and size appropriate to application. 1/4-inch grommets in corners for mounting.

2.04 MISCELLANEOUS IDENTIFICATION PRODUCTS:

A. Cable Ties: Fungus-inert, self-extinguishing, 1 piece, self-locking, Type 6/6 nylon cable ties with following features:

1. Minimum Width: 3/16-inch.

2. Tensile Strength: 50 pound minimum.

3. Temperature Range: -40 to 185 degrees F.

4. Color: As indicated where used for color coding.

B. Paint: Alkyd-urethane enamel. Primer as recommended by enamel manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install identification devices according to manufacturer's written instructions.

B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and or designations used for electrical identification with corresponding designations used in Contract Documents or required by codes and standards. Use consistent designations throughout Project.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.

F. Install painted identification as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.

2. Prime Surfaces: For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.

3. Apply 1 intermediate and 1 finish coat of silicone alkyd enamel.

4. Apply primer and finish materials according to manufacturer's instructions.

G. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inch below finished grade. Where multiple lines installed in common trench or concrete envelope do not exceed an overall width of 16 inch, use single line marker.

1. Install line marker for underground wiring, both direct buried and in raceway.

H. Color Code Conductors: Secondary service, feeder, and branch circuit conductors throughout secondary electrical system.

1. Field applied, color coding methods may be used in lieu of factory coded wire for sizes larger than 10 AWG.

a. Colored, pressure sensitive plastic tape in half lapped turns for distance of 6 inch from terminal points and in boxes where splices or taps are made. Apply last 2 turns of tape with no tension to prevent possible unwinding. Use 1 inch wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.

b. Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 3 inch from terminal and spaced 3 inch apart. Apply with special tool or pliers, tighten to snug fit, and cut off excess length.

2. Reference Specification 26 05 20, Electric Wires and Cables, for power cable identification coloring.

I. Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, maintenance holes, and switchboard rooms.

1. Legend: 1/4-inch steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.

2. Fasten tags with nylon cable ties; fasten bands using integral ears.

J. Apply identification to conductors as follows:

1. Conductors to Be Extended in Future: Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.

K. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with accepted legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.

2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and or emergency operations.

L. Install identification as follows:

a. Panelboards, electrical cabinets, and enclosures.

b. Electrical substations.

c. Contactors.

d. Control devices.

e. Transformers.

2. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

3.02 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 70

ELECTRICAL SYSTEM STUDIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide electrical system studies as indicated and in compliance with Contract Documents, and as follows.

1. Provide a short circuit, protective device coordination and arc-flash study for the electrical distribution system constructed under this contract. The study shall consider the electrical utility system upstream protective devices down to circuits that neither exceed 250 Volts nor exceed protection of 30 Amperes. The study shall include calculations used to verify the short circuit ratings of the electrical distribution equipment to be provided under this contract and to identify the required settings of associated protective devices.

a. Provide a report summarizing the coordination study including: one-line of system, relay and breaker setting tabulation, relay, circuit breaker, and fuse protective device coordination and short circuit calculation, all prepared by an independent specialty firm. Device calibration and settings are to be based on the results of this coordination study, and based on manufacturer Time Coordination Curves for each overcurrent protective device provided.

B. Provide a complete electrical system voltage and current harmonics analysis study of the electrical system from the main distribution bus to each Variable Frequency Drive (VFD) distribution bus or point of common coupling (PCC). The study shall consider the harmonic contribution of all VFDs on the electrical system.

C. The Contractor shall employ the services of a specialty firm, subject to review, with the specified demonstrated capability for calibrating and setting protective devices as specified herein.

D. Changes and additions of equipment characteristics based on the actual equipment supplied may be suggested by the results of the short circuit and protective device coordination studies. Submit suggested changes and additions as a part of the study. Field settings of devices, adjustments, and minor modifications to equipment that are required to accomplish conformance with the accepted short circuit and protective device coordination studies shall be provided at no additional cost.

1.02 REFERENCES:

A. Institute of Electrical and Electronics Engineers (IEEE):

1. C37.010: Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

2. 242: IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

3. 519: IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power System.

4. 1584: IEEE Guide for Performing Arc-Flash Hazard Calculations

B. National Fire Protection Association (NFPA):

1. 70E: Standard for Electrical Safety Requirements for Employee Workplaces

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Qualifications of specialty testing and/or study firm, as specified.

2. Short circuit and protective device coordination study for review and acceptance, concurrent with the preliminary shop drawing submission for the main electrical distribution system equipment and overcurrent protective devices. Submit an initial study for comment and a final study, with all electronic files, at the completion of the project.

a. The study shall be performed using the latest edition of one of the following commercial software program.

(1) SKM PowerTools

(2) EasyPower

(3) EDSA Paladin

b. The study shall consider the effects of motor contribution during fault conditions, at various buses in the system.

(1) Consider both all-on and all-off motor scenarios.

(2) Consider available fault current from sources shown on the P&ID, including, but not limited to the generator system. Assume up to two engine generator units not running in at least one motors-off scenario.

c. Consider both the maximum and minimum available fault current from the supplying feeders, and actual impedance of the 13,800V-supplying transformer at the main plant. This includes maximum and minimum expected motor contribution from motors within the plant.

d. Include the following elements within the study:

e. Cable sizes

f. Cable lengths

g. Raceway types and associated impedances.

h. Field-Verified information, such as existing transformer impedances to be provided by the Contractor.

i. The maximum fault contribution at the incoming source(s) shall be documented via correspondence from the authority maintaining the main plant electrical system.

j. Transformer inrush points and damage curves shall be plotted on coordination curves, based on actual manufacturer data, not per approximations

k. Obtain from the engine generator supplier, reactance values, protective device type and data and generator decrement curves. Include all engine generator / alternator information as an appendix to these Electrical System Studies.

l. Plot on common 8.5”x11” drawings, single line diagrams and the curves for each protective device to verify proper selectivity and protection for all components of the system for both the normal utility and standby generator source. Label each device uniquely. Do not show more than 5 overcurrent protective devices in Time-Current Curves unless showing relationship between main breaker and load-side breakers within a single piece of electrical equipment.

m. Identify recommended settings for all devices.

n. Devices which do not provide full selectivity and coordination are not to be used as a recommended device in the study.

o. Submittals of electrical distribution equipment affected by the study are not to be submitted until successful review of this study. Submittal or procurement of equipment prior to review or prior to resolution of all review comments is at the Contractor’s risk, and increased costs due to premature ordering are the responsibility of the Contractor.

3. This study shall consider starting when the system is powered from the main plant while on utility feed, and from the standby generator sources.

4. Voltage and current total harmonic analysis study at points of common coupling with the main plant and main distribution buses for all facility supply modes. (i.e. “Plant Feed A”, “Plant Feed B”, “Backup Generators”)

5. After review of coordination study, the Contractor shall set all devices based on the study.

6. After review of the Arc Flash study, the Contractor shall apply Arc Flash Labels based on the study.

7. After review of the Arc Flash study, the Contractor shall apply fused equipment labels based on the study.

1.04 QUALIFICATIONS OF SPECIALTY FIRM:

A. Submit evidence of the following:

1. Firm's Experience:

a. Specialty firm shall have been in the business of the type of work specified, for at least the past five years.

b. The firm shall have a minimum of five projects of equal or greater size, service, and the type of equipment specified.

c. At least the following information must be submitted:

(1) The number of years the firm has been in the business of performing coordination studies.

(2) Summary of five previously performed studies including:

(a) A brief description of each study.

(b) Name of owner of installation on which study was performed with address, telephone number, and contact person.

(c) Date of study.

(3) List of projects and contact persons for which protective device settings were performed.

(4) Any other information indicating the firm's experience, ability to perform the work, and business status.

B. The work identified in this specification is to be conducted by, or supervised by, a Utah-license Professional Engineer specializing in Electrical Power systems. The final approved Electrical Systems Study is to bear the supervising Utah-licensed Professional Engineer's stamp.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 SHORT CIRCUIT STUDY:

A. Perform a short circuit study in accordance with ANSI Standard C37.010 to verify the adequacy and correct application of circuit protective devices and other electrical system components.

B. The study shall address the case when the system is being powered from the utility source as well as from the on-site generating facilities. Minimum and maximum possible fault conditions shall be covered in the study.

C. Include the fault contribution of all motors. Horsepower shown in the Contract Documents may be used to calculate fault contribution of motors. In the short circuit study regenerative VFDs shall be replaced by conductors of the same size as the branch circuit conductors.

D. Calculate short-circuit momentary duties and interrupting duties on the basis of an assumed bolted 3-phase short circuit at each bus. The short circuit tabulations shall include X/R ratios, asymmetry factors, kVA and symmetrical fault-current. Where ground fault protection is specified, provide a ground fault current study for the same system areas, including the associated zero sequence impedance diagram. Include in tabulation form, fault impedance, X/R ratios, asymmetry factors, motor contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.

E. The studies shall include representation of the site power system, the base quantities selected, impedance source data, calculation methods and tabulations, one-line diagrams, conclusions and recommendations.

3.02 PROTECTIVE DEVICE COORDINATION STUDY:

A. Provide a protective device time current coordination study with coordination plots of current limiting devices, plus tabulated data, including ratings and settings selected. In the study, balance shall be achieved between the competing objectives of protection and continuity of service (with emphasis on continuity of service) for the system specified, taking into account the basic factors of sensitivity, selectivity and speed.

B. Provide separate plots for utility and generator operation as applicable. Show maximum and minimum fault values in each case. Multiple power sources shown in one plot is not acceptable.

C. Each primary protective device required for a delta-to-wye-connected transformer shall be selected so the characteristic or operating band is within the transformer parameters. Separate low voltage circuit breakers from each other and the associated primary protective device, by a 16 percent current margin for coordination and protection in the event of line-to-line faults. Separate protective relays by a 0.4 second time margin, or larger, as required to assure fault-side protective devices have an opportunity to open and clear before tripping upstream device(s). The protective device characteristics or operating bands shall be terminated to reflect the actual symmetrical and asymmetrical fault-currents sensed by the device. Provide the coordination plots for 3 phase and phase-to-ground faults on a system basis. Include all devices down to largest branch circuit feeder circuit breaker. Include all adjustable setting ground fault protective devices.

D. Identify discrepancies in the conclusions and recommendations of the report. Upon resolution of discrepancies and recommendation, update all associated analyses and revise the affected studies.

E. The coordination plots shall graphically indicate the coordination proposed for the several systems centered on full scale log forms. The coordination plots shall include complete titles, representative one-line diagrams and legends, associated upstream power system relays, fuse or system characteristics, significant motor starting characteristics, significant generator characteristics, complete parameters for power, and substation transformers, complete operating bands for low voltage circuit breaker trip devices, fuses, and the associated system load protective devices. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time-dial settings and pick-up settings required. The short-time region shall indicate the relay instantaneous elements, the magnetizing inrush, and ANSI transformer damage curves, the low voltage circuit breaker and instantaneous trip devices, fuse manufacturing tolerance bands, and significant symmetrical and asymmetrical fault-currents.

F. The thermal limit of all feeder cables to each bus and large motors, where applicable in the study, shall be shown.

G. No more than six devices shall be shown on one coordination plot. Of these six curves, two (the largest upstream device and the smallest downstream device) shall repeat curves shown on other coordination plots in order to provide cross reference. Give each unique protective device curve in the study a study-unique number or letter identifier to permit cross reference between plots. Do not use identifier letters or numbers more than once.

H. Each primary protective device required for delta-wye connected transformer shall be selected so that the characteristic or operating band is within the transformer parameters,

which, where feasible, shall include a parameter equivalent to 58 percent of the ANSI withstand point to assure protection for secondary line-to-ground faults. Prioritize coordination and designed system capacity over protection for secondary line-to-ground faults.

I. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings. Include C.T. ratio, burden and all other calculations required for the determination of settings.

3.03 MOTOR STARTING/RUNNING STUDY:

A. Provide a motor starting study for all large electric motors and drives over 15 Hp in size to determine voltage dip or power inrush limitations at selected locations due to starting of motors. Define minimum system voltages and compare to standard equipment voltage capabilities.

B. Provide a complete independent set of current-time characteristic curves for all motors 100 hp and above indicating coordination between the protective relays and the thermal characteristics of the motor.

C. Obtain from the motor supplier the necessary information to perform the study. Certified curves for “Safe Time vs. Current at 100 percent Voltage” and “Accelerating Time vs. Current at 100 percent Voltage” are absolutely necessary and shall become part of the final report.

D. Provide recommended settings for all motor protective devices supplied under this contract.

3.04 HARMONIC ANALYSIS STUDY:

A. Provide a voltage and current total harmonic distortion analysis for the distribution system from the main distribution bus to each VFD distribution bus point of supply at the main plant switchboard (08-SWGR-99100A / 08-SWGR-99100B).

B. Obtain harmonic analyses and characteristics for each VFD, reactor and/or filters to be supplied for each drive from the Contractor.

C. Perform a system analyses to demonstrate not more than 5 percent THD voltage and current distortion at all distribution buses identified in the study.

D. Where THD is greater than 5 percent, provide recommendations to reduce distortion at one or more VFD units by the addition of filters and/or reactors.

E. The harmonics analysis shall be performed assuming the system transformers are 70 percent loaded.

3.05 ARC FLASH HAZARD ANALYSIS:

A. Perform arc flash hazard analysis for the following items:

1. Switchgear.

2. Switchboards.

3. Panelboards.

4. Control panels with voltage over 50 volts.

5. Motor control centers.

6. Transformers of 15kVA and larger

7. Motor Controllers

8. Disconnect switches and safety switches protected at 30 amps and above, or operating at over 600 volts.

B. Methods of performing analysis:

1. Provide calculations per IEEE 1584-2018, or latest version officially published by IEEE.

a. If the conditions fall within the IEEE 1584-2018 parameters use the IEEE 1584-2018 calculations based on actual OCPD curves and settings.

b. If the conditions do not fall within the IEEE 1584-2018 parameters, use the Lee method.

C. Label each item for which the calculations were performed with the following information:

1. Information required by 2021 NFPA 70E, 130.5(H)(2).

2. Arc Flash Boundary.

3. Limited approach boundary.

4. Restricted approach boundary.

5. Calculated Incident Energy in cal/cm^2.

6. Caption “WARNING - PERSONAL PROTECTIVE EQUIPMENT IS REQUIRED WITHIN ARC FLASH BOUNDARY!”

3.06 FIELD TESTING:

A. Provide in accordance with Section 01 78 25 and as specified.

B. Integrate results of this study with functional testing of the contract electrical equipment in accordance with Section 26 05 10.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 05 90

ELECTRICAL CONTROLS AND MISCELLANEOUS ELECTRICAL EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and connect the electrical control equipment and miscellaneous electrical equipment, including such instruments and devices indicated and specified. Device enclosures for electrical equipment as indicated and specified.

B. Control panel enclosures and devices specified herein are provided under those specification sections which invoke this section for control panel requirements or as indicated on electrical drawings.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. D178: Standard Specification for Rubber Insulating Matting

B. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 volts maximum)

2. ICS 1: Industrial Control and Systems General Requirements

3. ICS 2: Industrial Controls and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts

4. ICS 4: Terminal Blocks for Industrial Use

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

D. Underwriter's Laboratories, Inc. (UL):

1. 467: Standard for Grounding and Bonding Equipment

2. 486A: UL Standard for Safety Wire Connectors and Soldering Lugs for Use with Copper Conductors

3. 486B: UL Standard for Safety Wire Connectors for Use with Aluminum Conductors

4. 489: Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

5. 823: Standard for Safety Electric Heaters for Use in Hazardous (Classified) Locations.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

C. Wiring diagrams to show control interface points provided with other equipment.

D. Shop drawings to include:

1. Outline drawings with elevations

2. Equipment arrangement drawings

3. Anchor bolt location drawings

4. Electrical schematics and wiring diagrams

5. Electrical fuse/circuit breaker characteristic

6. Equipment performance curves and data

7. Bill of installation/assembly materials

8. Equipment weights

9. Completed manufacturer’s data sheets

10. Sustainable design submittals

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS FOR ELECTRICAL DISTRIBUTION EQUIPMENT:

A. Siemens

B. General Electric Company

C. Eaton/Cutler-Hammer

D. Square D Company

E. Appleton Electric Company

F. Crouse-Hinds Company

G. O-Z/Gedney

H. ABB

2.02 SAFETY DISCONNECT SWITCHES:

A. Provide heavy duty type, safety switches, with external operating handles, 3 PST, rated 600 volt, 60 Hertz with ampere rating as indicated, and having provisions for padlocking.

B. Provide fuses for safety switches as indicated.

C. Heavy duty safety switches to be UL listed, File E 2875 and 154828, and meet or exceed NEMA Standard KS1.

D. Provide auxiliary electrical interlocks for motor heaters or other motor control circuits, including auto-transformer starter, starter control where indicated.

2.03 CONDUIT AND WIRING:

A. Provide conduit and wiring necessary to make connections between instrument panels, consoles, cabinets and external equipment and devices.

2.04 PUSHBUTTON AND SELECTOR SWITCH STATIONS:

A. Provide HAND-OFF-AUTO switches, push buttons, tumbler switches and other accessory devices as necessary for the control of motors and other electrical equipment or devices.

B. Provide pushbutton and selector switch stations designed for heavy-duty service and with momentary or maintaining contacts as indicated or as necessary for starting and stopping of equipment with 10 amp contact ratings.

C. Provide heavy duty switches and pushbuttons, Square D Company, Class 9001. Indicating lights to be led cluster type.

D. At stations provide nameplates with white letters on black background.

E. Provide safety lockout station with position indication located near motor to prevent application of current. Where pumps are located on lower levels than driving motors, furnish safety lockout station near each pump or other item of equipment.

F. Rate explosion-proof stations for the Group, Division and Class as indicated.

G. Provide galvanized cast iron enclosures for NEMA Type 4 watertight stations.

H. Provide fiberglass reinforced polyester NEMA Type 4X enclosures for stations located in highly corrosive areas. Provide gaskets and Type 316 stainless steel screws, to prevent entry of chemicals.

2.05 WALL MOUNTED COMBINATION STARTERS:

A. Unless otherwise indicated, provide each combination starter with motor circuit protector and full voltage magnetic starter. Provide starters in an enclosure that meets the requirements of the enclosure schedule. Provide motor circuit protectors and starters as specified in Section 26 24 19.

2.06 WALL MOUNTED CIRCUIT BREAKERS:

A. Provide manually operated circuit breakers, ambient compensated, providing thermal magnetic inverse time limit overload and instantaneous short circuit protection. Provide overload protection on all poles; trip settings as indicated.

B. Provide circuit breakers as specified under Section 26 24 19.

C. Provide circuit breakers housed in NEMA type enclosure indicated, having external operating handles with provisions for padlocking.

2.07 CONTROL PANELS AND ELECTRICAL ENCLOSURES:

A. Manufacturers:

1. McKinstry Incorporated

2. Hoffman, Inc.

3. Hammond Manufacturing

B. Provide control panels for motors and other equipment, as indicated. Ensure that dimensions, NEMA rating, construction and mounting of equipment are as indicated.

C. Provide enclosures with back panels constructed of at least 14 gage steel and provided with terminal blocks for connection of external wiring. Provide door and body stiffeners in panels over 36 inches in length. NEMA 4 and NEMA 4X panels to be provided with hand operated quick disconnects of stainless steel material.

D. Provide UL listed and NEMA rated pushbuttons, indicator lights and switches of heavy duty, oil tight types. Provide relays of industrial types, with 120 volt, 60 Hertz operating coils, and contacts rated for intended service. Power from fused control power transformers.

E. Provide nameplates for each panel and each device on panel. Nameplates of laminated plastic material, at least 3/32-inch thick, and with white letters on a black background.

F. Secure nameplates with self-tapping, Type 316 stainless steel metal screws.

G. Terminal Blocks:

1. Provide terminal blocks rated for 600 volts with screw type terminals

2. Terminal blocks to be one piece with full barriers

3. Provide General Electric EB-25 terminal blocks or equal

H. Provide print pocket on inside of enclosure and include record drawings for Owner's use.

I. Where 480 volts AC and 120 volts AC are required within the same enclosure, install components to insure separation of wiring for the panel voltage circuits.

J. Enclosures and panels located outdoors shall be provided with heaters and thermostats. Enclosures less than 24 inch high shall be provided with strip heaters and encapsulated leads. Enclosures 24 inch high and larger shall be provided with forced air heaters with thermostats as manufactured by Hoffman. Thermostats shall be provided with a range of 40 degrees F to at least 60 degrees F.

K. Enclosures 24 inch or larger shall be provided with light fixtures, light switch and 20 amp GFI protected receptacle. Light fixtures shall be UL listed for wet locations and provided with glass globe, metal guard and 100 watt incandescent lamp.

L. Where visual strobe or warning lamps are required, provide heavy duty beacon, Edwards Signal Catalogue No. 93.

M. Where audible horn alarms are required, provide Edwards Signal 870P.

N. Where equipment and devices are to be installed in hazardous locations, provide equipment and components suitable for the environment.

O. Where intrinsically safe wiring is required within the panels, the following requirements shall be met:

1. Within enclosures, conductors or intrinsically safe (IS) circuits shall be separated at least two inches from conductors of any non-intrinsically safe circuit. Within the enclosure the conductors shall be secured.

2. Intrinsically safe wiring shall not be routed in the same conduit as non-IS wiring.

3. Terminals in panels with IS wiring shall be identified in a manner that will prevent unintentional interference with the control circuits during testing and servicing.

P. All indicating lamps to be LED cluster type.

2.08 RUBBER MATS:

A. Rubber mats are not required.

2.09 CONTACTORS AND RELAYS:

A. Provide mechanically held, heavy duty type contactors (relays) for lighting control, rated 30 amps, 600 volts, with number of poles as indicated.

B. Provide contactor in the required NEMA enclosure suitable for wall mounting. Provide circuit breaker or fuse protection on each ungrounded pole. Provide contactor similar to Square D Company, Class 8903, Type LX.

C. Provide control power transformer with primary and secondary fuse protection. Control power to be 120 volts, single phase.

D. Provide timing relays by Allen Bradley, Series 700.

E. Provide industrial grade relays, NEMA rated, Square D Company, Class 8501.

PART 3 - EXECUTION

3.01 WIRING OF MISCELLANEOUS DEVICES:

A. Make electrical connections required for recording and indicating instruments, and miscellaneous devices. Provide electrical supplies to metering, instrumentation, control, and alarm systems. Provide dedicated fuse and power from switchgear battery system where supplying such devices associated with protective devices within a switchgear. Provide surge protection for battery power system where CTs or other protective devices are located outside of the building that encloses the switchgear.

B. Connect HAND-OFF-AUTO switches, safety switches, tumbler switches, and other accessory devices as indicated or necessary for control of motors and other electrical equipment or devices.

C. Install conduit and wiring and make electrical connections between all instrument panels, consoles, cabinets, and external equipment and devices.

3.02 WIRING OF EQUIPMENT FURNISHED UNDER OTHER SECTIONS:

A. As specified in Section 26 05 00, install conduit, wiring, and connections for equipment and devices furnished under other Sections of specifications, and as indicated.

B. Unless otherwise indicated, control equipment, relays, control wiring, conduit, and connections for control of heating, ventilating, and air conditioning systems are provided as specified in Division 23. Refer to mechanical specifications and drawings for locations of pressure-operated control switches, float switches, butterfly valves, solenoid operated valves, sump pumps, metering instruments, control panels, alarm actuating contacts, indicating lamps, limit switches, and other devices requiring wiring or interconnections with equipment supplied under Electrical Sections of these specifications.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 08 10

ELECTRICAL SYSTEM DEMONSTRATIONS

PART 1 - GENERAL

1.01 SUMMARY:

A. Demonstrate proper operation of electrical systems and equipment in presence of Engineer.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Demonstration log

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 PERFORMANCE:

A. Demonstrations:

1. Each piece of equipment

2. Each integrated system

B. Demonstration Log:

1. Keep log of individual demonstrations

2. Data:

a. Date and time of demonstration

b. Owner's representative

c. Equipment or system demonstrated

d. Result of demonstration.

(1) Success or fail

(2) If failure, description of failure

(3) Corrective action taken

(4) New demonstration result

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 08 13

FIELD INSPECTION AND ACCEPTANCE TESTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Perform electrical system tests to demonstrate that each component of each system is in proper working order and in accordance with applicable codes, manufacturer's instructions, drawings and specifications. Tests are in addition to, and no substitution for, factory tests of individual equipment.

1. Perform insulation and ground resistance tests before operating tests.

2. Determine proper rotation of motors before permanent connections are made.

3. Perform tests at first overcurrent protective device after a separately-derived source to assure no neutral-to-ground faults nor no line-to-ground faults. Do not energize system before performing this test in a witnessed condition, with no faults identified.

4. All of these tests shall be witnessed by the Owner and/or the Owner’s Engineer, or their representatives, at the Owner’s option. Repeat this test as requested by Owner’s or Engineer’s representative.

B. Testing shall be performed to:

1. Provide initial acceptance tests and recorded data that can be used as a bench mark for future routine maintenance and troubleshooting by facility operating staff.

2. Ensure a successful start-up with a minimum of last minute interruptions and problems.

3. Determine the suitability of the equipment and systems for energization and placing into operating service.

4. Provide assurance that each system component is not only installed satisfactorily but performs, and will continue to perform, its function in the system with reasonable reliability throughout the life of the facility.

C. Provide all supervision and labor, materials, tools, test instruments or other equipment or services and expenses required to test, adjust, set, calibrate, functionally and operationally check all work and components of the various electrical systems and circuitry throughout the installation. Provide sufficient personnel to assist in any

additional checks they may require for acceptance, start-up, run-in and placing the equipment and systems into continuous service.

D. The Contractor shall engage the services of a competent nationally recognized independent electrical equipment testing firm to perform specified field inspections, tests, and adjustments firm. The testing firm shall not be a subsidiary, division, nor department of either the installing Contractor or the manufacturer of the equipment materials or systems being inspected and tested. The testing firm shall be a fully accredited member of the International Electrical Testing Association, Incorporated (NETA), or an approved equal, and have the specialized experience and skill in the supervision and performance of all inspection and testing specified herein.

E. The testing firm shall perform the specified activities prior to the start-up and completion of the work identified in the Contract Documents.

F. The tests and inspections performed shall in no way relieve the Contractor of the responsibility for the performance of the tests, check outs, and inspections specified under other sections of the specification during construction.

G. The listings and descriptions of the tests, and checks described herein shall not be considered as complete and all inclusive. Additional normal standard construction (and sometimes repetitive) checks and tests may be necessary throughout the job, prior to final acceptance by the Owner.

H. Pay all costs for tests including expenses incident to retests occasioned by defects and failures of equipment to meet specifications.

1. Replace wiring and equipment found defective, or failing to meet specified requirements, without charge, unless written acceptance for repair is given by Engineer.

2. Unless otherwise specified, the Owner will supply electric power necessary for tests.

1.02 REFERENCES:

A. All inspections and tests shall be in accordance with the following applicable codes and standards latest revisions except as provided otherwise herein.

1. All Standard, Special and Supplemental Conditions of the Contract

2. Association of Edison Illuminating Companies (AEIC)

3. American National Standards Institute (ANSI):

a. Z244-1: American National Standard for Personnel Protection

4. ASTM International (ASTM)

5. Insulated Cable Engineers Association (ICEA)

6. Institute of Electrical and Electronic Engineers (IEEE):

   a. C2: National Electrical Safety Code

7. National Electrical Manufacturer's Association (NEMA)

8. International Electrical Testing Association (NETA):

   a. ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

9. National Fire Protection Association (NFPA):

   a. 70: National Electrical Code

   b. 70B: Electrical Equipment Maintenance

   c. 70E: Electrical Safety Requirements for Employer Workplaces

   d. 101: Life Safety Code

   e. 780: Lightning Protection Code

10. Occupational Safety and Health Administration (OSHA):

    a. Part 1926; Subpart V, 1926.950 through 1926.960

11. State and Local Codes and Ordinances

B. All inspections and tests shall utilize the following references:

1. Project Design Specifications

2. Project Design Drawings

3. Project Electrical System Studies

4. Manufacturer's instruction manuals applicable to each particular apparatus

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Submit test plans and test data in accordance with the requirements of Section 26 05 10.

2. Submit evidence of NETA membership, or an approved equal, experience and staff qualifications of the independent testing firm.

3. Submit in 3-ring notebook, test plans for each system and piece of equipment to be inspected and tested. Provide sample test data sheets with blanks identified where test data will be recorded, test instrument identification, calibration date, and blanks provided to identify the person performing the test and the person witnessing the test.

4. Submit test results.

1.04 SCHEDULING:

A. The Contractor shall be responsible for the preparation of proposed procedures and schedules for all inspections, tests, settings and calibrations specified or otherwise required prior to or during the check out for start-up and acceptance of all the electrical components, equipment and systems. This work shall be coordinated and to be compatible with both the work of other crafts and the project schedule. The above must be organized and submitted with all proposed testing and check out forms. The procedures shall provide specific instructions for the checking and testing of each component in addition to the system functional checks. Tests and inspections shall be scheduled as the job progresses and may require repetition in greater detail at a later stage of construction. All procedures submitted shall include job safety rules proposed.

B. Equipment shall be inspected and tested to determine its condition. See other applicable sections of the specifications and contract documents for required checks and responsibilities.

C. At any stage of construction and when observed, any electrical equipment or system determined to be damaged, faulty, or requiring repairs shall be reported to the Engineer. Corrective action may require prior approval.

D. Prior to check out and testing for start-up, ensure that all equipment and wiring is properly and permanently identified with nameplates and other identification as specified elsewhere. Check and tighten all terminals and connection points, remove all shipping blocks and hardware, thoroughly clean all equipment, repair all damaged or scratched finishes, inspect for broken and missing parts and review and collect manufacturer's drawings and instructions for submittal to the Engineer. Make routine checks and tests as the job progresses and as necessary to insure that all wiring and equipment is properly installed and wired.

E. All testing and checkout work shall be performed with fully qualified personnel skilled in the particular tests being conducted. This is essential for obtaining and properly evaluating data while the tests are in progress and for insuring that important facts and questionable data are reported.

F. All inspections, tests, and calibrations shall be reported in writing on forms submitted for review under Submittals. The recorded data form shall have the signatures of the persons conducting the tests and authorized witnesses. The forms shall be designed to serve as the test and inspection checklist for inspection requirements. "As-found" and "as-left" test data shall be recorded and reported in writing.

G. The sequence of all tests and checks shall be such that the equipment can be energized immediately after the completion of the applicable tests.

H. When applicable electrical tests and inspections specified herein, or otherwise required are completed and results reported and reviewed then the Contractor may consider that portion of the electrical equipment system or installation electrically complete. The Contractor shall then affix appropriate dated completion and calibration labels to the tested equipment. The Contractor shall notify the Engineer and Owner of electrical completion. If the Engineer or Owner finds completed work unacceptable, the Contractor will be notified in writing of the unfinished or deficient work which shall be corrected by the Contractor. The Contractor shall notify the Engineer in writing when all exceptions have been corrected. If later in-service operation or further testing determines problems attributable to the Contractor, these shall be corrected by the Contractor or suitable arrangements shall be made to suit operating circumstances.

PART 2 - PRODUCTS

2.01 TESTING EQUIPMENT:

A. Calibration:

1. Furnish all material, test equipment, and power sources required for testing, calibrating and check out. All calibration and setting checks by the independent testing laboratory shall be performed with laboratory calibrated test instruments of appropriate accuracy. This test equipment shall have calibrations traceable to the National Bureau of Standards. Testing laboratory dated calibration labels shall be visible on all test equipment. Calibrations over 6 months old will not be acceptable on field test instruments. The accuracy of all test instruments shall be at least twice that of the accuracy of the equipment, device, relay or meter under test. All testing instruments shall be checked to insure satisfactory operation prior to proceeding with the tests. Serial and model numbers of the instruments used shall be recorded on the test forms.

2. Make necessary openings in circuits for testing instruments and place and connect all instruments, equipment, and devices, necessary for the tests. Upon completion of tests, remove instruments and instrument connections and restore all circuits to permanent condition.

2.02 TESTING:

A. Coordination:

1. Coordinate activities, and cooperate with others on project, to ensure that systems are energized when required, loads applied, and other requirements of Section are carried out on timely, coordinated basis.

2. Conduct tests in presence of Engineer unless waived by the Engineer. Notify Engineer seven calendar days or more in advance when any test to be performed, and do not start tests without Engineer's permission.

3. Other Sections of specifications require services of one or more manufacturer's representatives, to ensure that equipment supplied has been installed properly and adjusted to proper working order. Advise representative of all applicable tests in this section, so that work will be coordinated, and tests combined where feasible.

4. It is important that equipment warranties or guarantees not be voided by testing and checkout work. The checks and tests to normally be supplemental to and compatible with the manufacturer's installation instruction leaflets and literature. Where deviations are apparent, the manufacturer's review shall be obtained prior to testing. Reasonable cooperation shall be extended to permit witnessing by the manufacturer's representative if so requested. Where any questionable repairs, modifications, significant adjustments, tests or checks are to be made, the Contractor shall contact the Engineer to determine if the work should be performed by or with the manufacturer's representative.

B. Preparation:

1. Make up no high and/or medium-voltage connections at service entrance, transformers, substations, motors, medium voltage motor control centers, switchgear and generator permanently until correct phase rotation of all equipment is determined. Install and insulate these connections temporarily, if necessary, while determining proper rotation. Make permanent connections after proper rotation has been established and subsequent to completion of insulation resistance and dielectric tests.

PART 3 - EXECUTION

3.01 INSULATION TESTS OF EQUIPMENT, CABLE, AND CIRCUITS:

A. General:

1. Perform DC insulation tests of the type specified on electrical equipment, apparatus and cables under any one or more of the conditions described as follows: At the time equipment such as motors, generators, transformers, power circuit

breakers and switches, switchgear, motor control centers, bus duct, and similar electrical equipment is:

a. Delivered to the site for care, storage, and/or installation,

b. Prior to energization and/or placing into service and acceptance by the Owner,

c. When damage to the insulation is suspected or known to exist,

d. After repairs or modifications to the equipment affecting the insulation,

e. Routinely as necessary to determine or evaluate the condition of the insulation, especially moisture conditions, to determine the need for drying, cleaning or other maintenance work or protection,

f. Where lightning or other surge conditions are known to have existed on the circuit.

2. Insulation tests are required to be performed by the testing firm at various stages of construction. The equipment, cable and systems that require testing, the maximum test voltages, and the type tests required shall be in accordance with the applicable paragraphs of NETA, or an approved equal.

3. List each circuit and measured resistance as test data.

4. Maintain record of all insulation resistance values. Identify conductor, or equipment, date that value was taken and resistance value. Arrange information in suitable neat tabular form and submit to Engineer.

3.02 SPECIFIC TESTS AND INSPECTIONS BY THE CONTRACTOR:

A. General:

1. The following specific items of work shall be performed by the Contractor. The list is not all inclusive, nor does it define how the tests and checks are to be made. Refer to applicable sections of NETA, or an approved equal, and equipment specifications for additional details. The equipment and cable shall be deenergized and isolated as necessary to perform the tests.

2. The engagement of the independent testing firm in no way relieves the Contractor of the responsibility for, or diminishes the importance of, performance tests, checkouts, and inspections during the various stages of construction. The specific work of the independent test firm is defined in Paragraph 3.03.

3. The Contractor shall perform all tests and inspections as defined in the other sections of this specification. Tests and inspections required by these sections are not necessarily repeated under specific equipment in Paragraph 3.02.

4. All equipment received for the job and for which the Contractor is responsible to be stored and cared for per the manufacturer's instructions. It is the Contractor's responsibility to obtain such information even where the instructions are not shipped with the equipment.

5. The Contractor shall assist the independent test laboratory in performing its work.

B. Equipment Test and Inspection During Construction and Prior to Acceptance Testing:

1. Motors (5 Hp and larger):

a. At the time of motor receipt, each motor shall be visually inspected for any physical damage and the motor meggered as described in Paragraph 1.e below.

b. All voltage motors shall be provided with adequate heating during storage. See Paragraph 3.01 for additional insulation tests for all motors of different voltages.

c. Before energizing any machine, visually inspect for serviceability. Check manufacturer's instruction manual for correct lubrication and ventilation. Verify that proper alignment has been performed. Check nameplate for electrical power requirements.

d. Test run all motors preferably uncoupled or unloaded, before placing into regular service. A check on the motor for rotation, speed, current and temperature rise to be made and results recorded. The proper color codes for phase identifications to be maintained. This may require lead swaps at the motor for proper rotation. A motor phase rotation meter shall be used prior to connection at motor to prevent later swaps.

e. Complete visual inspection and electrical tests (including optionally listed tests) per NETA ATS Section 7.15.1, (or the equivalent standard from an approved equal).

2. Medium Voltage Switchgear, Medium Voltage Motor Controllers and Medium Voltage Switches:

a. At the time of equipment receipt, the exterior shall be visually checked for any damage and the interior checked for damaged or loose components with special attention to insulators.

b. Prior to connecting cable leads to the equipment, internal bus bars and power connection shall be megger tested. If moisture is a problem, the equipment may have to be dried out before going into service. If the insulation resistance between conductors and ground reads below 50 megohms with the

fuses or current breakers removed, moisture, dirt or other contaminants may be a problem.

c. Cable phasing and identification to be checked prior to connecting cable leads.

d. Check to insure proper fuse sizes and settings of overload elements or relays in control centers.

e. Physically and functionally check all control circuits and devices and key, mechanical, and/or electrical interlock system. Alignment of circuit breaker elements or motor controllers with fixed connections in cubicles to be checked for ease of insertion and withdrawal.

f. Motor controllers, medium voltage switches, and disconnects shall be checked for proper fuse sizes and types and the information recorded and properly reported on the forms.

g. Check all bolted bus joints and all other power and control terminal connections. Calibrated torque wrench methods in accordance with manufacturer's instructions to be used on bus connections or where needed.

h. Complete inspection and electrical tests requirements per NETA ATS, (or the equivalent standard from an approved equal):

(1) Section 7.1: Metal Enclosed Switchgear and Switchboard Assemblies

(2) Section 7.5: Switches

(3) Section 7.6: Circuit Breakers

(4) Section 7.19: Surge Arresters

(5) Section 7.10: Instrument Transformers

(6) Section 7.11: Metering Devices

3. Grounding Systems:

a. All grounding loops and major equipment grounds shall be tested to remote earth or directly referenced to an extremely low resistance (approximately 1 ohm) reference ground bench mark. Visual inspection of all systems, raceway and equipment grounds shall be made to determine the adequacy and integrity of the grounding. All ground testing results shall be properly recorded, witnessed, and submitted.

b. Ground tests shall be performed in accordance with NETA ATS, Section 8.13 using a J. G. Biddle Company low resistance, Null balance type, ground testing with ‘ohmmeter with test lead compensation in place. (Or the equivalent standard from an approved equal.) The test instrument shall be the type which compensates for potential and current rod resistances.

c. Test each ground rod and submit tabulation of results to Engineer. Include identification of electrode, date of reading and ground resistance value in results.

d. Test each entire grounding system for continuity of connections and for resistance. Ensure that ground resistance of conduits, equipment cases, and supporting frames does not vary appreciably from that of system as whole and does not exceed 5 Ohms.

e. Where ground test results indicate the need for additional grounding conductors or rods that are not indicated on drawings or specified, additional grounding provisions shall be initiated to obtain the acceptable values. The Contractor shall be responsible for the proper installation of the grounding shown on drawings or specified and for the correction of improper installations as determined by inspections and tests.

4. Power Transformers:

a. At the time of equipment receipt, the exterior to be visually checked for any damage or any defects.

b. Perform complete inspection and electrical tests in accordance with NETA ATS, Section 7.2. (Or the equivalent standard from an approved equal).

5. Low Voltage Switchgear: Refer to NETA ATS, Section 7.2. (Or the equivalent standard from an approved equal). Perform all applicable tests and checks as described in NETA ATS, Section 7.2. (Or the equivalent standard from an approved equal).

6. Protective Relays and Metering:

a. Prior to final check out as described in Paragraph 3.03, visually inspect and correct, where appropriate, all relays, meters, wiring and related circuitry for tightness of connections, physical damage, compliance with specifications and Vendor data, mechanical condition, freedom of movement, and presence of or possibility of moisture, dust, or other contaminants.

b. Clean, check, and pre-set all protective relays. Final calibration and adjustment, etc., shall be by the independent testing firm. Refer to Paragraph 3.03.

c. Complete inspection and electrical tests per NETA ATS, Section 7.9. (Or the equivalent standard from an approved equal).

7. Low Voltage Motor Control Centers:

a. At the time of equipment receipt, the motor control centers shall be visually checked for any damage.

b. Perform inspection checks and electrical tests in accordance with NETA ATS, Section 7.16.2. (Or the equivalent standard from an approved equal).

C. Bus Ducts:

1. At time of equipment receipt, the exterior and bus work shall be visually inspected for any damage.

2. Perform inspection checks and electrical tests in accordance with NETA ATS, Section 7.4. (Or the equivalent standard from an approved equal).

D. Distribution Transformers:

1. All 480 volt primary, air-cooled, transformers shall be given an insulation test, by means of a megger, after connections with the primary cables are complete. The supply cable shall be meggered with the primary winding and to the open-air circuit breaker. Secondary leads may be meggered with the secondary windings to the open load breakers.

2. Continuity and correctness of connections of all windings, and ratings shall be checked.

3. Perform inspection checks, and electrical tests in accordance with NETA ATS, Section 7.2.3. (Or the equivalent standard from an approved equal).

E. Wire and Cable:

1. Before energizing, the continuity and insulation resistance of every circuit external to equipment shall be measured with a megger from each wire to all others and ground and test results recorded on forms. Tests shall normally be conducted at voltages 500 volts or lower. High potential testing will normally be performed by the independent testing laboratory as described in Paragraph 3.03.

2. Insulation resistance measurements shall be taken of the following: (Refer to Paragraph 3.01 for additional information.)

a. Motor Feeders: With motors disconnected, measure and record insulation resistance from load side of contactors or circuit breakers. Repeat this test after motors are connected and just before energizing at lower voltage as limited by the maximum test voltage for the motor.

b. Motor Control Circuits (600 Volts): With push buttons and overcurrent devices connected, measure and record insulation resistance from phase to ground only. It will be necessary to lift the neutral ground on the control transformers to perform this test. Also, isolate any control elements that should not be meggered.

c. Lighting Panel Feeders And Distribution Panel Feeders: Measure and record insulation resistance with circuit breakers, lighting transformers and panelboards connected, but with lighting branch circuit breakers or switches open.

d. Lighting Branch Circuits: Measure and record insulation resistance after all lampholders, receptacles, fixtures, etc., are connected but before lamping.

e. Feeder Circuits: Measure and record insulation resistance with connections to circuit breakers made up but with breakers open and loads not connected.

3. All cables and wires shall be checked for proper identification numbering and/or color coding.

F. Overhead Conduit Systems:

1. The overhead conduit system shall be checked for proper installation by using the following check list: (This list not to be considered all-inclusive but as a guide for inspection).

a. Conduits are supported on appropriate independent supports (i.e., not on process piping, pipe ways, or piping hangers).

b. Exposed conduits are run in a neat workmanlike manner, parallel or perpendicular to structural members.

c. Conduits are routed as far away from possible fire hazards and heat sources as practical.

d. Conduits are supported at the required intervals.

e. Pull boxes and fittings are installed so that covers are easily removable. Verify that all covers are installed and tightly bolted with gaskets provided where needed.

f. Number of bends in the conduit does not exceed 270 degrees without a pull box installed.

g. Circular cross sectional area is uniform at conduit bends. Single bends do not exceed 90 degrees.

h. Conduits are terminated in threaded hubs or bushings to prevent damage to wire.

i. Conduits joints have joint compound of the type specified and are tight and conduit ends are properly reamed and threaded not to engage less than 5 threads.

j. Pull fittings are of adequate size such that cable can be installed and replaced at a later date without the bending radius of the cable being less than code or manufacturer's requirements.

k. Seal fittings and/or sealing compound is installed at moisture barriers to prevent entry of moisture into equipment and/or where shown on plans.

l. Drains and conduit seals are installed on vertical conduit runs entering devices, equipment, and enclosures to prevent entrance of moisture.

m. Flexible conduit is installed at motors and other equipment as specified or required. Verify that all cabling and conduit runs are properly identified at each end.

G. Underground Conduit Systems:

1. Underground conduit systems shall be inspected and checked for compliance with standard practices, plans and specifications as the job progresses.

2. Upon construction completion of the underground conduit banks or runs and prior to backfill, the routing and the elevation and depth below grade shall be checked and any deviations from plans and/or specification to be recorded and in addition noted on record drawings.

H. Relay Panels, Operator and Instrument Control Panels, Communications Systems, Static Equipment, Programmable Controllers, Micro-Processors, Battery Systems and Other Miscellaneous Equipment:

1. Upon receipt of equipment, each item shall be inspected for damage, loose or missing parts.

2. Upon completion of equipment installation, all equipment and their control devices shall be visually and functionally tested for tightness of connections and for proper operation. In the case of battery systems, static inverters and the like, manufacturer's recommended test and installation manuals shall be reviewed and complied with. In the case of operator, instrument, and relay panels and cabinets or devices used solely for control, each circuit, where possible, shall be functionally tested for proper operation and conformance with drawings. Where functional testing is deemed undesirable by the Owner's Representative from a safety or plant operational standpoint, then continuity and terminal connection

verification checks will be adequate. The Contractor shall insure that instruments and associated components cannot be energized until instructed by the Owner's Representative. For functional, operational, and calibration checks of instrument loops, refer to the instrument installation specifications.

3. Panelboard electrical checks shall be as included in the Wire and Cable section of this specification, Paragraph 3.02.E. Panelboards to be checked for proper circuit identification on the door schedule.

I. Sealing of Openings: The Contractor shall inspect the entire job with the Engineer to insure that all openings are properly sealed as specified elsewhere.

J. Record Drawings: The Contractor shall maintain a master set or record drawings that show changes and any other deviations from the base drawing. The markups shall be made as the changes are done. At the conclusions of the job, these master record drawings shall be complete and delivered to the Owner's Representative for forwarding to the design group.

3.03 SPECIFIC TESTS AND INSPECTIONS BY THE INDEPENDENT TESTING FIRM:

A. The following specific items of work shall be performed by the independent testing firm, (see Paragraph 1.01.D.) The list is not all inclusive, nor does it define how the tests and checks are to be made. It is merely to define the minimum and type of tests that are required. For additional and supplementary requirements, refer to Paragraph 1.02.

B. Protective Relays and Metering:

1. Check, clean, set, calibrate and adjust all protective relays. Settings will be provided by the Contractor and reviewed by the Engineer prior to setting. Determine pickups, timing, seal-in and target operations. Check several points on the curves.

2. Check, calibrate and adjust all meters.

3. Visually inspect and correct where appropriate, all relays, meters, wiring and related circuitry for physical damage, shipping blocks, compliance with specification and vendor data, mechanical condition, freedom of movement, and presence or possibility of moisture, dust, or other contaminants.

4. Insulation resistance tests shall be made on this circuitry only where recommended by the manufacturer.

5. Simulated fault or other conditions at current transformers and voltage transformers, or initiating contacts shall be made where appropriate or necessary to assure the protective device function or characteristic and operation in the circuitry. Functional tests in the circuitry to verify tripping and operation shall be made in virtually all cases.

6. At the conclusion of tests and after placing into operating service under load conditions, measure and record all currents, voltages and phase angles at the terminals of all protective relays in medium and low voltage switchgear. Verify that all shorts are removed from current transformers where appropriate.

C. Medium Voltage Switchgear:

1. Check, set, calibrate and adjust all relays and meters as previously specified in Paragraph B.2, Protective Relays and Metering, and in addition, all power circuit breakers.

2. Perform DC insulation over-potential proof tests on medium voltage components of the system such as bus and breakers. This shall normally be done with the manufacturer's representative present. Lower voltage megger insulation tests to always precede the application of the proof test voltages to determine suitability for application of the higher voltages. Maximum test voltages to be as specified elsewhere. Breaker tests shall be performed with the breaker open and also closed.

3. Inspect switchgear and breaker for physical damage, tightness of connections, contact resistance, mechanical conditions, anchorage and alignment, shipping blocks, freedom of movement and operation, cleanliness and other installation and maintenance checks called for in manufacturer's instructions.

4. Bolted bus joints shall be inspected and tested by calibrated torque wrench methods in accordance with manufacturer's instructions.

5. Functionally and operationally test all devices, equipment and circuitry.

6. Physically and functionally check all key, electrical, mechanical or other interlock systems.

7. A ratio and polarity test shall be made of all current transformers (CTs) and potential transformers (PTs). Remove any CT shorts at the units or on terminal blocks. Perform complete wire tracing and continuity checks of all CT and PT wiring within the gear. Relaying and synchronizing circuits shall be given special attention to assure proper connections, phasing and operations.

D. Low Voltage Switchgear:

1. Perform all tests, calibration settings, inspections and adjustments as described under Paragraph C, Medium Voltage Switchgear. The DC over-potential proof tests shall be performed with a Biddle instrument at the maximum voltage specified elsewhere for 480 volt equipment.

E. Low Voltage Motor Control Centers:

1. No work by the independent testing firm is required on low voltage (600 volts and less) motor controls.

F. Molded Case Breakers:

1. No testing or checks of molded case circuit breakers is required by the independent testing firm.

G. Thermographic (Infrared) Surveys:

1. After the equipment has been placed in service, infrared surveys shall be performed on all designated electrical system apparatus specified below. The survey shall be performed with all apparatus energized and under full or normal load conditions. The survey shall include all connections and joints. Access covers and doors shall be removed or opened from all apparatus for the purpose of the survey. The survey shall consist of an on-site inspection performed by competent field engineering personnel using portable, imaging-display infrared camera equipment to locate and recommend corrective measures for overheated electrical connections, splices, taps, conductors and other abnormally hot items of apparatus, or portions thereof, that are a part of the designated apparatus.

2. The infrared survey documentation shall include a survey summary as well as detailed inspection reports containing photographic records of significant problems found, problem cause(s), required corrective action(s) and recommendations as to how promptly corrective action(s) should be taken.

3. The infrared camera equipment used shall be of the fully portable, image display type with photographic camera attached unit, and be capable of measuring apparatus temperatures with an accuracy of plus or minus 0.25 degrees C. at 30 degree object temperature. The testing firm and its assigned field engineer shall be regularly engaged in this type of work, to have prior experience in the use of the infrared camera equipment for this kind of application and to also be experienced in the normal inspection and test, of the electrical apparatus to be surveyed.

H. Electrical system apparatus to be surveyed to include:

1. Medium 15 kV, 5 kV, and low 480 voltage switchgear and breakers and disconnects and low voltage (480 volt) motor controls.

2. Small service transformers, and power transformers.

3. Power distribution panels and centers.

4. Variable speed AC drive controls and equipment.

5. Lightning arresters.

6. Rotating equipment.

3.04 LOSS OF AC POWER TEST:

A. After the satisfactory completion of all electrical system testing, perform a loss of AC power test. The main circuit breaker at the facility shall be placed in the "OPEN" position by the Contractor using all required safety and personal protective equipment in accordance with NFPA 70E.

B. During this test the representatives from the following organizations shall be present:

1. Contractor

2. Division 40 SCADA System Supplier

3. Main Electrical Distribution Equipment Supplier

4. Variable Frequency Drive Equipment Supplier

5. Engineer

C. The test shall verify that all electrical equipment in the system can withstand the loss of utility AC power. Under standby generator power, all automatically started equipment shall be witnessed to start and accept load without tripping offline or initiating false alarms.

D. The test shall be performed with the facility operated at near or full load.

E. All alarms associated with the loss of utility power and startup of the standby generator system shall be recorded.

1. Any nuisance type alarms associated with microprocessor faults or troubles shall be investigated and action taken to prevent reoccurrence.

2. When all nuisance type alarms have been resolved, the test shall be repeated to verify acceptable operation of the facility electrical system upon loss of utility power.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 09 29

LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide, test, and place into operating condition a complete and fully functional hard-wired, low-voltage relay lighting control system.

B. Area lighting control shall include:

1. Occupancy sensors with manual bypass capabilities.

2. Timing control.

3. Photo-electric controls.

C. The lighting control system shall include networked wiring and components, and shall be digitally linked to the Building Automation and Control System specified in Division 40.

1.02 REFERENCES:

A. Government Electronics and Information Technology Association (EIA):

1. 709.1: Control Network Protocol Specification

B. Federal Communications Commission (FCC):

1. Standard for Radio Frequency Equipment

C. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 volts maximum)

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

E. Underwriters Laboratories Inc. (UL):

1. 50: Enclosures for Electrical Equipment

2. 67: Panelboards

3. 508: Electrical Industrial Control Equipment

4. 916: Energy Management Equipment

1.03 SYSTEM DESCRIPTION:

A. Provide networked lighting control system consisting of components manufactured by single source.

B. Provide networked lighting control system consisting of:

1. Multiple relay panels linked over network wiring using open protocol for communications.

2. Multiple relay panels linked over network wiring using open protocol for communications, and be fully compliant with EIA 709.1

3. Relay panels and programmable switches connected together by networked wiring system extending from panel locations with single communications bus to allow switches to communicate with panels.

4. System connected to single time clock mounted in interior of relay panel.

5. Lighting system control to be interconnected with occupancy sensors, timers and photo-electric devices.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturer's product data, brochures including wiring diagrams in accordance with Section 26 05 10.

C. Wiring diagrams to show control interface points provided with other equipment.

D. Shop drawings to include:

1. Outline drawings with elevations.

2. Equipment arrangement drawings and control device data sheets and descriptions.

3. Anchor bolt location drawings.

4. Electrical schematics and wiring diagrams specific to this project. Generic system drawings shall be rejected.

5. Electrical fuse/circuit breaker characteristic.

6. Equipment performance curves and data.

7. Bill of installation/assembly materials.

8. Equipment weights.

9. Completed manufacturer's data sheets.

E. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems, anchorage and equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specifications 01 41 20 and 26 05 50. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

F. Additional Delegated Design: Provide design and layout drawings for sensing and control systems, as adjusted for specific lighting control hardware intended for provision. For low voltage keypads, submit proposed keypad layout for review and approval.

G. Spare Parts Data: After acceptance of the list of shop drawings, and not later than six months prior to the estimated date of substantial completion, furnish copies of spare parts data for each different item of materials and equipment specified. The data shall include a complete list of parts and supplies with current unit prices and source of supply, a list of supplies that are either normally furnished at no extra cost with the purchase of the equipment, or specified to be furnished in accordance with paragraph Special Tools and Spare Parts and a list of additional items recommended by the manufacturer to assure efficient operation for a period of 120 days.

1.05 OPERATION AND MAINTENANCE DATA:

A. Operation and maintenance manuals shall be specific to equipment purchased and crossing out of non-applicable items is not acceptable.

B. Comply with requirements of Section 01 78 23.

C. Operating and Maintenance Instruction Manuals:

1. At end of project, submit operating instruction manuals as specified in Section 01 78 23, outlining the step-by-step procedures required for system startup and operation. The instructions shall include the manufacturer's name, model number, service manual parts list and brief description of all equipment and their basic operating features. (Per 2018IECC C303.3, C408.2.5.2)

2. Maintenance instructions manuals outlining maintenance procedures shall be furnished. The manual shall include:

a. A troubleshooting guide listing possible breakdown and repairs

b. A simplified connection wiring diagram for the system as installed.

c. Provision of the names, addresses, and telephone numbers of service organizations that provide technical assistance and carry stock of repair parts for the system to be furnished. (Per 2018IECC C408.1.1)

d. Luminaire and Lighting Control System(s) specifications, programming procedures and means of illustrating to owner how building, equipment and systems are intended to be installed, maintained, and operated. (Per 2018IECC C408.1.1)

3. Performance Test Reports: Upon completion of the installed system submit in booklet form field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Standard Products: Material and equipment shall be the latest standard products of a single manufacturer regularly engaged in the manufacture of the product for 5 years as a minimum.

C. Services of Manufacturer's Representative as stated in Section 01 45 00 and as specified herein.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Equipment placed into storage shall be protected from the weather, humidity and temperature variations, dirt, dust, and other contaminants.

1.08 SEISMIC DESIGN REQUIRMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. It shall be the responsibility of the manufacturer and supplier along with the Electrical Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

1.09 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide a list of recommended spare parts for the first year of operation and for the first five years of operation, including a price list and location of the nearest facility from which all spare parts can be obtained.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. nLight, Acuity Brands Lighting Controls

B. General Electric Company, Total Lighting Control (TLC) Level 2, Networked.

C. Leviton Company, Lighting Controls.

2.02 WATT STOPPER, LIGHTING INTEGRATOR CONTROL SYSTEMS.GENERAL:

A. The Low Voltage Lighting Control System shall consist of relay panels and intelligent switches and/or photocells, timers and occupancy sensors connected together by a dataline, as well as all associated wiring.

B. The system shall include a DIN rail mounted time clock, photosensor control module and/or other low voltage control devices. These devices shall be totally compatible with the manual operation of the soft wired switches.

C. Requirements for the system installation are indicated elsewhere in the specifications for work including, but not limited to, raceways and electrical boxes and fitting required for installation of control equipment and wiring.

D. It is acceptable for luminaire switching and dimming controllers to be located on-board luminaire, with datalines installed per manufacturer instructions. Such data lines shall be enclosed in conduit. Where manufacturer's hardware does not provide means for conduit connection and system voltage is 30V or less, terminate conduit within 8 inches of the device and provide bushings at the ends of conduit, and seal interior end of conduit around dataline cable(s) with silicone caulk.

E. IECC 2018 Conformance – Provide a system conforming with the 2018 version of the International Energy Conservation Code (2018IECC), even if a specific requirement is not addressed in this specification.

2.03 RELAY PANELS:

A. Modular Relay Panels shall be UL listed and consist of the following:

1. NEMA 1 enclosure that can accept an interior sized to accept up to 24 control relays.

2. Power Supply: Transformer assembly with low voltage secondary wired transformers each with an individual secondary.

3. Transformers shall include internal over current protection with automatic reset and metal oxide varistor protection against power line spikes. Voltage rating at primary connection shall be as shown on the drawings.

4. Cover: Surface with captive screws in a hinged, lockable configuration. A wiring schedule directory card shall be affixed to the inside surface of the cover.

5. Interior: Bracket and intelligence board backplane with pre-mounted relays. Interiors shall be provided with the required installed and tested relays. Provide 20 percent space relays in each panel.

B. Panels shall be provided with an integral DIN rail mounting bar for installation of system components. Terminals shall be included in the interior to accept a dataline for the connection of soft wired dataline switches to the system, or to allow a dataline to be run between multiple panels for network communications between the panels.

C. Panels shall be provided with individual ON/OFF switches for both panel and dataline power.

D. Eight channels shall be provided in each interior regardless of size, each with an associated pushbutton to toggle the channel ON/OFF, and a terminal block for a separate dry contact input.

E. Any number of relays in the panel shall be able to be assigned to each channel, with overlapping allowed. Channels shall be set up via “Soft wiring”, i.e. no hand held programmer or keypad is required. Systems that require programmers or keypads, or that change relay states during set up are not acceptable.

F. Each channel pushbutton shall be provided with LED status indication - RED shall indicate that all of the relays within the channel group are ON; NO LED shall indicate that all of the relays within the group are OFF, and GREEN shall indicate the channel’s relays are in a MIXED status.

G. The system shall accept future functionality upgrades without removal of the panel.

H. Features:

1. Relays shall be momentary-pulsed mechanically latching contactors rated at 20 amps, 120 to 277 volts AC. They shall attach to the interior of the panel by a single plug-in connector.

2. Adjacent to each relay shall be an individual override button and an LED to indicate state.

3. Captive screw terminations shall be provided for all wiring connections.

4. Each channel shall also have an associated 1 amp, 30 volts DC isolated contact which may be used for status feedback or pilot light control.

5. The Relay Panel shall use an EEPROM to record the channel soft wiring assignments and the current status of all relays, thus insuring a 40-year backup of information in the event of a power failure. Systems that require a chargeable battery with less than 10 year's life shall not be allowed.

6. The unit shall provide LED status indication of the power supply status. Access to 24 volts AC and 24V rectified power for accessory devices shall be provided within the panel.

7. The panel interior shall use relays with pilot contacts to provide individual relay feedback to other control systems. Also, terminal blocks will be located next to each relay to allow standard low voltage switching devices to control the relay state.

   a. Devices can be either 2 or 3-wire, maintained or momentary inputs.

   b. The system shall also accept a 2-wire toggling input.

8. The system shall comply with the LonMark® lighting controller profile and provide capability for network binding to LonMark compliant building automation system components without the use of dry contacts, gateways, protocol converters or additional systems devices.

2.04 NETWORK DATALINE:

A. The intelligence in multiple panels shall be linked over a single dataline that uses the open Echelon/LonTalk™ protocol for communications, and be fully LonMark and LNS (LonWorks Network Services) compliant.

B. The dataline shall provide a highly reliable communications bus for transferring control and status between the relay panels.

C. The dataline shall be self-powering at each relay panel and not require any ancillary equipment to function properly.

D. The dataline, in addition to linking together multiple relay panels, shall be capable of extension and provide a single communications bus to allow soft wired dataline switches to communicate with the panels.

E. The dataline shall be able to connect to a single soft wired dataline time clock mounted in the interior of a relay panel or a separate enclosure at another location.

F. Features:

1. Dataline shall be 18/4 twisted conductor with shield meeting Class 2P NEC code requirements. The dataline can be run in a loop, serial, or star configuration.

2. System maximum length limit for all dataline wire in the system shall be not less than 1,500 feet. System maximum number of devices (panels/switch modules/tieclocks) limit on a dataline shall be not less than 127.

2.05 SOFTWIRED DATALINE SWITCHES:

A. To allow individual overrides, dataline switches shall be terminated to each panel 4 wire "Local Dataline". Switches shall be available in either single, dual, quad, or octal (1 button, 2 button, 4 button, or 8 button) designs. The single, dual, and quad devices mount in a standard single gang box, while the octal version mounts in a two gang box.

B. Each button in a switch module can be individually programmed. Programming is done by a "Softwiring Sequence" rather than with a handheld keypad or laptop. Each button can be assigned to any one of the following four functions:

1. Control any individual relay in any single panel.

2. Control any group of relays in any single panel

3. Control any of the eight channels (A-H) in a single panel.

4. Control the same channel letter (A-H) in any chosen group of panels in the system.

C. For applications that require pattern switching, any button can perform its function using an "ON/OFF/Not Controlled" pattern of relays instead of the normal All ON/All OFF.

D. Features:

1. Switches shall have a non-breakable Lexan body and a matching wallplate.

2. Each switch module shall use a bi-color LED pilot light for the individual buttons to indicate status of the controlled relay or group of relays. LED indications are Red for All ON, Green for Mixed State (some relays in the group ON and others OFF), and No LED for All OFF.

3. Switches shall be provided with a locator light to allow standard 3/8-inch tape to used for labeling the controlled loads.

4. The dual, quad, and octal switches shall all include a single master button that will override all relays controlled by the individual buttons OFF, or Restore them to their original state. Each switch unit's master button function can be configured to perform a "Master On/Off", "OFF Only", or "Disabled" function if desired.

5. Dip switches on the back of the module shall allow switch units to be designated for “Cleaning Crew” Control. This prevents the switch from turning off the occupant’s lights accidentally.

6. Each switch module shall be available with a locking control. Once a key is inserted, the individual buttons will function for five minutes.

2.06 SOFTWIRED TIME CLOCK:

A. Provide a soft wired time clock on the dataline.

B. From any plug-in point on the dataline, the time clock shall be used to:

1. Schedule any of the 8 channel groups (A-H) in the relay panel network.

2. Schedule program soft wired dataline switches. Schedules shall be defined using “Occupied vs. Unoccupied” times to simplify data entry.

C. The time clock shall include user-selectable intelligent scenarios to handle standard lighting control functions for each channel independently. Selectable scenarios shall include:

1. Scheduled ON / Scheduled OFF.

2. Manual ON / Scheduled OFF

3. Astronomical ON / Astronomical OFF (with optional offset)

4. Astronomical ON / Scheduled OFF (with optional offset)

D. Where required, each channel shall be assigned a standard time delay from 1-256 minutes. During “Occupied” hours, the time delays do not take effect. During “Unoccupied” hours, the time delays will ensure that overridden lights are automatically turned off.

E. Each channel can be assigned an automatic “blinking” of the lights before they are turned off to allow occupants the opportunity to enter an override without being put in the dark. The time interval between the blink warn and “off” operation shall be user configurable between 1 and 15 minutes.

F. Features:

1. The time clock will provide a clear 9-line, 22-character per line display and a simple user interface.

2. A single button can be used to bring up a context sensitive help screen to assist the user.

2.07 SOFTWARE:

A. Provide programming of the system parameters.

B. The system shall allow any user-definable feature (schedules, relay groups, switch assignments) to be field modified without the need for configuration software or systems integration expertise.

C. In addition to hardwired channel inputs, the system shall provide for integration to system components including, but not limited to, photocell controllers, HVAC controllers, security, access and fire safety systems without the use of dry contact, gateways or protocol converters.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install lighting control system as indicated on the drawings, in accordance with the manufacturer's diagrams and printed instructions, except where otherwise indicated.

1. Wiring: Wiring for systems shall be installed in conduit. Reuse existing fire alarm conduit system where applicable; otherwise, provide conduit as specified in Section 26 05 33. Enclosures shall comply with the requirements of UL 864. Enclosures having doors over 48 inches in height shall be provided with a three-point catch and lock; all other doors shall contain a cabinet type cylinder lock. Inserts shall be blind fastened so that no screws show on the panel front.

2. Sensors and control devices shall be installed in accordance with manufacturer's printed instructions.

3. Provide complete wiring and conduit between all equipment. Devices shall be mounted upon UL listed boxes. Wiring splices and transposing or changing of colors will not be permitted.

3.02 FIELD TESTING:

A. Test lighting systems to ensure proper calibration, adjustment, programming, and operation. (2018IECC C408.3)

B. Furnish instruments and personnel required for the tests. Tests shall be conducted for the following:

1. Verify that the system is free of grounds or open circuits. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized.

2. Verify that all switches and sensors are functioning as specified.

C. System tests to be performed under the supervision of a qualified manufacturer's representative.

D. Perform all tests to verify the correction of defects found in the initial testing. If testing identifies system modifications are required to accomplish the required operation, perform work at no additional cost to the Owner and retest the system.

3.03 TRAINING:

A. Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

1. 1 person-day per building panel

B. Coordinate training time with the Engineer and Owner.

C. Furnish training as follows:

1. Training in the system operation including manual control of output functions from the system control panel.

2. Training in the testing of the system.

3.04 STARTUP AND TESTING:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect field erection per building:

a. 1 person-day

3. Functional Testing: Perform a functional test. Tests to include all items specified.

a. 1 person-day

4. Testing: Field performance test equipment specified.

a. 1 person-day

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

   a. 1 person-day per building

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

3.05 RECORD DRAWINGS:

A. Provide final record drawings of the system showing all panels, relays, sensors and control devices. Include with overall electric power systems as-built drawings, including submission to Owner within 90 days of system acceptance, or as required by other parts of these Specifications, whichever is earlier. (Per 2018IECC C408.2.5.1).

B. Provide panel schedules.

C. Record system wiring diagrams to be provided.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 12 19

PAD-MOUNTED TRANSFORMERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section describes materials, installation, and testing of outdoor pad-mounted transformers.

1.02 REFERENCES:

A. American National Standards Institute, (ANSI):

1. Z55.1: Gray Finishes for Industrial Apparatus and Equipment

2. C2: National Electrical Safety Code

B. ASTM International (ASTM):

1. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.

2. D117: Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Oils of Petroleum Origin.

C. U.S. Department of Energy (DOE):

1. Distribution Transformers Energy Conservation Standard (10 CFR Part 431).

D. Institute of Electrical and Electronics Engineers (IEEE):

1. 386: Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V

2. C57.12.00: Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

3. C57.12.26: Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors (34 500 Grd Y/19 920 V and Below; 2500 kVA and Smaller).

4. C57.12.28: Pad-Mounted Equipment Enclosure Integrity

E. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

F. Occupational Safety & Health Act (OSHA):

1. Regulation 1910.7

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

C. Submit shop drawings giving equipment dimensions, anchoring information, and weights for each rating shown in the drawings and giving ratings of transformers, switches, fuses, and breakers. Provide data on pressure-relief valves, oil sampling valves, gauges, and separable connectors.

D. Submit catalog cuts for transformer pads.

E. Factory Tests: Furnish manufacturer’s certified standard test reports for the transformer ratings shown in the drawings and for the tests specified herein.

F. Instruction Manuals: Furnish manufacturer's installation and maintenance manuals on the transformers and accessories.

1.04 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Single source manufacturer regularly engaged in manufacturing pad-mounted transformers complying with requirements of these Specifications and experienced with at least 5 projects of similar size and scope

B. Product Selection for Restricted Space: Drawings indicate size, profiles, and dimensions for pad-mounted transformer equipment including clearances between pad-mounted transformers and adjacent surfaces and items, and are based on manufacturer’s preliminary information.

C. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Terms “NRTL” shall be as defined in OSHA Regulation 1910.7.

2. Terms “listed” and “labeled” shall be as defined in National Electrical Code, Article 100.

D. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

E. ANSI/IEEE Compliance: Comply with applicable requirements of ANSI/IEEE standards, including IEEE C2.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Coordinate delivery of pad-mounted transformers in shipping splits to allow movement into designated space.

B. Handle pad-mounted transformers components in accordance with manufacturer's instructions. Use factory installed lifting provisions.

1.06 SEQUENCING AND SCHEDULING:

A. Coordinate size and location of concrete bases and pads. Cast anchor bolt inserts into pad.

1.07 MAINTENANCE:

A. Extra Materials:

1. Furnish extra materials matching products installed as described below, packaged with protective covering for storage, and identified with labels clearly describing contents.

2. Touch-Up Paint: 3 half-pint containers of paint matching enclosure exterior finish.

3. Contact Lubricant: 1 container.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Eaton Cooper Power Series

B. Cooper Power Systems

C. ABB

D. General Electric

E. SIEMENS

2.02 TRANSFORMER:

A. General: Liquid-filled, pad-mounted transformer, complying with IEEE C57.12.26 and C57.12.28, with primary gang-operated 4-position V-blade load break disconnect switch(es), tap changer, fuse provisions, secondary terminals in separate compartments,

and accessories in a weather-resistant, tamper-proof enclosure. Isolate and interlock high- and low-voltage compartments. Doors shall be provided with padlockable three-point latch and pentahead bolt. Winding material for pad-mounted transformers can be either aluminum or copper.

B. Transformers shall comply with the 2016 Department of Energy (DOE) Efficiency Standards for Distribution Transformers, especially CFR title 10 Chapter II Part 431 (in Appendix A of Subpart K 2016)

C. Enclosure: Enclosure base shall have a 4 mil thick tar-mastic undercoat.

D. Transformer: Unit shall be dead front, 3-phase, two winding, 60 Hertz, 65 degrees C riseand elevation 4,500 feet above sea level. Self-cooled kVA ratings shall be as noted in the drawings. High voltage shall be as indicated on the drawings with two 2-1/2 percent taps above and below normal. BIL shall be 95 kV. Low voltage shall be as indicated in the drawings. Provide Envirotemp FR3 or equal insulating liquid per requirements of transformer's manufacturer and FM Global Standard 3990. Insulating liquid shall contain less than 1-ppm PCB chemicals.

E. Percent Impedance Voltage: Provide the following impedances subject to a plus or minus 7.5 percent impedance variation, unless noted otherwise on single line diagram(s):

kVA	Percent IZ
150 and smaller	2.0
225	3.5
300	4.0
500	4.0
750 and larger	5.75

F. Primary Compartment: Provide the following equipment as a minimum:

1. Dead-front construction.

2. Loop-feed construction.

3. Three dead-front elbow-type metal oxide varister (kV rating based on equipment voltage level) lightning arresters where shown in the drawings.

4. Load-break switch.

5. Draw-out dry well mounted current-limiting fuses.

6. Medium-voltage bushing inserts and bushings for separable elbow connectors conforming to IEEE 386 and rated for 15 kV or 5 kV based on application, 95 or 30 kV BIL, 600 amperes continuous, 20,000-ampere rms symmetrical for a time

duration of 0.17 second. Provide a parking stand for each elbow connector. Equip connector with steel-reinforced hook-stick eye, grounding eye, test point, and arc-quenching material.

7. Insulated means for locating up to two primary-side Current Transformers, configured as shown on plans, and as required for a complete functioning system.

8. Primary side Current Transformer(s), oriented and configured as shown on plans, and as required for a complete functioning system.

G. Low-Voltage Compartment: Provide the following equipment as a minimum:

1. Secondary low-voltage bushings with spade terminals designed for copper conductors.

2. Liquid level gauge, dial type with low level alarm contacts.

3. Thermometer, dial type with high temperature alarm contacts.

4. Oil filling connection.

5. Drainage and oil sample valves.

6. Neutral ground strap, removable.

7. Corrosion-resistant nameplate and connection diagram in conformance with IEEE C57.12.26 except that the number of gallons of coolant shall be shown.

8. Transformer case grounding pad.

9. Circuit breakers as indicated in the drawings.

10. Non-PCB and UL label.

11. Insulate conductors for systems where low voltage side is greater than 600V line-to-line.

12. Secondary side Current Transformer(s), oriented and configured as shown on plans, and as required for a complete functioning system.

13. Integrated sensors, including:

a. Cover mounted pressure relief device with alarm contacts.

b. Dial-type thermometer with alarm contacts.

c. Pressure vacuum gauge with contacts and bleeder.

2.03 LIQUID LEVEL GAUGE WITH CONTACTSFACTORY FINISH:

A. Provide with a factory-applied, corrosion-resistant finish which shall withstand 3,000 hours of exposure to the salt spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer coat to the metal surface in excess of 1/16 inch from the scribed test mark. Finish color shall be ANSI Z55.1 No. 61 light gray.

B. Cut edges or otherwise damaged surfaces of galvanized steel shall be coated with a zinc-rich paint conforming to Section 09 99 00, System No. 55.

2.04 TRANSFORMER PADS:

A. Provide cast-in-place concrete transformer pads sized per transformer manufacturer requirements and details as indicated on the drawings. Provide reinforcement for parkway (non-traffic) loading.

B. Provide precast concrete slab box, where indicated, consisting of transformer pad and precast concrete box below, sized per the drawings. Box shall have reinforcement for H-20 traffic bridge loading. Provide hot-dipped galvanized steel parkway covers for access openings.

2.05 FACTORY TEST:

A. Perform the following factory tests:

1. Routine factory tests, IEEE C57.12.00 Section 8.1.

2. ANSI full wave impulse test, observed by oscilloscope.

3. ANSI reduced full wave, chopped wave impulse test with oscillograph record.

4. Complete ANSI temperature tests.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install pad-mounted transformer in conformance to the manufacturer's mounting instructions including securing it to the concrete slab by at least four anchor bolts.

3.02 GROUNDING:

A. Pad-mounted transformer shall have all noncurrent-carrying metal parts connected to a solid earth ground electrode.

3.03 SIGNS:

A. Install "DANGER--HIGH VOLTAGE--KEEP OUT" signs with tamper-proof stainless steel screws on each accessible side of pad-mounted transformers.

3.04 FIELD TESTS:

A. After the installation has been completed, conduct an operating test demonstrating that all equipment devices operate in accordance with the requirements of the drawings and specifications.

B. Operating Test: Energize the transformer and adjust the output voltage to the specified value. Further readjust tap settings, if necessary, after the facility being served is in normal operation.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

B. Adjusting: Adjust primary taps so secondary voltage is above and within 2 percent of rated voltage.

END OF SECTION

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SECTION 26 13 13

MEDIUM VOLTAGE CIRCUIT BREAKER SWITCHGEAR

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide a 4,160 Volt-class, 250 MVA nominal 3-phase class, metal-clad drawout switchgear assembly complete with circuit breakers, transformers, relays, meters, and accessories as indicated and in compliance with Contract Documents.

B. Section 26 13 13 appies to 01-SWGR-99100A and 01-SWGR-99100B, the 4.76KV switchgear inside 0104 IPS Electrical Buidling, where the switchgear shall be indoor rated per IEEE C37.20.2, part 7.17 "Indoor MC switchgear, access, and ventilation."

C. Section 26 13 13 also applies to 01-SWGR-99110, the generator paralleling switchgear at 0105 IPS Standby Power & Fuel Storage. Provide enclosure that is outdoor rated per IEEE C37.20.2, part 7.18 b) "Outdoor MC switchgear, access, and ventilation, with aisle" and also meeting the requirements of Section 26 13 13, 2.02.B.14 Walk-in Enclosure for Generator Paralleling Switchgear. The Contractor shall furnish and install, where indicated on the drawings, a complete standby power generation and load management power distribution and control system.

1. The Standby Power System consists of the following as applicable:

a. Generator sets

b. Generator Control Switchgear (with associated monitoring and distribution equipment)

c. Generator Paralleling Digital Master Controller

d. Generator Paralleling Remote I/O Cabinet (In the IPS Electrical Building)

e. Battery System(s)

f. Networking System(s)

g. Generator Neutral Grounding equipment

2. The Standby Power System Supplier (EPSS) shall be an authorized service provider for all components of the Standby Power System (EPS). In order to assure maximum equipment uptime and best service response to the owner, the Standby Power System Supplier shall be an factory-authorized dealer with

complete EPS parts and service available on a 24 hour emergency basis within a 100 mile radius of the project site.

3. The Generator Control Switchgear shall be by the same manufacturer as the generator sets and furnished with the generator sets by the (EPSS) as a total system.

4. The Standby Power Systems Supplier must be capable of servicing the Generator Paralleling Switchgear and the Generator sets, and be able to supply replacement parts for both factory supplied equipment. Proof for technicians capable of serving both roles within the EPSS organization is required. A single point of contact on behalf of multiple manufacturers does not meet the requirement.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. C39.1: Requirements, Electrical Analog Indicating Instruments.

2. Z55.1: Gray Finishes for Industrial Apparatus and Equipment.

B. Institute of Electrical and Electronics Engineers (IEEE):

1. C2: National Electrical Safety Code

2. C37.06: American National Standard for Switchgear - AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities

3. C37.09: Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

4. C37.20.2: Metal-Clad Switchgear

5. C37.90: Standard for Relays and Relay Systems Associated with Electric Power Apparatus

6. C57.13: Standard Requirements for Instrument Transformers

C. National Electrical Manufacturers Association (NEMA):

1. C37.55: Metal-Clad Switchgear Assemblies - Conformance Test Procedures.

D. International Electrical Testing Association (NETA):

1. ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

E. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

2. 70E: Standard for Electrical Safety in the Workplace

F. Occupational Health and Safety Administration (OSHA):

1. 1910.7: Definition and Requirements for a Nationally Recognized Testing Laboratory

G. Underwriters Laboratories, (UL):

1. 347: Medium Voltage Industrial Control Equipment.

1.03 SUBMITTALS

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers product data in accordance with the requirements of Section 26 05 10.

C. Submit a system protection device coordination study prepared by the switchgear manufacturer.

1.04 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Single source manufacturer regularly engaged in manufacturing and assembling substations complying with requirements of these Specifications and experienced with at least 5 projects of similar size and scope. Single source manufacturer is responsible for assembled substation.

B. Product Selection for Restricted Space: Drawings indicate size, profiles, and dimensions for unit substation equipment including clearances between unit substations and adjacent surfaces and items, and are based on manufacturer's preliminary information.

C. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Terms "NRTL" shall be as defined in OSHA Regulation 1910.7.

2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

D. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

E. ANSI/IEEE Compliance: Comply with applicable requirements of ANSI/IEEE standards, including IEEE C2 and C57.12.80.

F. Provide classroom training and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions per Section 01 78 24.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Store protected from weather and so condensation will not form on or in substation components. Provide temporary heaters in accordance with manufacturer's recommendations to prevent condensation.

B. Handle substation components in accordance with manufacturer's instructions. Use factory installed lifting provisions.

1.06 SEQUENCING AND SCHEDULING:

A. Coordinate size and location of concrete bases and pads. Cast anchor bolt inserts into pad.

1.07 MAINTENANCE:

A. Extra Materials:

1. Furnish extra materials matching products installed as described below, packaged with protective covering for storage, and identified with labels clearly describing contents.

2. Two spare fuses of each size and type.

3. One complete set of indicating lamps for number provided on switchgear.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Siemens.

B. General Electric Co.

C. ABB.

D. Eaton.

E. Schneider Electric.

F. Powell Industries

2.02 MATERIALS:

A. Mounting Sills:

1. Furnish steel channel sills with suitable drilled holes for mounting, aligning, and bolting switchgear in place. Method of mounting as indicated. Size and arrangement of sills as recommended by switchgear manufacturer. Paint completed sills with two coats of aluminum paint or other acceptable corrosion-resistant finish before being set in place. Set and level channel sills.

2. If switchgear equipment pads are to be located on concrete floor slabs, furnish painted steel channel mounting sills and anchor bolts, including location instructions, to General Contractor for setting in place during construction of concrete equipment pads.

3. Furnish painted steel channel mounting sills and anchor bolts, including location instructions, to General Contractor for setting in place during construction of switchgear equipment pad.

B. Housing and Construction:

1. Housing: Rigid, self-supporting, structural steel units welded throughout. Assembled unit consists of basic metal-clad switchgear units assembled together to form continuous unit. Mount potential transformers with current-limiting fuses in separate compartments and provide with hinged doors for easy access. Housing compartments: Steel constructed of suitable thickness and in manner that when bolted together in proper positions, each circuit is isolated from adjacent circuits. Switchgear assembly shall conform to ANSI Standard C37.20.

2. Where necessary provide screened openings for ventilation.

3. Furnish doors for front section to provide for installation and removal of circuit breaker removable elements. Doors: Smooth surfaces, steel sheets. Hinges: Concealed removable pin type.

4. Equip doors with one lock-type handle which will take padlock to prevent opening. Hole size for accommodating padlock: 1/2-inch diameter.

5. Furnish additional fasteners on each door in closed position to prevent distortion when subjected to forces resulting from breaker opening under load or from short circuit conditions. Provide fasteners with knob 2 inch minimum diameter or handle located on outside of doors.

6. Equip doors with combination swing limit and latch to hold door in open position. Swing limit device limits opened position of door to prevent damage to adjacent switchgear metal surfaces, instruments, and devices.

7. Door shall be prevented from being opened with the circuit breaker energized in the closed position. Circuit breaker must be tripped and de-energized before door can be opened.

8. Provide removal panels for rear access to breaker cubicles and for ease in terminating bottom entry of power feeder cables.

9. Fit potential transformer compartments with doors or removable panels equipped with provisions for padlocking.

10. Power cables enter switchgear from above or below as indicated.

11. Provide bare copper ground bus not less than 2 inch by 1/4-inch extending entire length of switchgear, secured to each unit. Provide terminals for connection to grounding system which are suitable for accepting NEMA compression two-hole bolted type lugs.

12. All structural bolts, nuts and washers: Cadmium-plated steel or other suitable corrosion-resistant finish.

13. Complete structure shall be factory assembled and tested. After complete assembly, test each standard unit for operation under service conditions by impressing primary current and voltage on instrument transformers to assure accuracy of wiring, correctness of control and relay circuits, and functioning of equipment.

14. Walk-in Enclosure for Generator Paralleling Switchgear:

    a. As indicated on the drawings, provide an outdoor, weatherproof, protected walk in enclosure, fabricated and coordinated with the switchgear to form an integral enclosure.

    b. The entire length of the aisle shall be wide enough to permit removal of a circuit breaker, including width required for equipment on opposing wall, as required.

    c. Adequate space shall be provided for convenient installation, operation and maintenance of the batteries and battery charger. The aisle area shall be not less than shown on the drawings.

        (1) Reference Section 26 33 23, “Central Battery Equipment” for external battery requirements, adjacent to 01-SWGR-99100.

(2) Provide battery system within building or enclosure housing 01-SWGR-99110. Provide battery system generally conforming to Section 26 33 23, except adjusted if written approvals by Engineer of Record are approved as required to allow manufacturer-standard equipment that substantially meets the same performance.

d. The entire space under the enclosure shall be provided with a cement pad adequately reinforced. The walk-in enclosure shall include a floor sufficient to allow the circuit breakers to be interchanged and serviced without causing the floor to deflect. The entire floor shall be approximately 4 inches above grade level.

e. The roof of the enclosure shall slope to allow for adequate run off of moisture. Provide Utah-licensed PE certification of seismic resilience and capability to support snow load requirements, as per local municipality.

f. The entire area between the floor and foundation, including feeder conduits, shall be enclosed by structural steel or steel sheets.

g. The enclosure shall include proper ventilation suitable for the ambient site conditions required.

h. Enclosure Personnel Doors:

(1) Locate a door wide enough to allow a circuit breaker to pass at each end enclosure.

(2) The pre-hung doors shall be safety type, steel with concealed or semi-concealed hinges for attachment. The pre-hung door frames are to be welded to the equipment structure.

(3) Provide the doors with UL Listed panic hardware on the inside and handle on the exterior. A latch bolt controlled by a key cylinder shall lock the door from the outside.

i. Enclosure Rear Doors:

(1) Provide suitable weatherproof type doors on the rear of the switchgear enclosure for each termination access. Attach the doors to the enclosure with a with surface mounted strap type hinges. Each door includes three point latches with stainless steel pad-lockable type handles.

(2) The doors shall be capable of a swing of 180 degrees (nominal).

j. Cubicle Heaters:

(1) Install an electric strip heater within each circuit breaker cubicle and cable termination compartment to limit excessive humidity during adverse weather conditions. Thermostat shall be set and marked with manufacturer's recommended setting.

(2) Heater and associated control wiring shall be pre-wired at the factory. Properly fuse the wiring and protect to prevent terminal overheating.

k. Lighting:

(1) Exterior mounted LED lighting with photocell mounted above the two entrance doors. Battery backup lighting fixtures mounted inside the enclosure to meet code egress requirements.

(2) Provide ceiling mounted, LED fixtures over the front aisle, with fixtures parallel to the switchgear sufficient for operation and maintenance.

(3) Fixtures shall be securely mounted.

(4) Install a 3-way switch at each enclosure entrance to control the lighting. Provide 4-way switch(es) as appropriate if there are more than 2 entrances.

l. Receptacles: Provide heavy duty duplex ground fault current interrupter (GFI) receptacle. located at the personnel door entrance. Do not provide exterior convenience receptacles.

15. Inspection Windows; Provide inspection windows for inspection of components exposed to medium voltage, such as fuses, cable terminations, circuit breaker, and so forth, as recommended by the manufacturer, and/or as available as standard options. Provide windows and/or covers as required to maintain the overall rating of the enclosure. Provide same for components operating at 10 amps or above.

C. Control Panels:

1. Unit front doors: Hinged steel panel of suitable thickness for mounting instruments, relays and control equipment. Provide panels with handle and suitable mechanical latch to hold panels securely in closed position.

D. Circuit Breakers:

1. Circuit breakers 250 MVA, rated 1200 amperes (or as indicated on the drawings), 4,760 volts nominal, with momentary rating of 23 kA amperes symmetrical. Circuit breakers of equal rating: Completely interchangeable.

2. Circuit breakers: Stored-energy type for operation on 120 volt DC source. Circuit breakers may be vacuum interrupter type or air-magnetic. Mechanically and electrically trip free and electrically operated by means of stored-energy mechanism, normally charged by universal motor, but which can be charged by manual handle for emergency operation. Air-magnetic circuit breaker equipped with three independent arc chutes, complete with blowout coils. Interposing relays provided in control circuits, where required, for remote control of circuit breakers. Time for energizing trip coil until circuit breaker is interrupted at 25 to 100 percent of interrupting rating, not more than 5 cycles.

E. Disconnecting Devices:

1. Equip breakers with main and control circuit disconnecting devices to make circuit breaker a removable element. Locate and securely mount disconnecting devices to maintain alignment. Main contacts and supports guaranteed not to distort or fail under mechanical and thermal stresses due to full load and short circuit duties specified for circuit breaker ratings.

2. Provide automatically closing shutters to cover openings for main contacts in order to prevent accidental contact with live parts when circuit breaker is withdrawn from its operating position. Shutters shall be closed when breaker is in test position and fits tightly to exclude rodents.

F. Drawout Mechanism:

1. Circuit breakers: Drawout type. Each unit having self-contained manually operated device for withdrawing the circuit breaker from its operating position. Breaker only removed or replaced by using manual operating device. Suitable guide rails and stops furnished for aligning unit in proper position when inserting or withdrawing removable element.

G. Auxiliary Apparatus Compartments:

1. Provide auxiliary compartments, matching rest of structure, as indicated. Furnish compartments with hinged front enclosures similar to those furnished with basic metal-clad units and with insulated buses and connections where necessary.

H. Bus Bars, Connections and Supports:

1. Provide bus bars and connections with all necessary supports, insulation and clamps. Where connections are made, silver plated bars to provide proper contact surfaces for carrying full load current.

2. Power buses designed for not less than 1,200 amperes capacity through entire length of bus without exceeding maximum temperature of 54 degrees F above ambient of 104 degrees F.

3. Power buses extend entire length of switchgear and securely fastened to each unit.

4. Main bus connections and branch taps by high-pressure bolted joints and copper bar with silver plated surfaces.

5. Entire bus structure braced and secured in place to withstand forces caused by 250 MVA short circuit conditions. Main bus and branch taps insulated, in addition to bus support insulators.

I. Wiring:

1. Furnish units completely wired, including cleats and terminal blocks. Switchgear wiring made with standard switchgear wire with fire-resisting braid. Use no wire smaller than No. 14 AWG. Wiring on instrument panels with flexible connections to terminal blocks. Wiring in accordance with latest rules of National Electrical Code (NEC).

2. Clamp type terminal lugs for main terminals. Size of cable for individual units as indicated.

J. Instrument Transformers:

1. Instrument transformers of dry type. Instrument transformers conforming to ANSI Standard C57.13. Current transformers with 5-ampere secondaries for relaying and metering. Current transformers with thermal and mechanical ratings at least equal to those of circuit breakers.

2. Potential transformers of drawout type with voltage ratio as indicated on drawings. Normal rating of 400 Volt-Amperes and capable of carrying 1,000-volt amperes continuously with temperature rise not exceeding 55 degrees C ambient. Provide with primary current-limiting fuses.

K. Control Power Transformers:

1. Control power transformers: Rating of 4,160-120 volts, single-phase, 3-wire, 60 Hertz, with kVA rating as required by switchgear. Primary fuses for the control power transformer mounted on disconnecting or drawout fuse mounts. Secondary fuses also provided.

L. Instruments, Relays, and Control Components:

1. Instruments and relays semi-flush mounted with glass covers and dusttight gaskets. Alternating current instruments and relays suitable for operation on 5 ampere current transformer secondary circuits, 120-volt potential transformers and at frequency of 60 Hertz.

2. Instruments, relays and meters accurately calibrated and adjusted before shipment. Instrument, relays and meters not injuriously affected by short-circuit currents as specified elsewhere in this specification. Accuracy of 1 percent.

3. In general, indicating instruments are 4-1/2-inch rectangular type, 250 degree scales and white with black markings. Provide moving elements with accessible zero adjustments external to case.

4. Inspect instruments, relays and meters for satisfactory operation and, if necessary, adjust after installation.

5. Control switches: Rotary type with positive means for maintaining contact. Silver-to-silver contacts provided with easily removable protective covers.

6. Protective relays: Rectangular semi-flush drawout type with built-in testing facilities. Relays and relay systems shall conform to IEEE C37.90.

7. Test blocks for both current and potential, small wiring, and terminal blocks.

M. Indicating Lights:

1. Indicating lights of low current type rated at 24 volts, with resistors suitable for operation over maximum range specified for control voltage. Lamps easily removed and replaced from front of panel. Red and green indicating lights showing closed and open position of the breakers, respectively, and amber lights indicating automatic trip of breakers.

N. Fuses:

1. Provide necessary fuses, including two spare fuses of each size and type.

O. Nameplates:

1. Furnish engraved nameplates of laminated plastic with white lettering on a black background for all panels, control switches, instruments, and like.

P. Provisions for Heating and Lighting:

1. Equip cubicles with (1) built-in strip heaters with ON-OFF switch and wiring, (2) lamp receptacles with suitable lamps for general lighting both front and rear of compartments, and (3) convenience outlets with proper protective devices.

Q. Painting:

1. Coat front and rear of all metal panels and interior and exteriors of all metal structures with rust-resisting priming coat after properly sanding and chemically cleaning surfaces.

2. Coat interior surfaces of switchgear with one finishing coat of light gray quick lacquer or synthetic enamel. Exterior surfaces given two finish coats of ANSI Z55.1 No. 61 gray.

R. Accessory Equipment:

1. Furnish one complete set of manufacturer's standard metal-clad accessories for operation and inspection of switchgear as follows:

   a. Test plugs for drawout relays and test blocks.

   b. Inspection and test cabinet including control pushbutton, control relay secondary coupler and wiring complete for electrical operation of circuit breaker when removed from stationary structure.

   c. Transfer truck.

   d. Removable Breaker Lifting Device

2. Control Wiring and Device/Terminal Blocks:

   a. Utilize minimum 14 AWG type SIS cable for control wiring.

   b. High flexible stranding shall wire shall be used in resrtrricted spaces or across hinged sections.

   c. No more than two wires shall be connected to any one terminal on any device or terminal block

   d. Terminal blocks shall be suitable for ring tongue connectors.

   e. Twenty percent (20 percent) spare terminals shall be provided on any terminal block segment.

3. Meet seismic requirements indicated in Section 01 41 20 for the site such that equipment is operational after an event.

S. Circuit Boards – General Requirement:

1. Provide manufacturer’s conformal coating options for all circuit boards where this option is available. This includes, but is not limited to, processor, protective relay, network switch, Modbus/TCP gateway, power electronics, and HMI interface components.

2.03 UNIT EQUIPMENT:

A. Equipment to be provided for each unit, as follows (exact quantities of equipment for each compartment shall be the responsibility of the Contractor):

1. Pending final single line diagrams.

2. Equipment, components, devices, relays, meters, etc. shall be supplied and electrically interconnected (pre-wired) to the extent possible as applicable to the switchgear in accordance with the following drawings and as required by the Contract Documents, especially:

a. Supplying Substation Single Line Diagrams: 0100-E602 and 0100-E603

b. IPS Switchgear Meter and Relay Diagrams: 0100-E604 and E-605

2.04 IPS STANDBY SWITCHGEAR METER AND RELAY DIAGRAMS: 0100-E606 AND E-607SOURCE QUALITY CONTROL:

A. Test at the factory in accordance with IEEE C37.20.1 and NEMA, including operating and high potential tests.

B. Test breakers in accordance with IEEE C37.09 and ANSI/IEEE C37.20.2.

C. Test breakers in a switchgear cell of the basic design in which the breaker will be used.

1. Include continuous current test.

2. Include momentary current test.

3. Include BIL test.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install in accordance with IEEE C37.20.1.

B. Install switchgear on level structural steel channels accurately embedded in the floor per the manufacturer’s instructions.

C. Install switchgear plumb and level and with each section aligned properly.

D. Make electrical connections between equipment sections using connectors furnished by manufacturer.

E. Install engraved plastic nameplates in accordance with Section 26 05 53.

F. Ground and bond switchgear in accordance with Section 26 05 26.

G. Bond duct banks with cables that route to switchgear to switchgear's grounding electrode system.

H. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors, sized as shown.

I. Complete switchgear grounding and lightning arrester connections prior to making any other electrical connections.

3.02 FIELD QUALITY CONTROL:

A. Energize the space heaters as soon as each switchgear is delivered to the site. Obtain power for the heaters from the temporary power and lighting system until they can be energized from the source shown.

B. Furnish the services of a representative of the manufacturer of the switchgear to check the installation before it is energized. Submit to Engineer, 3 copies of a signed statement from manufacturer's representative and addressed to Owner that the equipment has been properly installed and is in good working order. Include:

1. Operation of each circuit breaker.

2. All circuit breaker trip functions.

3. Control power transfer system.

C. Test in accordance with the latest standards of ANSI and NEMA.

D. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

E. Check tightness of accessible bolted bus joints using calibrated torque wrench.

F. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each, at test voltage of 1000 volts; minimum acceptable value for insulation resistance is 2 megohms.

G. Perform power frequency withstand testing in accordance with IEEE C37.09.

H. Physically test key interlock systems to insure proper function.

I. Inspection and test in accordance with NETA ATS, except Section 4. (Or equivalent tests from an approved equal.)

J. Perform inspections and tests listed in NETA ATS, Section 7.6. (Or equivalent tests from an approved equal.)

K. Use IR inspection windows to record baseline thermography of the system and to identify and resolve any hotspots during commissioning process. Provide electronic written summary with photos from all IR windows. Ensure all relevant components are viewable from these windows.

3.03 ADJUSTING:

A. Adjust all operating mechanisms for free mechanical movement.

B. Tighten bolted bus connections in accordance with manufacturer's instructions after placing switchgear.

C. Adjust protective relays in accordance with recommendations of the Short Circuit Analysis and Protective Device Coordination Study of Section 26 05 70 and as directed by the Engineer.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

B. Furnish complete, clear, and concise instructions for installation, operation, and care of equipment.

END OF SECTION

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SECTION 26 13 13S

MEDIUM VOLTAGE CIRCUIT BREAKER SWITCHGEAR – SOO SUPPLEMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This supplement includes the Sequence of Operations for the Medium-Voltage Switchgear identified for paralleling standby Medium-Voltage (MV) Generator Sets to MV Distribution and Sources, including but not limited to paralleling with the normal-power MV Sources.

B. This Sequence of Operations (SOO) describes the integration requirements for a system with:

1. Main-Tie-Main power sources from an off-site normal power source,

2. Various demand loads,

3. Up to 3 generators feeding a common generator bus:

a. This generator switchgear bus is spatially separated from the switchgear providing power to load breakers on tie-separated busses.

b. Protective relays and breakers are specified at both ends.

c. The load busses are normally energized and separated from the common generator bus by an emergency tie breaker. The common generator bus is normally de-energized.

d. At Contractor's preference, either of the following breakers can be used for synching or paralleling the generators to the normal power system, or vice-versa:

(1) The generator-supplied breaker on the load-feeding switchgear

(2) The load switchgear-feeding breaker on the generator paralleling switchgear.

4. Reference Single Line Diagrams and Plan Drawings for additional information and requirements.

1.02 DEFINITIONS:

A. Determine definition of words and abbreviations in this Section:

1. As defined within this specification.

2. "Utility Power" and "Utility" are simplifications to describe medium voltage normal-power feeds from utility-supplied switchgear at the main Salt Lake City Water Reclamation Facility, which may or may not include paralleled or dedicated generator power. It is noted the "Utility" feed to this facility's switchgear is a subfeed from a Rocky Mountain Power (RMP)-supplied and generator-backed switchgear.

3. As defined by other specifications within Division 26.

4. As defined by other Specifications within this project.

5. As defined in Relevant NFPA or other AHJ-adopted Codes.

6. As defined in IEEE technical documents.

1.03 KEY PARAMETERS

1. Power ramping while paralleled shall not exceed 100kW-per-second, whether loading or unloading, except where system faults require emergency shut-down. Under fault conditions, protective devices shall open and shut down power to the fault in accordance with protective relaying coordination requirements.

2. Provide study as required in other Sections, as required to ensure scope of any such shutdown is minimized, and maximum backup power remains available. Provide alarm signal for SCADA integration of any such fault, including information to determine nature and scope of fault for the HMI operator.

3. Delegated design – it is the Contractor's responsibility to assure that system stability is such that power will not reverse-feed to the normal-power sources during transition. This implies a stability study and generator governance as required to parallel without backfeeding, while also continuing to provide acceptable power quality, including both voltage range and frequency.

B. Back-feeding provisions:

1. Under normal conditions, load balance generators as required to ensure any contribution back to utility power source lasts for less than $1/10^{th}$ of a second. This includes when restoring power to normal.

2. Provide manual override such that power can be back-fed to the utility source when needed, such that the source breaker becomes a load breaker in emergency conditions, and this Backfeeding Mode is both set and reset at the generator

paralleling system master control panel. Include cancellable warning for SCADA operator before engaging, to ensure the main plant power is disconnected from RMP before enabling this feature, and to consider disabling this feature before returning to RMP power.

C. Provide instrumentation and monitoring of utility breaker and tie breakers as required to determine utility status and to monitor and control relevant breakers for both parallel supply in islanding operation and paralleling operation with the utility.

D. Provide adjustable user-prioritizable control of load breakers to determine which breakers should open in the event of an overload. Default setting is to open the spare circuit breakers, then the off-site power source breakers, then individual VFDs, starting at 6, and decreasing to 1, and then the 480V loads.

E. Provide interface to SCADA system. Provide, at a minimum Modbus TCP registers as required for:

1. Status of utility availability, including both utility-side voltage and utility-side frequency.

2. Status of each breaker between utility and generators.

3. Indication of values monitored at each transducer within distribution switchgear.

4. Indication of values monitored at each transducer within generator-paralleling switchgear.

5. Determination of both magnitude and direction of power flow through utility breaker.

1.04 FUNCTIONAL SEQUENCE OF OPERATIONS

A. Automatic / Standby Mode, With Normal Power in Steady-State:

1. The utility main breaker is closed serving utility power to the load bus.

2. The synchronizing emergency tie breaker 52MZ is open.

3. The generator main breakers 52G11, 52G21, and 52G31 are open.

4. Generator paralleling gear main breaker 52MZP is closed.

5. The automation is standing by to act in response to a utility failure. Utility failures occur when protective relays open, or when voltage or frequency is outside of bounds.

6. Failures in supplies to only 52MX or 52MY cause breaker(s) associated with failure to open, and remaining breaker to close, following synch check / delay.

B. Emergency Mode; Transition Upon Normal Power Failure:

1. Utility Failure at both supplying breakers 52MX and 52MY.

2. Utility protective relaying and/or transducer senses utility voltage or frequency out of tolerance.

3. The utility main breaker is opened.

4. A run request is sent to the generator plant. (This is left to contractor means/methods, and is to be transparent to the SCADA operator.)

5. The first generator up to voltage and frequency is closed to the generator paralleling switchgear bus.

6. The emergency tie breaker, 52MZ, is closed at the load-supplying switchgear to energize loads.

7. The remaining generators are synchronized and paralleled to the bus as they come up to voltage and frequency.

8. The system is now in Emergency Mode.

C. Utility Restoration and Exit from Emergency Mode:

1. Utility protective relaying and/or transducer senses utility voltage and frequency within tolerance.

2. Following an adjustable time delay (which can be abbreviated by the operator, default value of 30 minutes) to assure that the utility power source is stable, the generator plant is synchronized and paralleled to the utility source by closing the utility main breaker.

3. The paralleling control system immediately starts unloading one generator as required to avoid reverse-feeding the utility grid, while not unloading faster than 100kW/s.

4. The generator plant is soft ramp unloaded until the utility source is nominally serving the entire system load.

5. The emergency tie breaker, 52MZ, is opened.

6. The generator breakers 52G11, 52G21, and 52G31 are opened.

7. The generators are allowed to run for their programmed cool down period, then shut down.

8. The system is now back in Automatic/Standby Mode.

D. Storm Mode, Similar to Emergency Mode, but Manually-Controlled:

1. Entry

a. The operator places the Master Mode Selector Switch into the Transfer to Emergency position. - A soft button on the Human-Machine Interface (HMI) touchscreen is an acceptable substitute.

b. A run request is sent to the generator plant. (This is left to contractor means/methods, and is to be transparent to the SCADA operator.)

c. The first generator up to voltage and frequency is closed to the generator bus.

d. The remaining generators are synchronized and paralleled to the bus as they come up to voltage and frequency.

e. The generator plant is synchronized and paralleled to the utility source by closing the emergency tie breaker. Generator governors are controlled such that there is zero energy contribution to the bus.

f. The generator plant is ramp loaded, at 100kVA/sec until it is serving nominally the entire load on the bus and the utility main breaker is opened.

g. The system is now in Storm Mode.

2. Exit from Storm Mode

a. The operator removes the Master Mode Selector Switch from Transfer to Emergency position and returns it to the Auto position. - A soft button on the Human-Machine Interface (HMI) touchscreen is an acceptable substitute.

b. Following an adjustable time delay (which can be abbreviated by the operator), the generator plant is synchronized and paralleled to the utility source by closing the utility main breaker, either 52MX or 52MY, as previously supplying, or as selected by Operator.

c. The generator plant is ramp unloaded, at the same rate as loaded, until the utility source is nominally serving the entire system load.

d. The 52Z emergency tie breaker is opened.

e. The generator breakers are opened.

f. The generators are allowed to run for their programmed cool down period.

g. The system is now back in Automatic/Standby Mode.

E. No Load Test Mode

1. Entry

a. The No Load Test Switch is placed in the ON position. A soft button on the Human-Machine Interface (HMI) touchscreen is an acceptable substitute.

b. All available generators are started.

c. The first generator up to voltage and frequency is closed to the bus.

d. The remaining generators are synchronized and paralleled to the generator paralleling switchgear bus as they come up to voltage and frequency.

e. The system is now in No Load Test Mode.

2. Exit

a. The No Load Test Switch is placed in the OFF position. A soft button on the Human-Machine Interface (HMI) touchscreen is an acceptable substitute.

b. All generator breakers are opened.

c. The generators are allowed to run for their programmed cool down period.

d. The system is now back in Automatic/Standby Mode.

F. Utility Fail Test Mode

1. The Utility Fail Test Mode is understood to be manually conducted by Operators causing the 52MX and/or 52MY breaker(s) to open, simulating a real loss of power.

G. Load Add/Shed Control

1. Load control is to be through the SCADA system. Provide, at a minimum read-only Modbus TCP registers as required for:

a. For Plant SCADA systems to energize loads sequentially upon outage. Ensure backup power system will not close breakers opened for reasons other than load shedding. Track breakers opened for load shedding, and re-close them within 2 minutes of opening, and where opened for more than 2 minutes, provide alarms for operator intervention. The intent of this requirement is to avoid unanticipated closing of circuit breakers. Also provide immediate alarm at SCADA console of any breakers opened for load shedding, and identify the system will attempt to re-close within 2 minutes of opening, or manual re-closing will be required.

b. Provide pollable registers as required to continuously determine:

(1) The number of generators online.

(2) The system voltage.

(3) The system frequency.

(4) Individual generator output kW.

(5) Individual generator output kVA.

2. Coordinate with SCADA provider for HMI reset feature when system trips out for undervoltage or under-frequency beyond acceptable setpoints for scale and time.

3. It is not an acceptable alternative to directly control load-supplying breakers.

H. Generator Demand Priority Control

1. The System Controls shall include a Generator Demand Priority Control function to automatically match the on-line generator capacity to the loads to avoid unnecessary operation of all the generators when the loads are low.

2. The following controls shall be provided for each generator:

a. User-adjustable Generator Priority Selector

b. Status indicator for the Generator Priority Selected

c. Status indicator for generator On-line or Off-line

3. The Generator Demand Priority Control shall have the following controls:

a. Generator Demand Priority Control Switch (On/Off) - A soft button on the Human-Machine Interface (HMI) touchscreen is an acceptable substitute.

b. User-adjustable Generator Remove % (as a function of a single generator capacity)

c. User-adjustable Generator Remove Delay

d. User-adjustable Generator Add % (as a function of a single generator capacity)

e. User-adjustable Generator Add Delay

4. Upon entrance into Emergency or Storm modes, all generators shall be started and paralleled to the bus. After the Remove Time Delay, generators shall be removed from the bus as a function of the generator percentage loading by the user selected

Generator Remove time delay. Generators shall be removed from the bus in descending priority. Should the generator percentage loading increase to the user selected Generator Add limits for the user selected Add Delay, the next generator will be started, synchronized and paralleled to the bus. Generators shall be added to the bus in ascending priority order. Should the generator plant ever reach 95% loading, the next priority generator shall be started and added to the bus with no time delay.

I. On-Line Paralleled Load Testing

1. Continuous performance – Throughout this test mode, provide background monitoring of the system such that full emergency power will kick in if normal power systems are lost, with all generators available, not just the generator undergoing a load test while paralleled to the grid.

2. Entrance:

   a. The SCADA system provides signal for appropriate Engine Generator to come on-line for load testing. (Provide such signal handling for each generator unit, including start-mode, percent loading, and as otherwise required to implement this mode.)

   b. Specified generator begins idle.

   c. Synchronizing systems govern generator set and wait for synch between the generator bus and the load bus, and synch the generator set. Breakers close as applicable, depending on number of generators operating in this configuration.

   d. Generator increases loading to 80%, or to percentage of loading determined by SCADA operator HMI, with hard system lock-outs to between 0-100%, with additional lockouts to ensure overload duration does not exceed manufacturer limitations. Ensure all lock-outs account for generator deration for elevation above sea level.

   e. Automatically decrease load whenever required to avoid reverse-feeding power to the utility through the utility main breaker. Continuously limit generator output to ensure at least 500kVA of power is drawn into the plant at all times during load testing, as required to assure no grid contribution, with respect to the accuracy of the CT units within the switchgear. Provide SCADA integration for HMI alert message for this condition.

   f. Generator load is modulated as adjusted at SCADA HMI.

3. Exit:

   a. Operator Signals to discontinue operation

b. Generator decreases load contribution to 0%.

c. Generator breaker opens.

d. If last generator breaker has opened, then open generator system paralleling main breaker.

e. Generator idles as required for system cooling and safe shut-down.

f. Generator shuts down at timeframe per manufacturer recommendations. Delay to be 5 minutes if not stated by manufacturer or if ambiguous.

4. In the event of a utility failure during a Load Bank Test:

a. The remaining generators are synchronized and paralleled to the bus as they come up to voltage and frequency.

b. The system is now in Emergency Mode.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

(Not Used)

END OF SECTION

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SECTION 26 20 00

ELECTRIC MOTORS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Low voltage electric motors and accessories, furnished under other Sections, and which are a part of equipment assemblies shall be in conformance with the requirements specified in this Section, unless otherwise noted. This section includes performance, and descriptive type specifications.

B. Medium voltage electric motors and accessories are specified by this Specification Section and per Section 43 21 00.34, “Vertical Wet Pit Solids Handling Pumps And Appurtenances”. Referenence Section 42 21 00.34 for additional requirements.

C. Unless otherwise specified or approved, all electric motors furnished and installed by the Contractor shall conform to the requirements specified herein.

1. Motors connected to a Variable Frequency Motor Controller shall be inverter duty rated in accordance with the requirements of NEMA MG-1.

2. Motors rated 1 hp or greater shall be premium efficient type per NEMA MG-1.

1.02 REFERENCES:

A. Institute of Electrical and Electronics Engineers (IEEE).

1. 112: Test Procedures for Polyphase Induction Motors and Generators

2. 1349: IEEE Guide for the Application of Electric Motors in Class 1, Division 2 Hazardous (Classified) Locations

B. National Electric Manufacturer's Association (NEMA):

1. MG-1: Motors and Generators

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

1.03 SUBMITTALS:

A. Shop drawings: Submit the following in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 00.

1. Descriptive literature and motor characteristics.

2. Shop drawings and descriptive data to include:

a. Complete list of all motors to be furnished.

b. Outlines, dimensions, weights, and wiring diagrams.

c. Location of main and accessories boxes with size of conduit entrance.

d. Efficiency and power factor at 1/2, 3/4 and full load.

e. Bearing design data and grease requirements.

f. Nameplate data

g. Shop test report

h. Field acceptance test report

i. Strip heaters KW and voltage ratings

j. Power factor correction capacitors, where required.

k. Built in overload protection device where applicable.

l. Starting restrictions, acceleration time-current curve of motor starting load (100 hp and larger).

m. Thermal damage curve and allowable stall time, full voltage (100 hp and larger).

n. Thermal monitoring and protective devices.

o. Vibration Sensors and Vibration Sensor Monitors.

3. Submit Pump, Motor and VFD Coordination Certificate. Refer to Section 01 33 00 for form.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Motors to comply with the latest reference standards listed below.

1. National Electrical Code (NEC)

2. Underwriters Laboratories, Inc. (UL)

3. National Electric Manufacturer's Association (NEMA).

   a. MG-1: Motors and Generators

4. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA)

5. American National Standard Institute (ANSI)

6. Institute of Electrical and Electronics Engineers (IEEE).

   a. 112: Test Procedures for Polyphase Induction Motors and Generators

   b. 1349: IEEE Guide for the Application of Electric Motors in Class 1, Division 2 Hazardous (Classified) Locations

C. Routine tests shall be performed on representative motors, and shall include the information described on NEMA MG1-12.54 Report of Test Form for Routine Tests on Induction Motors. Efficiency shall be determined in accordance with IEEE Publication No. 112, Method B. Power factor shall be measured on representative motors.

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with APWA Section 01 66 00 and as specified.

B. Shipping:

1. Ship motors assembled to driven equipment complete except where partial disassembly is required by transportation regulations or for protection of components.

2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

3. Deliver spare parts at same time as pertaining materials. Delivery to Owner after completion of work.

C. Receiving and Storage:

1. Inspect and inventory items upon delivery to site.

2. Store and safeguard equipment and material in heated storage facility as recommended by equipment manufacturer and required by APWA Section 01 66 00.

3. Protect motors from moisture at all times.

4. Protect motors from exposure to elements for which they are not designed. Install and energize temporary electrical service to motors with space heaters.

5. Unless protected by manufacturer's packing, upon delivery, carefully wrap each motor in three layers of 8-mil-minimum polyethylene. Secure the wrap with adhesive tape. For base-mounted motors, wrap the entire assembly.

D. Prolonged Storage:

1. For extended outdoor storage, remove motors from equipment and store separately.

2. If storage is anticipated to be longer than two months, store in accordance with the manufacturer instructions including the following additional steps.

3. Maintain motor space heaters energized.

4. Fill the oil reservoirs of motors with sleeve bearings to the proper level with the specified oil.

5. Motors with anti-friction bearings to receive an initial change of grease and then be re-greased every six months.

6. Remove the motor shaft braces and the rotate motor shaft every two weeks. Replace the shaft braces prior to relocation to the installation site. Under no circumstances should the motor be lifted without the braces in place.

7. Provide vapor phase corrosion inhibitor pad (emitter) inside the wrapping.

PART 2 - PRODUCTS

2.01 MOTOR MANUFACTURERS:

A. Motors rated below 1kV:

1. General Electric Company

2. Reliance Electric

3. U.S. Motors

B. Motors rated above 1kV:

C. Toshiba.

D. U.S. Motors.

E. Weg Motors.

F. E Motors.

G. National Oilwell (previously Louis-Allis).

2.02 CONTINENTAL ELECTRIC MOTORS.ELECTRIC MOTOR RATINGS:

A. Voltage Ratings:

1. Unless otherwise specified, motors with ratings of 3/4 to 350 hp shall be rated 460 volt (nameplate rating), 3-phase, 60 Hertz; motors of 1/2 hp or less to be rated 115 volt, single-phase, 60 Hertz.

2. High voltage motors, if indicated on drawings, shall be as specified in associated equipment Specification Section and per this Specification Section.

B. The following specific motor requirements shall be in the equipment specifications:

1. RPM

2. Motor enclosure type

2.03 MOTOR DESIGN REQUIREMENTS:

A. Motor heaters shall be supplied on all medium voltage motors and on motors installed outdoors or in unheated areas. Heaters shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 volt, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate.

B. Unless otherwise specified or permitted all electric motors furnished and installed by the Contractor shall conform to the requirements hereinafter set forth.

C. Motors connected to variable frequency motor controller shall be inverter duty rated.

D. Every motor shall be of sufficient capacity to operate the driven equipment under all load and operating conditions without exceeding its rated nameplate current or power or its specified temperature limit at rated voltage. Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where indicated on the electrical drawings to be operated on a reduced voltage starter, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.

E. The motor shall have sufficient capacity to operate the driven equipment as given in the equipment detail specifications. The motor shall not be required to deliver more than its rated nameplate horsepower, at unity (1.0) service factor, under any condition of mechanical or hydraulic loading.

F. The motor shall be suitable for rated horsepower and full service factor operation at 4,500 feet elevation above sea level.

G. Type of Motors:

1. All motors shall be NEMA Design B or of a type having starting characteristics and ruggedness as may be necessary under the actual conditions of operation and, unless otherwise specified, shall be suitable for full-voltage starting.

H. Insulation:

1. Reference later within this specification for requirements for insulation of shaft bearings for motors supplied by variable frequency motor controllers.

2. All motors shall have Class B or Class F insulation with temperature rise by resistance at full load rating of a Class B insulation in accordance with NEMA Standards for Motors and Generators, NEMA MG1, and based on a maximum ambient temperature of 40 degrees C unless otherwise specified.

3. Insulation systems shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalies and mechanical or thermal shock for 480 volt motors. Provide 80 degrees C, Class B rise or better by resistance at 100 percent load and provide a Class F insulation system, suitable for an ambient temperature motor operation of 0 to 40 degrees C at no more than 4,500 feet above sea level for inverter duty motors. This temperature rise shall be met when motors are operated and controlled with the VFD(s). The motor insulation system shall have full capability to handle the common mode voltage conditions imposed by the VFD.

4. Motors for outdoor service shall have vacuum/pressure impregnated epoxy insulation for moisture resistance.

5. Insulation for inverter duty motor windings shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be injured when exposed to repeated pulse type waveforms, repetitive high voltage transients, switching frequency and rate of rise of the pulse. Class H varnish shall be used.

I. Enclosures:

1. Motors shall have a steel or cast iron frame and a cast iron or stamped steel conduit box, as specified below. Conduit box shall be split from top to bottom and shall be capable of being rotated to four positions. Synthetic rubber-like gaskets shall be provided between the frame and the conduit box and between the conduit box and its cover. Motor leads shall be sealed with a non-wicking, non-hygroscopic insulating material. A frame mounted pad with drilled and tapped hole, not less than 1/4-inch diameter, shall be provided inside the conduit box for motor frame grounding.

    a. Totally enclosed fan cooled: TEFC motors shall have a steel or cast iron frame, cast iron end brackets, cast iron conduit box, 1.15 service factor at 40 degrees C, tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger) and upgraded insulation by additional dips and bakes to increase moisture resistance.

    b. Totally enclosed non-ventilated: TENV motors shall include the same rating and accessories as specified for TEFC motors.

    c. Explosion proof motors shall comply with all requirements of Class I, Division I, Group D, hazardous locations as defined by the NEC and with all other safety codes pertaining thereto.

J. Special Purpose Motors:

1. Chemical duty motors shall be provided with severe duty rating. Motors shall be of the corrosion resistant type conforming to motors designated by the manufacturer as Corro-Duty, Mill and Chemical, Custom Severe Duty, or similar quality designation. Severe duty motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box and 1.15 service factor at 40 degrees C and tapped drain holes (corrosion resistant plug for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger).

2. Hermetically sealed air conditioning units, elevators, hoists, cranes and other devices complying with special safety codes shall be furnished with motors, control equipment, accessories and safety devices for approved, safe, and efficient operation, in accordance with the manufacturer's standards and to be rated for the duty cycle as specified for the driven equipment. Minimum service factor 1.15 above 3 hp.

3. Submersible motors shall be manufacturer's standard.

4. Synchronous and wound rotor motors shall be specified elsewhere in the specifications when required.

5. Inverter duty rated: Motors for operation on variable frequency motor controller shall meet current power quality levels published in NEMA MG1. Enclosures shall be equal to those furnished for severe duty or explosion proof motors. Motor shaft and bearings shall be insulated. Internal service factor shall be 1.15 that of the nameplate. Ventilation system shall be designed for maximum heat transfer. Stator laminations shall be stagger-stacked and stamped from high grade electrical steel to minimize eddy-current losses and heat build-up caused by inverter induced harmonics. Rotors shall be configured to minimize skin-effect heating.

K. Auxiliary Devices:

1. Three phase motors shall not be provided with starting capacitors.

2. Single-phase motors requiring switching devices and auxiliary starting resistors, capacitors, or reactors shall be furnished as combination units with such auxiliaries either incorporated within the motor housings or housed in suitable enclosures mounted upon the motor frames. Each combination unit shall be mounted upon a single base and to be provided with a single conduit box.

3. Motors 200 hp or over, or where specified in other sections, shall have:

a. Winding temperature detectors that are:

(1) Factory installed

(2) Embedded

(3) Bi-metallic switch type or thermistors with relay with leads terminating in the main conduit box.

(4) Designed and prototype-tested to protect the motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts or ventilation failure.

(5) Arranged to have normally closed contacts, that open upon abnormal conditions.

(6) In quantities of not less than three detectors per motor. Provide two RTDs per phase for MV motors over 450HP, one on each side of the stator.

(7) Listed as part of overall motor assembly.

b. Bearing temperature sensors, meeting the same requirements of winding temperature sensors, except:

(1) Need not be embedded into the actual bearing.

(2) Shall allow for removal and replacement with hand tools as required to replace either sensor or bearing.

c. Vibration Sensors that are:

(1) Factory installed.

(2) Accompanied by a listed and compatible vibration sensor monitor module with appropriate time-delay features to alarm when severe vibration is encountered, and to avoid nuisance indications from vibrations not associated with machine failure. Coordinate monitor to be compatible with motor controller auxiliary power supply.

(a) In addition to the requirements listed above, for the vibration monitoring system at each IPS raw wastewater pump provide complete system with the following functions:

- One discrete output to indicate high vibration, suitable for interlocking out the VFD upon excessive vibration.
- Ethernet capability for communication of sensor values and alarms to SCADA.
- Systems compatible with local 120V power supply.
- With enclosure suitable for the location, or located within I&C cabinet, where space exists.

(3) Either:

(a) Tri-axial type for either non-sleeve bearings or for gears.

(b) Displacement-type (in/sec) for sleeve bearings.

(4) Sensor Format:

(a) Motors rated less than 1kV - Arranged to have normally closed contacts, that open upon abnormal conditions.

(b) Motors rated 1kV and higher - To match proprietary system recommendations for the application, compatible with vibration sensor monitor described earlier in this section, and completely powered/serviced by vibration sensor monitor. Provide system with compatible vibration and speed reference sensors.

(c) Coordinate with motor, pump, and/or coupling manufacturer to provide sensor manufacturer's recommended mounts, such as threaded wells, for maximum quality sensing.

(5) Listed as part of the overall motor assembly.

d. Non-Drive end insulated bearing, with additional bearing(s) as required for motors supplied by Variable Frequency Motor Controllers.

e. Shaft Grounding Kit – Identified for use in grounding the motor shaft to the frame of the motor with a lower impedance than is usually required to microweld the bearing race to the moving parts of the bearing. AEGIS™ shaft grounding kit, or approved equal.

L. General Design of Motors:

1. Motors shall comply with the latest NEMA Standards Publication No. MG1 for Motors and Generators, unless otherwise specified.

2. All polyphase non-explosion proof motors shall be designed for energy efficient operation and meet the requirements of MG1-12.53 a and b.

3. Motor windings shall be braced to withstand successfully the stresses resulting from the method of starting. The windings shall be treated thoroughly with acceptable insulating compound suitable for protection against moisture and slightly acid or alkaline conditions.

4. Bearings shall be of the self-lubricating type, designed to ensure proper alignment of rotor and shaft and to prevent leakage of lubricant.

a. Bearings for open motors shall be of the sleeve or ball type, as specified under the respective items of mechanical equipment.

b. Bearings for totally enclosed and explosionproof motors shall be of the ball type.

c. Bearing minimum L-10 fatigue life in hours at 100 percent load shall be 50,000.

d. Bearing grease shall be of the 120 degrees C thermal capability type.

5. Vertical motors shall be provided with thrust bearings adequate for all thrusts to which they can be subjected in operation.

a. For motors rated 1kV and above:

(1) Motors operated in a vertical position shall be designed for vertical operation and shall have thrust bearings with a rated B-10 life of 40,000 hours as defined by AFBMA standards. In addition, motor thrust bearings shall be capable of withstanding a momentary upthrust equal to at least 30 percent of the rated downthrust capacity and any other transient loads imposed on the bearings during starting or

shutdown. Thrust and guide bearings shall be oil lubricated and shall be continuously submerged in oil when the motor is not in use. Provide a means for visual observation of the oil level for bearings while the motor is in operation. No filtered water-cooling may be used.

6. For motors rated 1kV and above:

   a. Provide copper stator windings. Do not provide aluminum windings. Provide motors with form-wound coils and a sealed insulation system equivalent to the General Electric "Custom Polyseal" system, Westinghouse "Thermalastic Epoxy" system, or U.S. Motors "Everseal" system.

   b. Balance motors after assembly to an overall vibration amplitude of 1 mil (0.025 mm) maximum, when measured at the machine bearing housing.

   c. Provide motor Motor Enclosure and Speed per Process Pump Schedule, or as scheduled in driven equipment specification.

   d. Perform the following nonwitnessed tests at the factory, conforming with NEMA MG1:

      (1) No load current and speed.

      (2) Locked rotor current.

      (3) High potential tests.

      (4) Winding resistance.

      (5) Full load heat run with temperature rise measured by resistance method.

      (6) Percent slip.

      (7) Efficiency at full, 3/4, and 1/2 loads.

      (8) Power factor at full, 3/4, 1/2, and no load.

      (9) Starting torque.

      (10) Locked rotor current test and determination of pullout torque as calculated from locked test.

7. Vertical motors of the open type shall be provided with drip hoods of acceptable shape and construction. When the drip hood is too heavy to be easily removed, provision to be made for access for testing.

8. All three phase two speed motors shall be of the two-winding design.

9. All three phase motors shall be provided with a 1.15 service factor.

10. Three phase motors shall be of cast iron construction including frame and end brackets.

11. Totally enclosed motors shall be provided with automatic breather and drain

12. Motor nameplates shall be stainless steel.

13. Motor Terminal Boxes and Leads:

    a. Motors shall be furnished with oversize conduit terminal boxes to provide for making and housing the connections, and with flexible leads of sufficient length to extend for a distance of not less than 4 inches beyond the face of the box. The size of cable terminals, and terminal box conduit hoses shall be as permitted by the Engineer. An acceptable type of solderless lug to be furnished. Totally enclosed and explosionproof motors to have cast-iron terminal boxes.

    b. Leads for space heaters shall be brought out into an auxiliary, cast, conduit box on the motor side opposite to the main terminal box. Auxiliary box to have 1 inch threaded conduit openings and shall be so constructed that conduit entrance may be placed at top, bottom, or either side.

    c. A grounding terminal shall be provided in the main terminal box and a bronze grounding bolt to be furnished at the conduit side of the motor frame.

14. Provide screens over openings.

15. Reference specifications for driven equipment to determine requisite motor type and housing.

M. Motor Efficiencies:

1. Three phase motors rated 1 hp and larger shall be of the premium efficiency, “Design E”, type per Table 12.1 of NEMA MG1 Part 12. Motors shall have a NEMA Nominal Efficiency not less than the values referenced in NEMA MG1. Efficiency values shall be based on tests performed in accordance with IEEE Publication No. 112, Method B. Motors with horsepower or rpm’s not listed shall conform to comparable standards of construction and materials as those for listed motors.

N. Shop Painting:

1. Unless otherwise specified, motors shall be given a shop application of paint filler or enamel sealer, a flat coat of undercoater for enamel, and two coats of enamel or, in lieu of this treatment, other corrosion-resistant treatment customary with the manufacturer.

2. Coat per manufacturer-standard color with oil-resistant, outdoor-rated paint. Apply prime coat at the factory. Reference Section 09 90 00 for additional requirements.

O. Motor Data:

1. The Contractor shall furnish the Engineer with five certified copies of characteristic curves of each motor furnished, except 115-volt motors. Curves shall be supplied as a part of the driven equipment submittal.

P. Motor Shop Tests:

1. Motor shop tests shall be made in accordance with the IEEE Test Codes as specified in the NEMA MG1 Standards for Motors and Generators. NEMA report-of-test forms to be used in submitting test data.

2. Motor efficiency shall be determined by use of IEEE Standard 112 Test Method B, and by use of MGI-12.53 a and b.

3. For induction motors larger than 100 hp, complete tests of each motor furnished to be made and certified tests data sheets to be submitted, unless witness shop tests are required by the technical specifications pertaining to the equipment. Each motor shall be tested at rated voltage for: efficiency and power factor at 50, 75, and 100 percent of it rated horsepower; for temperature rise, torque, no-load current, starting current, full load current, and dielectric strength; and for compliance with all specified performance requirements.

4. For induction motors 5 hp, up to and including 100 hp, copies of routine tests reports of electrically duplicate motors shall be furnished.

5. For motors 3 hp or less, no test data need be furnished.

Q. Spare Parts:

1. Provide in accordance with Section 01 78 23 and as specified.

2. Furnish one spare bearing of each type for each motor size and type.

R. Capacitors for Motors:

1. All 3-phase, non-explosionproof 460 volt motors 50 hp and above (except for motors driven through variable frequency drive units) shall be provided with a capacitor of the maximum kVAR. Size recommended by the motor manufacturer and in accordance with the requirements of the NEC.

2. Capacitors shall be furnished with the motors. All capacitors to be installed and wired in accordance with the requirements of the NEC.

3. Capacitor shall be rated 600 volt, 3-phase, 60 Hertz.

4. Each capacitor unit to be enclosed in a corrosion-resistant weatherproof dusttight housing for indoor/outdoor use with threaded conduit connection. A heavy duty corrosion-resistant wall rack shall be provided with each capacitor. Discharge resistors to be included to reduce the voltage to 50 volts or less within one minute after the capacitor is disconnected from the source.

5. Capacitors shall be dry film or liquid insulated and shall be hermetically sealed in steel enclosures.

6. Each capacitor unit shall be furnished with three high interrupting capacity current limiting fuses. Fuss shall be equipped with blown-fuse indicators.

7. Capacitor enclosures shall be suitable for conduit connection and of the NEMA enclosure type required for the area as indicated on the Drawings. Covers shall be gasketed, bolt-on type.

8. Capacitors shall be UL listed.

9. Capacitors shall be by General Electric Co.; Square D Co.; Sprague.

2.04 ELECTRICAL INTERFACE:

A. All items of electrical equipment that are furnished with process, heating, ventilating, or other equipment shall conform to the requirements specified under the applicable electrical sections of the Division 26 specifications. Enclosures for electrical equipment such as switches, starters, etc., shall also conform to the requirements specified under the applicable electrical sections of the Division 26 specifications.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Verify heaters are energized on motors installed in outdoor or unheated areas.

B. After motor installation but before connection to power wiring, test motor winding insulation in accordance with the applicable Division 26 requirements.

C. After connection to power wiring, check for operating temperature, correct rotation, vibration, alignment and operating current drawn under load.

D. Submit all motor test results for review and record.

E. Adjust and test protective features as required to assure reasonable protection from thermal damage and from excess vibration. Adjustments to be minimum practical values in accordance with manufacturer instructions and as required to avoid false alarms.

3.02 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 22 14

DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide copper-wound, dry-type transformers as indicated and specified.

B. Provide transformer windings and enclosures rated for the installation location and in accordance with the requirements herein.

C. Transformers shall be “Energy Star” rated.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. Z55.1: Gray Finishes for Industrial Apparatus and Equipment

B. ASTM International (ASTM):

1. D635: Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

C. National Electrical Manufacturers Association (NEMA):

1. ST 20: Dry-Type Transformers for General Applications.

D. International Electrical Testing Association (NETA):

1. ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

E. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

F. Underwriters' Laboratories, Inc. (UL):

1. 506: Standard for Specialty Transformers.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

C. Submit shop drawings and manufacturer's product data of the transformer. Information to include:

1. Outline drawings including dimensions.

2. Weight.

3. Ratings and tap configuration.

4. Core and coil material.

5. Insulation system description.

6. Loss data and efficiency.

7. Accessories.

8. Mounting requirements.

9. Nameplate data.

10. Testing data.

D. Submit a Certificate of Compliance indicating conformance to the Seismic Requirements specified. Certificate shall be signed and sealed by a Professional Structural Engineer holding current registration in the state for work of this project.

E. For informational purposes only, provide manufacturers printed installation instructions including anchoring details to meet earthquake requirements as specified and indicated on structural drawings.

1.04 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements specified in Section 01 41 20.

B. It shall be the responsibility of manufacturer and supplier along with the Electrical Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with APWA Section 01 66 00.

B. Deliver transformers individually wrapped for protection and mounted on shipping skids.

C. Accept transformers on site. Inspect for damage.

D. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle and stored in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.07 REQUIREMENTS OF REGULATORY AGENCIES:

A. Furnish transformers in accordance with NEMA ST 20 and UL 506.

B. Furnish transformers with UL listing mark.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Square D Co.

B. Eaton-Cutler-Hammer Corp.

C. Siemens Inc.

D. ABB.

2.02 TRANSFORMERS:

A. In NEMA 1 and NEMA 12 designated areas, furnish general purpose, ventilated, dry-type transformers in indoor-style enclosure. On single-phase transformers and three-phase transformers above 9 KVA, provide not less than two windings per phase.

1. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.

2. Ventilation openings shall prevent accidental access to live components.

3. Thoroughly clean and paint enclosure at the factory with manufacturer's prime coat and standard finish.

B. In NEMA 4 or NEMA 4X designated areas, provide transformers with encapsulated windings and stainless steel enclosures.

C. Auto transformers shall not be used in place of general purpose dry-type transformers.

D. Furnish at least two 2-1/2 percent full capacity taps above and below nominal in high voltage winding for transformers rated above 15 kVA. Two five percent taps below rated voltage for transformers rated 15 kVA and below.

E. Furnish transformers, single-phase or three-phase, as indicated. Furnish transformers with kVA ratings as indicated.

F. Furnish three-phase transformers, Delta-Wye, Delta-Delta or Wye-Wye connected as indicated, and conforming to latest NEMA standards. Scott Tee connected transformers are not acceptable above 9 kVA.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Furnish transformers with primary and secondary voltages and frequency, wye connected, as indicated for secondary windings, with neutral brought out for cable termination.

I. Furnish transformers designed for continuous operation at rated kVA with normal life expectancy as defined in NEMA ST 20.

J. For transformers rated 30 kVA or less, ensure that performance is obtained without exceeding 115 degrees C average temperature rise by resistance or 145 degrees C hot spot temperature rise in 40 degrees C maximum ambient and 30 degrees C average ambient. Do not allow maximum coil hot spot temperature to exceed 185 degrees C.

K. Furnish transformers with 220 degrees C insulation materials with proven reliability for 15 kVA transformers and above. Furnish 185 degrees C insulation on transformers below 15 kVA.

L. Transformers rated greater than 30 kVA shall be provided with low-loss 80 degrees C full load operating temperature rise rating.

M. Furnish transformers made of flame retardant materials that will not support combustion as defined in ASTM D635.

N. Furnish core mounting frames and enclosures of welded and bolted construction with mechanical rigidity and strength to withstand shipping, erection and short circuit stresses.

1. Cores shall be grain oriented, non-aging, and silicon steel.

2. Coils shall be continuous windings without splices except for tapes.

3. Coil loss and core loss shall be minimum for efficient operation.

4. Primary and secondary tap connections shall be razed or pressure type.

5. Coil windings shall have end fillers or tie downs for maximum strength.

O. Transformers located in areas where fire protection system sprinklers are located shall be provided with NEMA 2 rated enclosure to protect transformer from water falling at an angle of 75 degrees from the vertical.

P. Furnish transformers designed to meet UL thermal overload test of 200 percent of rated current for one half hour.

Q. Furnish transformers not to exceed the 65 degrees C rise established by UL as safe limit for maximum surface enclosure temperature.

R. Furnish transformers with sound level not exceeding:

Average Sound Level in dB

kVA	NEMA ST 20
0-09	40
10-50	45
51-150	50
151-300	55
301-500	60

S. Install transformers with sound levels greater than 50 dB on resilient vibration isolating mounts to prevent amplification of sound. Transformers rated 15 kVA and larger to be provided with rubber washer anti-vibration pads and molded neoprene assemblies to isolate noise from the transformer to the mounting surface.

2.03 SHOP TESTING:

A. Submit results of audible-sound-levels tests in accordance with NEMA ST 20 of similar size transformer.

B. Production test each unit in accordance with NEMA ST 20.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Set transformer plumb and level. Install and guard transformers as specified by latest NEC and ANSI standards, and in accordance with manufacturer's printed instructions.

B. Furnish adequate space around transformer to dispose of transformer full load losses by ventilation without creating excessive ambient temperature. Verify working clearances as required by the NEC are met.

C. Unless indicated otherwise on drawings, wall mount with suitable supports, transformers rated 15 kVA and below. Floor mount transformers rated above 15 kVA unless otherwise indicated on the drawings. In addition, all transformers located in NEMA 4 or NEMA 4X designated areas shall be wall mounted on Type 316 stainless steel channel supporting systems with Type 316 stainless steel concrete inserts, minimum 7 feet-6 inches AFF. Provide all required seismic restraints.

D. Provide lifting lugs and jacking plates on transformer enclosure.

E. Provide concrete pad for all floor mounted transformers.

F. Clean metal parts, excepting cores and core mounting frames, then rust-proof and apply heavy coating of inert primer. Paint coverplates and external metal parts with two finish coats of ANSI Z55.1 No. 61 or 49 Gray.

G. Verify mounting pads are in place to reduce noise.

H. Install grounding and bonding in accordance with the drawings and Section 26 05 26.

3.02 FIELD TESTING:

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

3.03 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 23 15

NEUTRAL GROUNDING RESISTOR

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes materials and installation of neutral grounding resistors for resistance grounding of power distribution systems as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. C19.3: Compressors for Process Industries

B. National Electrical Manufacturers Association (NEMA):

1. C29.3: Wet-Process Porcelain Insulators-(Spool Type)

2. ICS 1: Industrial Control and Systems: General Requirements

3. ICS 6: Standard for Industrial Controls and System Enclosures.

C. Underwriter's Laboratories, Inc. (UL):

1. 347: Medium Voltage Industrial Control Equipment.

1.03 SEISMIC DESIGN REQUIRMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. Conform to the requirements specified in Section 01 41 20 and Section 26 05 50, Seismic Controls for Electrical Systems.

C. It shall be the responsibility of manufacturer and supplier along with the Electrical Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

1.04 SUBMITTALS:

A. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 01 33 00 and Section 26 05 10 “Electrical Work – General”.

B. Submit manufacturer's descriptive and technical literature and any details required to demonstrate that the equipment will function properly as a unit. This material shall include:

1. System configuration with single-line diagrams. Identify devices by location, size, and manufacturer type number.

2. Detailed descriptions of equipment including weights, dimensions, foundation requirements, installation requirements, and heat dissipation.

3. Complete dimensional plan views indicating sizes and clearances required for all equipment.

4. Interconnection and schematic diagrams for power and control wiring showing all interconnection and wiring with terminal numbers for each wire. Clearly identify contacts, terminal blocks, and wire numbers for remote devices. Show field devices and wiring on diagrams.

5. Nameplate designations.

C. Submit factory and site acceptance test procedures for review 30 days prior to tests. Include a detailed description of all tests to be performed.

D. Submit copies of certified factory test reports.

1.05 OPERATION AND MAINTENANCE MANUALS:

A. Submit operation and maintenance manuals in accordance with Section 01 78 23 “Operation and Maintenance Data”. The manuals shall describe the equipment in full and shall include the following major items:

1. Operating instructions and start-up procedures including receiving and installation requirements.

2. Maintenance instructions listing preventive and corrective maintenance procedures. Corrective maintenance procedures shall identify the most probable failures and the appropriate repairs. Reference test measurement levels to specific test points on the installed equipment.

3. Provide spare parts data for each item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply. Provide a list and itemized price breakdown of spare parts recommended for stocking. The parts selected shall be those that, in the manufacturer's judgment, will be involved in the majority of maintenance difficulties encountered.

4. Control schematics, ladder diagrams, and interconnection drawings.

5. Catalog cuts and technical manuals for system components.

6. Copy of guarantees and warranties issued for the various items of equipment, showing all dates of expiration.

7. Copies of test results.

8. Final copies of shop drawings incorporating manufacturing and field changes.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 40 00 “Quality Requirements”.

B. Ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied. Review the proper installation of each type of device with the equipment supplier prior to installation.

1.07 DELIERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 61 00, “Control of Materials”.

B. Shipping:

1. Ship equipment, and materials, except where partial disassembly is required by transportation regulations or for protection, complete with identification and quantity of items.

2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Provide nameplates as specified in Section 26 05 10 “Electrical Work – General”.

B. The grounding resistor shall be manufactured by Westinghouse Electric Corporation, Bender Incorporated, or equal.

2.02 NEUTRAL GROUNDING RESISTOR:

A. Design, construct, and test the neutral grounding resistors and enclosures in accordance with the latest applicable sections of NEMA, ANSI, and UL.

B. The grounding resistor shall meet the requirements shown on relevant single line diagram(s), maximum temperature rise 135 degrees F (75 degrees C).

C. Construct resistor units of stainless steel, edge-wound type with welded connections between units. The edge-wound helix strap shall be wound around a refractory core reinforced by longitudinal stainless-steel supports. Individually support each resistor element at each end by ceramic insulators in such a manner that one end of the helix bar support is freely attached to a roller which shall permit expansion of the supporting bar when subject to high temperatures.

D. Provide resistor frames with a screen-type enclosure with openings in the side and top not to exceed 1/2-inch (13 mm). Construct of aluminum (Alloy 6061-T6) with bolted construction using steel hardware. When required, provide the enclosure with current transformer mounting and entrance bushing. Support each frame by porcelain pin and cap-type insulators. The insulators shall conform to NEMA C29.3.

E. Provide the grounding resistor and enclosure with provisions for lifting and suitable for pad mounting outdoors.

2.03 FINISH:

A. Clean chemically and treat steel surfaces to provide a bond between the primer paint and metal surfaces. Final coat shall be in accordance with manufacturer's standard paint.

2.04 FACORTY TESTS:

A. Test and inspect equipment in conformance with NEMA ICS 1-109 and ANSI C19.3. The tests shall verify the physical configuration of assembly and workmanship, the mechanical adjustments of parts and components, and the sequencing and functional operations of control systems.

B. Perform a dielectric test (Hi-pot) on circuit wiring, with appropriate connection separated to avoid equipment damage, to confirm the insulation resistance to withstand breakdown to a selected test voltage. The test method shall be as specified in NEMA ICS 1-109-21.

C. Test power cables and buses phase-to-ground for insulation breakdown resistance and circuit isolation as specified in NEMA ICS 1-109.21.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Secure neutral disconnect switchgear rigidly to floor, supporting steel, or mounting pad with anchor bolts or Phillips Drill Company concrete anchors. Provide supplemental steel, per delegated design by a Utah-License Professional Engineer, as required to mount the neutral grounding resistor as shown in the Electrical plans.

B. Connect neutral conductor to one of the poles of the switch. Do not use the other two poles. Connect the corresponding bus to the conductor connected to the grounding

resistor. Electrically interlock the switch with the corresponding generator breaker as shown in the drawings.

3.02 FIELD TESTING:

A. Test the operation of the resistor and switches to verify correct operation. Perform adjustments as required for correct operation.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00 “Execution and Closeout Requirements”.

END OF SECTION

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide panelboards rated 600 volts or less and 1200 amperes or less.

B. Provide with circuit breakers and cabinets complete, as indicated and specified.

1.02 REFERENCES:

A. Federal Specifications (FS):

1. QQ-S-365B: General Requirements for Silver Plating, Electro Deposited

2. W-C-375B: Automatic Circuit Breakers

3. W-P-115A: Panel, Power Distribution

B. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 volts maximum)

2. AB 1: Molded Case Circuit Breakers

3. PB 1: Panelboards

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

D. Underwriter's Laboratories, Inc. (UL):

1. 50: Cabinets and Boxes

2. 67: Panelboards

3. 86A: Wire Connectors and Soldering Lugs for Use with Copper Conductors

4. 489: Circuit Breakers, Molded Case and Circuit Breaker Enclosures

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturer's product data in accordance with requirements of Section 26 05 10.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. All panelboards shall be designed, manufactured and assembled in accordance with the referenced standards.

C. Listing and Labeling: All panelboards shall be listed and labeled by Underwriter's Laboratories, Inc. (UL), or other nationally-recognized testing laboratory (NRTL).

D. Service Entrance panelboards shall be UL/NRTL-labeled as suitable for that purpose.

E. Single-source Responsibility: Provide panelboards products that are new, and from the same manufacturer for each building or job. Panelboard components shall be from the same manufacturer, or listed as an assembly thereof.

PART 2 - PRODUCTS

2.01 PANELBOARD MANUFACTURERS:

A. Manufacturers acceptable contingent upon products' compliance with the specifications:

1. Cutler-Hammer Products

2. General Electric Company

3. Siemens Corp.

4. Schneider Square D

2.02 PANELBOARDS:

A. Factory assembled deadfront type panelboards.

B. Furnish panelboards complete with branch circuit breakers and a main circuit breaker or main lugs only as indicated.

C. Furnish panelboards with full capacity separate ground bus, separate insulated neutral bus and furnish panelboards connected to a 3 phase, 4 wire service or single phase, 3-wire service as indicated.

D. Provide panelboards with the voltage, frequency and current ratings as indicated conforming to NEMA Standard PB1, Federal Specification W-P-115A. U.L. 67, and the NEC.

E. Furnish the panelboard main and neutral buses, with minimum 98 percent conductivity rectangular copper bars provided with bolted type lugs as necessary.

F. Drill buses to fit either "A", "B" or "C" Phase connectors, and ensure that connectors are inter-changeable and installed in a distributed phase sequence.

G. Prevent terminal lugs from turning per NEMA standard PB 1 and ensure they are suitable for the conductor material and size.

H. Provide main bus-bracing for each panel board adequate for 10,000 amperes symmetrical short circuit at 240 volts and 42,000 amperes symmetrical short circuit at 480 volts unless otherwise indicated.

I. Where the word “space” occurs on panel schedules, provide all necessary hardware in the space, including connection straps, mounting brackets, and filler plates so that only the addition of a future circuit breaker is required. Connection straps shall be rated a minimum of 100A in panelboards of 400A rating or less and a minimum of 225A in panelboards above 400A rating, unless otherwise noted on panel schedules.

J. Tinned buses, connectors and terminals to a minimum thickness of 0.005-in., conforming to the requirements of Federal Spec. QQ-S-365B.

K. Provide integral surge protection device (SPD) in accordance with Section 26 43 13 where indicated on the Drawings.

2.03 CIRCUIT BREAKERS:

A. Each circuit breaker shall be bolted into position in the panelboard, whether by direct bolted connection to the bus or by being bolted to the panelboard frame. Each circuit breaker shall be replaceable without disturbing adjacent units. Plug-on circuit breakers held in place only by spring force of the bus lug and the pressure of the deadfront are not acceptable.

B. Furnish frame sizes, trip settings and number of poles as indicated. Clearly and visibly mark circuit breakers with ampere trip rating. Furnish breakers meeting the requirements of F.S. W-C-375B and NEMA AB1.

C. Furnish all breakers with quick-make, quick-break, toggle mechanisms and thermal-magnetic, inverse time-limit overload and instantaneous short circuit protection on all poles, unless otherwise indicated. Automatic tripping indicated by the breaker handle assuming a clearly distinctive position from the manual ON and OFF position. Furnish breaker handle that is trip-free on overloads.

D. Do not use single pole breakers with handle ties or bails in lieu of multi-pole breakers.

E. For each panelboard, furnish quantity four handle lock devices for individual breakers to prevent the manual opening of the selected breakers. Turn devices over to Owner at completion of the project work.

F. Ensure that voltage and interrupting rating of all breakers in a panelboard is not less than voltage and short circuit rating of the panelboard main buses, as indicated. Furnish breakers suitable to operate satisfactorily at the frequency indicated.

G. Furnish ground fault interrupter (GFI) circuit breakers for certain circuits as indicated on the drawings.

H. Furnish equipment level ground fault protective (GFP) circuit breakers for heat tracing circuits as indicated on the drawings.

I. Furnish manufacturer's locking provisions for circuit breakers as indicated on the drawings.

J. Furnish single pole breakers with full module size. Do not install two pole breakers in a single module.

K. Furnish time-current characteristic curves and catalog information and data for each size of breaker furnished.

2.04 CABINETS:

A. Provide cabinets with NEMA enclosure type as indicated and without knockouts. Drill cabinets only for the exact conduit entrances and mounting bolts.

B. Finish cabinet fronts, trims and surface-mounted boxes in ANSI No. 61 or 49, light-gray enamel over a rust-inhibitive primer. Attach the fronts (exterior trims) to the boxes or interior trims, by quarter-turn, indicating trim clamps. Design cabinets for surface or flush mounting as indicated.

C. Unless otherwise specified, construct panelboard cabinets of code-gauge galvanized, sheet steel and equip with gutters of ample size for the risers and outgoing circuits. Ensure that the cabinets do not exceed 78 inch in height.

D. Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab. Equip locking tab with provision for a screw such that removal of trim requires a tool, at the Owner's option. Installation shall be tamper resistant with no exposed hardware on the panelboard trim.

E. Provide enclosure with the following side gutter dimensions:

1. Left side minimum 4-1/2 inch measured from inside lip of the box to the installed deadfront.

2. Right side; minimum 4-1/2 inch measured from inside lip of the box to the installed deadfront. With the door-in-door cover in place; minimum 3-1/4 inch from installed outer door hinge to the installed deadfront.

2.05 FACTORY TESTING:

A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Mount panelboards, plumb and rigid without distortion of the box. Mount such that the height of the top operating handle does not exceed 6 feet 7 inches from the floor.

B. Hang each door of the cabinet on semi- or fully-concealed hinges with a combination catch and lock.

C. On cabinets 48 inch high and over, install a 3 point catch assembly latching at top, bottom and approximate middle.

D. Verify all panelboard locks are keyed alike.

E. Provide typed directory card filled-out to clearly indicate the load served.

F. Door hinge to be on the side opposite escape route if applicable.

3.02 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 24 19

MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide motor control center, totally enclosed, free-standing, cabinet-type structure with motor starters, circuit breakers and/or fused switches and other equipment, as indicated and specified. Motor control center to operate at 480 volt, 3 phase, 3 wire, 60 Hertz.

B. Complete motor control center to be designed, assembled, wired, and tested at the point of manufacture in accordance with the latest NEMA, UL, and ANSI standards.

C. Use manufacturer's standard when data is not specified.

D. Provide Surge Protective Devices (SPD) as indicated, and as specified in Section 26 43 13.

E. Provide MCCs with Short Circuit Current Rating as shown in Single Line Diagrams, or as shown in schedules, whichever is more conservative. Provide with labels incorporating the results of the arc flash studies provided under Section 26 05 70.

F. Provide MCC line ups with means for Arc Flash energy reduction, complying with 2020 NEC Article 240.87. Provide means other than the following 240.87 options:

1. "Energy-reducing maintenance switching with local indictator", 240.97(B)(3)

2. "An Intantanous trip setting on the main breakers." , 240.97(B)(5)

3. "An instantaneous override", 240.97(B)(6)

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. C39.1: Electrical Analog Indicating Instruments

B. Institute of Electrical and Electronic Engineers (IEEE):

1. C57.13: Standard Requirements for Instrument Transformers

C. National Electrical Manufacturers Association (NEMA):

1. AB 1: Molded Case Breakers

2. ICS 2: Industrial Controls and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts

3. KS 1: Enclosed Switches

D. National Fire Protection Association (NFPA):

1. 70: National Electric Code (NEC)

E. Underwriters' Laboratories, Inc. (UL):

1. 489: Molded-Case Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

2. 845: Standards for Motor Control Centers

3. 1008: Standard for Automatic Transfer Switches

4. 1066: Low Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

C. Complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts, installation instructions.

D. Complete wiring and schematic diagrams for the equipment furnished. Each wiring diagram shall be legible and not reduced from the original design drafted format. Provide a list of equipment on each wiring diagram for which it is applicable.

E. Equipment layout.

F. Time versus current curves for protective devices.

G. Data sheets for all devices provided as part of the assembly.

H. All other details required to demonstrate that system has been coordinated and will properly function as a unit.

I. Spare Parts Data: Provide a list of recommended spare parts for the material and equipment to be provided, including current unit prices and source of supply (indicate which supplies are furnished at no extra cost with purchase of equipment) and in accordance with Section 01 78 23.

J. Operating and Maintenance Instruction Manuals:

1. Furnish:

a. Operating instruction manuals outlining step-by-step procedures required for system startup and operation and in accordance with Section 01 78 23.

b. Manufacturer's name, model number, service manual parts list.

c. Brief description of equipment and basic operating features.

d. Maintenance instruction manuals outlining maintenance procedures, for all devices, including compartment installation, circuit breakers, motor starters and fuses.

e. Troubleshooting guide listing possible breakdown and repairs.

f. Record drawing wiring diagrams for the system.

K. Performance Test Reports: Upon completion of installed system, submit in booklet form all field tests performed to prove compliance with specified performance criteria including final position of controls.

L. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.04 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. Conform to the requirements specified in Section 01 41 20.

C. It shall be the responsibility of manufacturer and supplier along with the Electrical Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

1.05 SPARE PARTS:

A. Furnish following spare parts for each motor control center:

1. Twelve lamps for indicating lights.

2. One coil for each size of starter furnished for each motor control center.

3. One complete set of fuses for each size furnished.

4. One set of contacts for each size of starter furnished.

5. One control transformer for each volt-ampere capacity unit furnished.

6. One remote I/O module for every 20 starters.

B. Package items in suitable containers bearing labels clearly indicating contents and equipment with which used.

1.06 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied. Review the proper installation of each type of device with the equipment supplier prior to installation.

C. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Assist in location of devices, methods of mounting, field erection, etc.:

a. 10 person-days

3. Functional Completion Testing:

a. 10 person-days

4. Startup:

a. 15 person-days

5. Commissioning:

a. 10 person-days

6. Service-inspections during first year of operation, for use at Owner's request, and exclusive of repair, malfunction or other trouble-shooting service calls:

a. 10 person-days

7. Person-day is defined as one 8-hour day, excluding travel time.

8. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

9. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

1.07 DELIVERY STORAGE AND HANDLING:

A. Provide in accordance with APWA Section 01 66 00 and as specified.

B. Shipping:

1. Ship equipment, and materials, except where partial disassembly is required by transportation regulations or for protection, complete with identification and quantity of items.

2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

3. MCCs shall be separated into shipping blocks no more than three vertical sections each. Each shipping block shall include a removable lifting angle, to allow attachment by suitable lifting equipment.

4. Deliver spare parts at same time as pertaining equipment. Delivery to Owner after completion of work.

5. Channel bases:

a. For front and rear, minimum of 1-1/2 inch by 3 inch standard channel with suitable holes for mounting motor control center, and holes for grouting and flow of concrete.

b. Shipped in advance with accurate template of motor control center mounting holes or dimension layout drawing for embedding in concrete pad, floor slab, or securing to floor.

6. Attach lifting angles to main frame of structure to distribute weight equally. Deflection or distortion is cause for rejection.

7. If the equipment cannot be placed into service after its receipt, store in a closed building or structure, in a clean, dry and ventilated area free from temperature, dirt and moisture extremes. Acceptable storage temperatures are from 32 degrees F to 104 degrees F with temporary heaters provided within enclosures to prevent condensation. Provide heavy plastic envelope directly over motor control center to protect against dust, dirt, and moisture. Provide lifting angles outside of envelope.

C. Storage:

1. Inspection and inventory items upon delivery to site.

2. Store and safeguard equipment, material and spare parts.

1.08 WARRANTY AND SERVICE:

A. Provide in accordance with Section 01 78 36 and as specified.

B. Guarantee components, parts, and assemblies supplied by manufacturer against defects in materials and workmanship for a period of 12 months after acceptance or beneficial occupancy, whichever happens first.

C. Ensure that equipment manufacturer has local branch office staff with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. The equipment manufacturer shall be ISO 9001 or 9002 certified.

B. Manufacturer’s acceptable contingent upon products' compliance with the specifications.

1. Eaton/Cutler-Hammer Inc.

2. General Electric Company

3. Siemens Energy & Automation, Inc.

4. Square D Company

2.02 COMPONENTS:

A. Motor control center construction: Comply with UL 845

B. Starters: Comply with the requirements of NEMA ICS 2

C. Instruments: Comply with ANSI C39.1

D. Enclosures:

1. Enclosures for motor control centers: NEMA Type 1 gasketed, unless otherwise indicated on the Contract Drawings.

2. Motor control centers: NEMA Class II-S, Type B wiring.

3. Outline dimensions of motor control centers and arrange equipment and devices as indicated.

4. The minimum depth of a motor control center is 20 inch. Arrange motor control centers for back-to-back mounting of the starter units where indicated.

5. Each MCC shall consist of one or more vertical sections of heavy gage steel bolted together to form a rigid, free-standing assembly. A removable 7 gage structural steel lifting angle shall be mounted full width of the MCC shipping block at the top. Removable 7 gage bottom channel sills shall be mounted underneath front and rear of the vertical sections extending the full width of the shipping block. Vertical sections made of welded side-frame assembly formed from a minimum of 12 gage steel. Internal reinforcement structural parts shall be of 12 and 14 gage steel to provide a strong, rigid assembly. The entire assembly shall be constructed and packaged to withstand normal stresses included in transit and during installation.

E. Buses:

1. Locate main horizontal bus at top with ampere rating as indicated. Isolate bus from both front and back compartments.

2. Neutral bus if required: Rated at full capacity.

3. Main and vertical buses: 98 percent conductivity tinned copper bars of suitable size carried on supports fabricated from an acceptable insulating material.

4. Short circuit bus bracing: As indicated.

5. Vertical buses: A minimum rating of 300 amperes for front only units, a minimum rating of 600 ampere for back-to-back units. Insulate or isolate vertical buses.

6. Provide continuous 2 inch by 1/4 inch tinned copper ground bus along length of the motor control center.

7. Contact surfaces of bar-to-bar connections and lug-to-bar connections: Silver plated.

8. Phase rotation of vertical buses: Make same when viewed from front or from either side of motor control center.

9. Bolts and other hardware: Galvanized or stainless steel or equal.

10. Provide horizontal wireways at top and bottom of each vertical section. Provide vertical wireways with wire supports for each vertical section. Interconnect all wireways.

11. Provide standard corrosion resistant fasteners for unit doors hardware which operate without special tools.

F. Barriers:

1. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a glass filled polyester support assembly that braces the bus against the forces generated during a short circuit. The horizontal bus shall be isolated from the top horizontal wireway by a two-piece rigid non-conductive barrier. The barrier design shall allow qualified personnel to slide the barriers both left and right, to allow access to the bus and connections for maintenance without having to remove the barrier. Barrier sliding shall occur via an upper and lower track system.

2. The vertical bus shall be housed in a molded glass-filled polyester support that provides bus insulation and braces the bus against the forces generated during a short circuit. These supports shall have openings every 3 inch for unit stab-on connections. Each opening shall be provided with an automatic shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the MCC.

3. Barriers shall be provided in the vertical structure and unit designs to prevent the contact of any energized bus or terminal by a pull wire routed through the conduit or wireway areas.

G. Motor Control Center Units:

1. Motor control center units: Drawout type. Units larger than NEMA Size 4 having bolt-in construction. Provide fully interchangeable removable units of same size and type.

2. Interlock disconnect devices with associated doors, to prevent closing the disconnect device with the door open unless a tool is used or a defeater device is operated.

3. Furnish disconnect devices capable of being locked in either the open or closed position.

4. Arrange each unit so that when its starter has been removed, its door may be closed to cover the opening.

5. With following features:

a. Viewing window through door of each compartment for visible disconnect inspection to verify that stabs are disconnected from bus.

b. Provide Infrared (IR) inspection window in the main circuit breaker doors, the tie circuit breaker door, and as recommended by the MCC manufacturer for maintenance personnel to periodically inspect the gear without opening doors and accesses. However, one side of the MCC may be shut down at a time for the inspection process.

H. Motor Control Center Starter Units:

1. Unless otherwise indicated, use minimum NEMA Size 1 combination starter, consisting of a circuit breaker, or motor circuit protector and magnetic starter, as indicated. Momentary and interrupting ratings of circuit breakers, motor circuit protectors, and fused disconnect switches coordinated with main bus bracing. Type of starters, i.e., full voltage, reduced voltage, reversing, non-reversing, two-speed, etc., are as indicated. Furnish magnetic starters with thermal overload protection on each phase with external manual reset.

2. Solid-State Overload Relay:

a. Provide a solid-state overload relay for protection of the motors. The relay shall be Cutler-Hammer type CEP7 from equipment manufacturer.

b. The overload relay shall provide high accuracy through the use of state-of-the-art microelectronic packaging technology. The relay shall be suitable for application with NEMA Size 1 through Size 7 motor starters.

c. The overload relay shall be modular in design, be an integral part of a family of relays to provide a choice of levels of protection, be designed to directly replace existing electromechanical overload relays, and be listed under UL Standard 508.

d. The overload relay shall have the following features:

(1) Self-powered.

(2) Class 10 or 20 fixed tripping characteristics.

(3) Manual or automatic reset 4.

(4) Phase loss protection. The relay shall trip in 2 seconds or less under phase loss condition when applied to a fully loaded motor.

(5) Visible trip indication.

(6) One normally open and one normally closed isolated auxiliary contact.

(7) Test button that operates the normally closed contact.

(8) Test trip function that trips both the normally and normally closed contacts.

(9) A current adjustment range of 3.2:1 or greater.

(10) Ambient temperature compensated.

(11) Ground fault protection. Relay shall trip at 50 percent of full load ampere setting.

(12) Jam/Stall protection. Relay shall trip at 400 percent of full load ampere setting, after inrush.

2. Verify type (single- or 2-winding) of two-speed motor being installed. Furnish type of motor starter necessary for control of motor. Furnish decelerating, time-delay relay for each two-speed starter.

3. Remote Input/Output (I/O) Modules (compatible with system specified in Section 40 67 00):

   a. Motor Control Center assemblies shall be provided with a factory assembled Remote I/O modules which are configured to provide remote control and indications from the Facility Control System (by others). Remote I/O modules shall be capable of communication with the Facility Control System using Ethernet/IP protocol.

   b. Provide Motor Control Centers with pre-wired distributed I/O wiring which originates at Remote I/O modules located within the MCC. Provide 24 VDC power supply with sufficient capacity to supply the I/O modules, communication card and relays. The power supply shall be installed in an MCC unit with a disconnect switch and overcurrent protection.

   c. Remote I/O shall be configured to provide the control and status functions depicted on the project Motor Control Diagrams and as described herein.

   d. Barriers shall be provided to separate the distributed Remote I/O wiring from power wiring.

   e. The Remote I/O cabling system shall be designed to allow separation of the MCC sections into shipping splits.

4. Provide reduced voltage solid-state type starters with thyristor (SCR) bridge consisting of at least two SCRs per phase to control the starting and stopping of industry standard motors.

   a. The soft start shall provide torque control for linear acceleration without external feedback independent of motor load or type of application.

b. The gating of the thyristors will be controlled in such a manner to ensure smooth and stable acceleration ramp.

c. The soft start shall be controlled by a microprocessor that continuously monitors the current and controls the phasing of the SCRs. Analog control algorithms shall not be allowed.

d. All soft start power ratings will utilize the same control board/module.

e. A shorting contactor shall be supplied with the soft start controller units. Protective features and deceleration control options integral to the soft start shall be available even when the shorting contactor is employed.

f. The soft start controller unit shall be designed to operate from an input voltage between minus 10 percent and plus 10 percent of nominal voltage rating.

g. The soft start controller unit shall operate from an input voltage frequency range of plus or minus 5 percent. By configuration, it shall be capable of operation at a supply line frequency that can vary by plus or minus 20 percent during steady state operation.

h. The soft start shall be capable of supplying 400 percent of rated full load current for 23 seconds at maximum ambient temperature.

i. All soft start controller unit power and control devices shall be rated heavy duty and capable of 5 evenly spaced starts per hour at 400 percent of full rated current for 25 seconds per start without tripping.

5. Furnish starter operating coils suitable for operation on 120 volt, single-phase, 60 Hertz.

6. Furnish each starter with at least one normally open and one normally closed auxiliary contact. Furnish additional normally open and/or normally closed auxiliary contacts for indicating lights, interlocking and other requirements as indicated.

7. Motor horsepower indicated on Contract Drawings may not be same as furnished, if larger motors are furnished, circuit breakers, fused switches, starters, wire and conduits of larger capacity may be necessary and, if so, furnish them at no additional cost.

8. Furnish within each starter compartment a control transformer with primary fuses and secondary fuse. Secondary voltage 120 VAC, unless otherwise indicated. Determine load of each motor control circuit including equipment and devices provided under the other specification sections and furnish control circuit transformer 2-winding, dry-type of suitable volt-ampere rating, but not less than

75 volt-amperes. Control circuit loads may consist of but not be limited to solenoid operators, motorized valves, motorized dampers, relays, motor heaters, etc.

I. Variable frequency drives (VFDs) shall be provided in MCCs where indicated. VFDs shall be in accordance with Section 26 29 23, and include 5 percent input reactors, and dV/dt output filters for cable leads to motors in excess of 100 feet of cable length. VFDs shall include network interface to provide interconnection with plant control system through remote I/O network.

J. Circuit Breakers:

1. Main and tie breakers to be low voltage power circuit breaker with auxiliary contact for alarm on open or trip condition. Circuit breakers to be provided in accordance with UL Std. 489. Provide with long time, short time, instantaneous and ground fault solid state adjustable trip units.

2. Unless otherwise indicated, furnish manually operable circuit breakers and provide thermal-magnetic, inverse-time-limit overload, and instantaneous, short-circuit protection. UL listed circuit breakers conforming to NEMA Std. AB-1 and UL Std. 489.

3. Breakers: Molded case type, rated 480 volts, 2 or 3 pole and having 100 ampere or larger frames. Minimum interrupting rating equal to bus bracing required. Furnish current limiting type, where indicated.

4. Furnish overload protection on all poles with trip settings as indicated. Breakers of 225 ampere frames and larger with interchangeable trip units and adjustable magnetic trip elements.

5. Where indicated, furnish circuit breakers with shunt trip.

6. Furnish time-current characteristic curves and other necessary information and data for each size of breaker furnished.

7. Should supplied HVAC equipment require a maximum overcurrent device less than 15 amps, provide fused disconnect-type MCC bucket instead, with fuses sized for the load.

K. Motor Circuit Protectors:

1. Motor circuit protectors being completely enclosed molded case devices with current sensing coil in each of 3 poles having adjustable magnetic trip setting by means of single knob on front. Motor circuit protector manually operable. Protector designed to meet NEC requirement concerning motor full load and locked-rotor current. Minimum interrupting rating equal to bus bracing required.

2. Where indicated, current limiters, completely enclosed in molded case, bolted to load end of motor circuit protector to provide at least 100,000 amperes symmetrical interrupting rating at 600 volts. Limiters coordinated with protector so at low level short circuit, protector interrupts circuit without limiter operation. Faults interrupted by limiter also trip the protector and open all 3 poles. Equip each limiter with an indicator to show that the limiter has interrupted a fault.

L. Contactors:

1. Contactors for electric heating and other non-motor loads: Similar to motor starters except without overload relays or heaters. NEMA size as indicated, except 30 amperes minimum rating, tungsten lamploads.

2. Contactors for lighting loads: Mechanically held. Ampere ratings as indicated, except 30 amperes minimum rating tungsten lamploads.

M. Control Devices:

1. Control relays: Heavy-duty, industrial or machine tool type with at least two normally open and two normally closed contacts. Coils 120 volts, 60 Hertz.

2. Contacts: Rated 10 amperes, 250 volt alternating current.

3. Time-delay relays: Adjustable, pneumatic type, range 2 to 60 seconds and operated on 120 volts, 60 Hertz, with at least one normally open and one normally closed timed contact.

4. Pushbuttons and instrument selector switches: Heavy-duty, oil tight units, 30 mm, rated 10 amperes continuous current at 120 volts.

5. Indicating lights: LED type, heavy-duty, oil-tight, 30 mm units with push-to-test features.

6. Control and selector switches: Rotary type with enclosed contacts. Equip each switch with rectangular escutcheon and pistol-grip handle, except handles for instrument phase selector switches equipped with round knurled or slotted handles. Switch contacts rated 10 amperes continuous, 600 volts.

N. Nameplates: Furnish each motor control center and each unit of motor control center with engraved nameplate. Nameplates of laminated sheet plastic, 1/16 inch thick, engraved to provide white letters on black background. Fasten nameplates in place with corrosion-resistant screws.

O. Instruments:

1. Instruments: Panel type, approximately 3-1/2 inch or 4-1/2 inch square as indicated, semi-flush mounted. Accurate within 1 percent of full scale. Select

scales so full load readings occur at approximately 70 percent of full scale. UL listed instruments conforming to ANSI C39.1.

2. Furnish suitable instrument transformers. Conforming to ANSI C57.13.

   a. Current transformers of window type and insulated for 600 volts.

   b. Furnish potential transformers with current limiting primary fuses.

3. Running time meters: Mechanical style, panel-mounted, round, UL Certified, non-reset type, 3-1/2 inch with register to indicate hours and tenths of hours up to 99,999.9 hours. Meters to operate on 120 volts, 60 Hertz. Provide with 3-hole bezel mount.

4. Furnish current and potential test blocks with plugs where indicated. Clearly identify current, voltage and phase for blocks and plugs.

2.03 WIRING:

A. Conductors: Copper; size as required by load, except that no control wire is smaller than 14 AWG. Use insulation that is flame retardant, and moisture and heat resistant.

B. Cables and conductors: Bundled and tie wrapped securely in wireways furnished.

C. Identify internal wiring at terminations by T&B wire markers or equivalent.

D. All spare starter auxiliary contacts to be wired to terminal blocks.

E. Terminal Blocks:

1. Rated 600 volt for power with current rating as required by loads.

2.04 FINISH:

A. Finish motor control centers with ANSI No. 61, light-gray enamel over rust-resistant undercoat.

B. Furnish instruments and control devices with standard black finish.

C. Use, mixing, application, and curing of paint on items requiring painting in accordance with paint manufacturer's written recommendations.

2.05 FACTORY TESTS:

A. The entire MCC shall go through a quality inspection before shipment, verifying the equipment to the factory shop drawings. This inspection will include:

1. Physical inspection and verification of:

a. Structure including verification of all bolted connections

b. Electrical conductors, including:

(1) Bussing including verification of all bolted connections

(2) Wiring

(3) Unit compartments

2. Electrical Tests:

a. Electrical tests include:

(1) Power circuit phasing

(2) Control circuit wiring and verification of satisfactory operation of all relays and other devices

(3) Instrument transformers

(4) Meters

(5) Ground fault system

(6) Device electrical operation

b. AC dielectric tests shall be performed on the power circuit.

3. Markings/Labels, include:

a. Instructional and warning type labels

b. Underwriters Laboratory (UL)

c. Inspector's stamps

4. The manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the MCC meets operating specifications.

B. Equipment that is shipped without evidence of the required tests being performed to verify satisfactory operation will be subject to non-acceptance.

C. If the MCC cannot be placed into service reasonably soon after its receipt, store it in a clean, dry and ventilated building free from temperature extremes. Acceptable storage temperature is from 32 degrees F to 104 degrees F.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install steel channel sills that have suitable drilled holes for mounting, aligning, and bolting each motor control center in place. Method of mounting, as indicated. Size and arrangement of sills, as recommended by motor control center manufacturer and acceptable to Engineer. Paint completed sills with two coats of aluminum paint or other acceptable corrosion-resistant finish before being set in place. Properly set and level channel sills.

B. If motor control center equipment pads are located on concrete floor slabs, furnish painted steel channel mounting sills and anchor bolts, in time for placing concrete for construction of concrete equipment pads.

C. Install items in accordance with manufacturers' printed instructions.

D. Verify all loads on the motor control center including equipment and devices provided under the other electrical and non-electrical specification sections. Provide information to motor control center manufacturer for sizing of buses, control transformers, and protective devices. Verify that cables and conduits for loads are sized for the actual equipment provide in accordance with the NEC.

E. Set motor circuit protectors and circuit breakers based on load installed.

F. Check and provide a thermal overload on each phase of a starter unit. Match overloads to motor being installed.

G. Deliver spare parts to Owner.

H. Provide conduit, wiring, and grounding interconnections.

I. Perform continuity and operational tests on circuits to demonstrate that motor control center is operationally safe and functionally correct.

J. Provide one set of manufacturer wiring diagrams marked with all changes made in the field.

3.02 TESTING:

A. Adjust and verify all settings and inputs to meters and relays.

3.03 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 27 17

CONTROL PANELS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide materials and installation of custom control panels as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. Underwriters' Laboratories, Inc., (UL):

1. 486A: UL Standard for Safety Wire Connectors and Soldering Lugs for Use with Copper Conductors

2. 508: Electrical Industrial Control Equipment

3. 508A: Industrial Control Panels

4. 1059: Safety Terminal Blocks

1.03 SUBMITTALS:

A. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

B. Submit a complete list of equipment, materials, and any details required to demonstrate that the equipment will function properly as a unit. This material shall include:

1. System configuration with single-line diagrams.

2. Detailed descriptions of equipment including weights, dimensions, installation requirements, and heat dissipations.

3. Internal panel layouts indicating spacing and dimensions.

4. Panel front layouts.

5. Catalog cuts of devices used.

6. Control schematics, ladder diagrams, and interconnection drawings.

7. Nameplates.

8. Program and programming data for the PLC and OIT including logic diagrams and screen shots of OIT graphics. Include complete data table of all PLC variables for communication with the plant main control system to facilitate comprehensive remote monitoring, control and alarming of the screw press systems.

1.04 MANUFACTURER'S SERVICES:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Check installation and calibrate the equipment:

a. 4 person-days

3. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.

a. 2 person-days

4. Performance Testing: Field performance test equipment specified.

a. 2 person-days

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

a. 2 person-days

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer’s published field service rate.

7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 DIAGRAMS:

A. Schematic diagrams shall show the equipment serial or tag number, the Owner's drawing number, contract number, or similar identification which will indicate the particular

equipment to which the diagrams apply. Diagrams shall show all equipment in the electrical system including internal wiring of subassemblies. Diagrams of subassemblies may be furnished on separate sheets.

B. Identify each device by a unique number or number-letter combination.

C. Conductor Identification: Identify each conductor by a unique number, letter, or number-letter combination. Consecutive numbering is preferred. Conductors connected to the same terminal or tie point shall have the same identification. Where multiconductor cable is used, a color code may be used to supplement the above identification. Where color-coded multiconductor cable is used for wiring identical components, such as limit switches, the color code used shall be consistent and charted on related diagrams.

D. Provide a schematic diagram for each electrical system. The schematic diagram shall be drawn between vertical lines that represent the source of control power. Show control devices between these lines. Show actuating coils of control devices on the right-hand side. Show contacts between the coils and the left vertical line.

1. Where the internal wiring diagrams of subassemblies are furnished on separate sheets, they shall be shown as a rectangle in the schematic diagram with external points identified and cross-referenced to the separate sheets of the control circuit. Show coils and contacts internal to the subassemblies in the rectangle connected to their terminal points.

    a. Exception No. 1: Where relay and electronic circuits are mixed, diagrams may be drawn between horizontal lines that represent the source of control power.

    b. Exception No. 2: Overload relay contacts may be connected to the right of the coil (common) if the conductors between such contacts and the coils of the magnetic devices do not extend beyond the control enclosure.

2. For clarity, show control device symbols in the order in which the controls are positioned on the diagram.

3. Use a cross-referencing system in conjunction with each relay coil so that associated contacts may be readily located on the diagram. Where a relay contact appears on a sheet separate from the one on which the coil is shown, describe the purpose of the contact on the same sheet.

4. Show spare contacts.

5. Show limit, pressure, float, flow, temperature sensitive, and similar switch symbols on the schematic diagram with utilities turned off (electric power, air, gas, oil, water, lubrication, etc.) and with the equipment at its normal starting position.

6. Show contacts of multiple contact devices, e.g., selector switches, on the line of the schematic diagram where they are connected in a circuit. Indicate a mechanical connection between the multiple contacts by a dotted line or arrow. This does not apply to control relays, starters, or contactors.

7. Additional charts or diagrams may be used to indicate the position of multiple contact devices such as drum, cam, and selector switches.

8. Show the purpose or function of switches adjacent to the symbols.

9. Show the purpose or function of controls such as relays, starters, contactors, solenoids, subassemblies, and timers on the diagram adjacent to their respective symbols. Show the number of positions of solenoid valves adjacent to the valve solenoid symbol.

10. Show values of capacitors and resistors on the diagram.

11. Descriptive terms for command and status functions shall be in the present or past tense. For example, Raise Transfer-Transfer Raised; Advance Transfer-Transfer Advanced. Do not use terms such as "Transfer Up."

E. The panel front and internal layouts shall show the general physical arrangement of components on the control panel. Identify devices with the same marking as used on the schematic diagram. Spare panel space shall be dimensioned. The drawings shall include a layout of the operator's console or push-button station, but terminal numbers need not be shown.

2.02 CONTROL ENCLOSURES:

A. Design and test control enclosures in conformance with UL 508. Enclosure types shall be as follows unless noted otherwise in the drawings:

Indoor Use	NEMA Type 12
Outdoor Use	NEMA Type 4
Indoor or Outdoor Use, areas open to process flow, corrosive Area	NEMA Type 4X
Electrically Hazardous Areas	NEMA TYPE 7

B. The depth of the control enclosure or compartment shall be a minimum consistent with the maximum depth of the control devices plus the required electrical clearance. In no case shall the depth of the enclosure be less than 8 inches.

C. Provide mounting panel for mounting of interior components. Panel finish shall be white enamel.

D. Where heating from control devices results in a temperature rise which is detrimental to the contained equipment or its operation, provide louvers or forced air ventilation. Design ventilating openings to prevent the entrance of any deleterious substance. When forced air ventilation is required, the cabinets shall be pressurized. Air filters shall be of commercially available types and sizes.

E. Provide a permanent metal data pocket attached to the inside of the enclosure. If space permits, the pocket shall be at least 10 1/2 inches wide and of depth and thickness to accommodate electrical diagrams.

F. Enclosure construction shall be minimum 14 gage steel. Finish shall be white enamel inside and gray prime outside over phosphatized surface. Provide continuous hinges for enclosure doors with external screw clamps. Provide hasp and staples for padlocking.

2.03 CONTROL WIRING:

A. 120-volt control wiring shall be Type MTW, THWN, or THHN. Conductors shall not be smaller than No. 14 AWG. Ampacity shall be in accordance with the NEC.

B. Instrumentation signal cables shall be of the type used for field wiring.

2.04 MARKING:

A. Identify wire terminations with a number to correspond with the schematic diagrams. Identification tags shall be preprinted white heat-shrinkable tubing, Raychem Thermofit TMS.

B. Plainly and permanently identify control and power devices using the same identification as shown on the schematic diagrams. Show identification for devices inside the enclosure on a plate adjacent to, not on, the device.

1. Exception No. 1: Where the size or location of the devices make individual identification impractical, such as on electronic assemblies, use group identification.

2. Exception No. 2: Where panel layouts do not permit mounting identification plates adjacent to components, such as relays, place the permanent relay identification on the relay where it is plainly visible, and provide a second identification on the top of the panel wireway cover directly below the relay. Identify the wireway covers to show their proper location.

C. Identification plates for devices mounted inside and outside the control enclosure shall be one of the following:

1. Laminated phenolic for engraving stock; a minimum of 0.062 inch thick. Hold plates in place with metallic drive screws or the equivalent. Use permanent adhesives for attaching nameplates to wireway covers.

2. Noncorrodible metal; a minimum of 0.031 inch thick for engraving stock or 0.012 inch thick for embossing stock. Hold plates in place with metallic drive screws.

2.05 SUPPLY CIRCUIT DISCONNECTING MEANS:

A. Provide a supply circuit disconnects for each control panel. Disconnects shall be a circuit breaker mounted within the control enclosure operated by a variable depth flange-mounted circuit breaker operating mechanism. Provide separate disconnects for sides of hot-swap PLC cabinets, and their associated power systems.

B. This PLC supplies instrumentation located outside of the building. Provide:

1. Surge protective devices on:

a. The input side of each power supply.

b. The output side of each power supply.

c. The load side of each pair of Active Redundancy Modules.

2. Provide separate power supplies and sources to each side of the hot-swap PLC.

3. Provide Active Redundancy Modules, to equalize loading between both power systems, to supply field loads. Divide field loads into separately-supplied busses, each with selectively coordinated supplying circuit breakers and surge protection, as follows:

a. Instruments serving pumps 01-P-11110, 01-P-11130, and 01-P-11150, their ancillaries, and associated level measurement.

b. Instruments serving pumps 01-P-11220, 01-P-11240, and future pump 01-P-11260, their ancillaries, and associated level measurement.

c. Instruments common to both sides, such as common discharge valve manifold, gas detectors, and similar.

4. Ensure adequate power supplies for total peak control system load, plus at least 25% spare capacity with spare capacity persisting even if one power supply fails.

5. Diode modules are not an acceptable substitute for Active Redundancy Modules.

6. Provide internal UPS system, for each power supply, as a backup to the supplying power system, and to allow . Minimum run time of 90 minutes at full loading.

7. Provide ventilation or cooling as required to keep all items within cabinet to 90 degrees Fahrenheit or less.

2.06 PLC AND OIT EQUIPMENT:

A. All new PLC equipment shall be based on Schneider M580 family of products, and shall be programmed with Unity Pro software, latest revision.

1. Provide hot-swappable PLC system with duplicate processing. Minimum requirements for each side follow:

a. Separate I/O into different racks as:

(1) First Rack:

(a) I/O Associated with Pumps 01-P-11110, 01-P-11130, and 01-P-11150, including associated interlocks, monitors, etc.

(b) Centralized I/O for balance of SW-1

(2) Second Rack:

(a) I/O Associated with Pumps 01-P-11220, 01-P-11240, and future pump 01-P-11260, including associated interlocks, monitors, etc.

(b) Spare cards ready to replace Centralized I/O for balance of SW-1.

b. CPU: M580 BME P58 1020 or better, upgrade the processor model and memory if necessary based on the specified programming and functionality requirements.

c. Power Supply: BMX CPS3500 or better, upgrade the power supply if necessary for the installed mix of input and output cards.

d. Analog Input Cards: BMX AMI 0810, 4-20 maDC Isolated Differential type. Provide auxiliary signal isolators and/or boosters if required.

e. Analog Output Cards: BMX AMO 0410, 4-20 mADC Isolated Differential type. Provide auxiliary signal isolators and/or boosters if required.

f. Discrete Input Cards: BMX DDI 6402K, Isolated 120 VAC. Provide interposing relays if required.

g. Discrete Output Cards: BMX DDO 6402K, Isolated 120 VAC relay type. Provide interposing relays if required.

h. Rack: Select the PLC rack number of slots to accommodate required modules plus a minimum of two (2) spare slots.

i. All new processors are to be adequately sized to provide sufficient memory and processing capacity to handle the I/O, logic, communications, and data requirements typical of a modern, fully automated facility and for the defined I/O mix.

j. Communication for the PLC network is Ethernet over copper and/or Fibre.

k. Provide at least 20 percent spare I/O of each type to each panel assembly.

2. Provide all necessary racks, power supplies, cables, communication cards, and accessories. Physically separate sides of the hot-swap PLC where possible.

B. Each new PLC panel assembly is to include constant voltage regulating transformers/conditioners suitably sized for the panel load equal to Sola Hevi-Duty MCR series and incoming power transient surge suppression equal to Sola Hevi-Duty STV100K series. Connect the surge suppressor dry contacts to a PLC input at each panel and coordinate with the control system integrator/programmer as required for these contacts to be monitored.

C. Provide all run-time licenses necessary for the operation of the new PLC and HMI installations.

D. OIT Equipment:

1. Provide a Schneider Harmony colour touchscreen OIT unit type HMIGTO5310 flush mounted in the main control panel.

2. The display shall be 10.4-inch 640 x 480 pixel TFT LCD.

3. 24 VDC power supply with internal battery backup.

4. NEMA 4X environmental protection with hazardous area rating if required.

5. Program the HMI unit with Schneider Vijeo Designer V6.1HMI programming software.

6. The HMI shall be programmed to provide for the monitoring and control of all input and output points, loops and systems through graphic display screens. Additionally, the HMI programming shall include:

a. Process parameter displays

b. Alarm management

c. Trending of key process variables

2.07 CONTROL DEVICES:

A. Provide 120 volt control circuit transformer if incoming power supply is not 120 volts. Provide 100 volt-ampere spare capacity that is in addition to the connected loads. Protect, with circuit breaker(s), one side of secondary winding and ground other side. Provide primary winding circuit breakers on both lines.

B. Provide indicator lights, selector switches, push buttons, meters, operator display etc., as required for correct operation. Mount on the front panel of the control enclosure.

C. Push buttons and selector switches shall be suitably rated for the environmental conditions and/or hazardous area rating of the panel location. Provide with quantity of contact blocks required for correct operation. Units shall be UL listed with NEMA A600 rated contacts.

D. Push buttons shall be standard size, round, flush head with momentary contacts.

E. Selector switches shall be round with standard operator.

F. Indicating lights shall be round, transformer type suitably rated for the environmental conditions and/or hazardous area rating of the panel location complete with color of lens indicated in drawings or as required and legend plate. Lamps shall be high-density LEDs**.** Indicating lights shall be push-to-test type.

G. Elapsed time meters shall be synchronous motor driven, 0 to 99,999.9-hour range, non-reset type, suitable for semiflush panel mounting. Provide General Electric Type 240, 2-1/2 inch Big Look unit; Eagle Signal HK series.

H. Variable frequency drives shall comply with Section 26 29 23.

I. Control relays shall be magnetically held and shall have convertible contacts. Control relays shall be UL listed with NEMA B300 rated contacts and coil voltage, number of poles, and pole arrangement as required for correct operation. All relays shall be of the same manufacturer. Relays shall be Allen-Bradley Bulletin 700, Westinghouse Type AR, IDEC RH Series.

J. Time delay relays shall be UL listed with contacts rated 10 ampere noninductive load, 120 volts, with coil voltage, number of poles, pole arrangement, and maximum timing adjustment as required for correct operation. Relays shall be plug-in, solid-state type with manufacturer’s standard timing adjustments.

K. Mechanically held relays shall have coil voltage, number of poles, and pole arrangement and rating as required for correct operation. Provide integral coil clearing contacts.

L. D-C power supplies shall have ratings as required by the powered equipment. Provide power supplies in a dual-redundant configuration with integral overcurrent protection.

2.08 TERMINAL BLOCKS:

A. Provide terminal blocks for incoming and outgoing control wires. Wire and mount terminal blocks so that internal and external wiring do not cross over the terminals. Do not terminate more than two conductors at each terminal connection.

B. Field wiring shall terminate on the "field side" of the terminal blocks. Do not connect internal panel wiring to the "field side" of the terminal blocks. Do not connect field wiring to the "panel side" of the terminal blocks.

C. Terminal blocks shall be modular, rail mounted, rated at 20 amperes, 600 volts capable of terminating wire sizes No. 12 through No. 24 AWG and constructed of polyamide thermoplastic. Terminal blocks shall be UL listed in accordance with UL 486A and UL 1059. Current-carrying parts shall be copper or brass electroplated with tin/lead. Terminal connection shall be a screw clamp pressure plate connection, designed such that the clamping screw does not clamp the screw directly to the wire.

1. Provide larger terminals for system power where required per Instrument Loop Diagrams (ILD) / Specification 40 61 13 / Specification 40 61 13b, or where required for larger size of marshalled power conductors.

2. Provide separate terminals for each project and future pump power sources. Protect each of these terminals separately with circuit breakers, and assure upstream selective coordination.

D. Provide symmetrical steel assembly rails, end brackets, jumper bars, and other accessories as required for a complete terminal block assembly.

E. Consecutively number terminal blocks from top to bottom with preprinted marking tags. Tags shall be white polyamide and hot printed with black symbols so that the print is permanent.

2.09 WIRING METHODS:

A. Panel wiring shall be neatly contained in panel wireways, including incoming and outgoing field control wiring. Panelways shall be white or light gray colored, restricted slot design, with matching snap-on covers. Provide panelways with mounting holes and nylon "push" rivets for mounting. Panelways material shall be PVC or noryl.

B. Provide minimum 2 inches of clearance between panelway and wire terminations to allow for clear viewing of wire identification marking.

C. Tie wiring run to control devices on the front door together at short intervals and secure to the inside front door with adhesive mounts. Mounts shall be adjustable releasable-clamp type for wire bundles 0.69 inch in diameter or smaller or releasable nylon cable ties for bundles larger than 0.69 inch in diameter. Attach mounts to front panel with adhesive.

2.10 FACTORY TESTS:

A. Inspect and test control panel for correct operation and inspect for thermal performance/hotspots. Test each circuit for continuity, short circuits, and fault grounds.

2.11 SPARES:

A. Provide spares, in wall-mounted hinged cabinet, for the following. Label cabinet "PLC SPARES":

1. Circuit breakers, at least 2 of each type.

2. Terminal blocks, at least 2 of each type.

3. Fused Terminal blocks, at least 2 of each type.

4. SPD, at least one of each rail-mounted type.

PART 3 - EXECUTION

3.01 FIELD TESTS:

A. Test control panel with field wiring connected. Set adjustable set points and time delays for proper operation of equipment. Check operation of control panel and field devices to verify correct operation. Perform required adjustments for correct operation.

B. Cooperate with the owners control system integrator to establish reliable Ethernet communications between the screw press PLC control system and the main plant SCADA control system. Test and verify that all of the PLC remote monitoring and control variables are functioning correctly and properly scaled at the main plant SCADA.

C. Use infrared thermography to confirm internal equipment temperatures are 90 degrees Fahrenheit or less under loading conditions during commissioning process. Improve cooling system until all components operate at 90 degrees or less. Submittal review will not include review for thermal performance and performance is the responsibility of the Contractor.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide field test, and place in operating condition, wiring devices as indicated and specified.

1.02 REFERENCES:

A. Federal Specifications (FS):

1. W-C-596-F: Plug, Electrical Connector, Receptacle, Electrical.

2. W-S-896-F: (1P-2P-3W) Switch, Toggle, Single Unit with wall plates.

B. National Electrical Manufacturers Association (NEMA):

1. WD 1: General Requirements for Wiring Devices

2. WD 6: Wiring Devices – Dimensional Requirements

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

D. Underwriters' Laboratories, Inc. (UL):

1. 20: General Use Snap Switches.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturer's product data in accordance with requirements of Section 26 05 10.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S COMPLIANCE:

A. Manufacturer’s acceptance contingent upon products compliance with specifications.

B. Provide all devices with UL label.

2.02 MANUFACTURERS:

A. Allen-Bradley Co.

B. Appleton Electric Co.

C. Cooper Wiring Devices.

D. Eaton Cutler-Hammer, Inc.

E. Crouse-Hinds Co.

F. Hubbell Electrical Products.

G. Pass & Seymour, Legrand.

H. OZ Gedney.

I. Nelson Electric.

2.03 MATERIALS AND COMPONENTS:

A. Wall Switches:

1. Provide alternating current, general-use, snap switches, in flush device boxes or on outlet box covers, totally enclosed in composition case, with insulated mounting yoke and sidewired, binding screw-type terminals. Single-pole, 2-pole, 3-way, or 4-way switches rated 20 amperes at 120/277 volts a.c. Switch to meet Fed. Spec. W-S-896-F and UL-20.

2. Switches for controlling lighting:

a. Cooper Wiring Device Cat. No. 2221, 2222, 2223, or 2224

b. Hubbell Cat. No. 1221, 1222, 1223 or 1224

c. Bryant Electric Cat. No. 4901, 4902, 4903 or 4904

d. Pass & Seymour, Cat. No. 20AC1, 20AC2, 20AC3 or 20AC4

3. Provide pilot type lighting for switches controlling lights in seldom frequented locations.

B. Watertight/Weatherproof Switches:

1. Provide watertight switches consisting of flush mounting switches in NEMA Type 4 gasketed cast metal boxes. Switch operable through shaft in matching cast metal cover, twenty-ampere, 120/277-volt switch enclosures:

a. Crouse-Hinds Type MC or MCC.

b. Appleton Cat. No. WDM 175 and WVG1

c. OZ Gedney Cat. No. WSP and WCT120

C. Explosionproof Switches:

1. Provide explosionproof switches consisting of flush mounting switches in cast metal boxes meeting requirements for NEMA Type 7D enclosure approved for use in NEC Class I, Group D, Division 1, atmosphere. Switch operable through shaft in matching cast metal cover. 20-ampere, 120/277-volt switch assemblies:

a. Crouse-Hinds Type EFS

b. Appleton Electric Type EFS

c. Nelson Electric Cat. No. SCAD

D. Flush Receptacles:

1. Provide 20-ampere, 125-volt flush receptacles constructed in flush device boxes, and of grounding type in composition case with insulated mounting yoke, side-wired, binding screw-type terminals. Receptacles to conform to Fed. Spec. W-C-596-F.

2. Duplex Receptacles:

a. Cooper Wiring Devices Cat. No. 5362

b. Hubbell Cat. No. 5362

c. Bryant Electric Cat. No. 5362

d. Pass & Seymour Cat. No. 5342

3. Duplex GFCI Type Receptacles:

a. Harvey Hubbell, Inc. Cat. No. CR5352

b. Cooper Wiring Devices Cat. No. GF20

c. Leviton Manufacturing Company Cat. No. 6899

4. Single Receptacles:

a. Cooper Wiring Devices Cat No. 5361

b. Hubbell Cat. No. 5361

c. Pass & Seymour Cat. No. 5351

E. Special Receptacles:

1. Provide weatherproof devices with weatherproof while in use covers where located in damp or wet locations. S-1.

a. Provide in corrosive areas (NEMA 4X) provide NEMA 4X listed and identified weatherproof while in-use covers, as required to comply with 2020 NEC 406.9(B)..

2. Provide watertight, gasketed cast-metal enclosures with covers in areas subject to hose-down, meeting requirements, and either standard single or duplex type:

a. Appleton Electric Cat. No. AEE3382 and AEP3361, Style 2

b. Crouse-Hinds Cat. No. ARRH33 and APJ3385, Style 2

3. Provide receptacles with matching plug or cord cap designed to meet NEMA 4 requirements when plug, cord and receptacle are assembled.

4. Provide explosion proof 20-ampere receptacles, of the delayed action type, preventing contact from being broken until arc has been extinguished. Receptacles with angle covers and spring-closed flaps:

a. Crouse-Hinds Type CPS

b. Appleton Electric Type CPS

5. Furnish one explosion proof plug for each three receptacles, with minimum of one. Plugs to match receptacles and from same manufacturer.

6. Provide welding receptacles whereby plug ground contact makes contact with receptacle ground contact before current carrying contacts engage, and when withdrawing plug, ground contact remains engaged until after current carrying ground contacts disengage. Provide ampere rating as indicated on the drawings.

F. Outlet Boxes and Enclosures:

1. Provide outlet boxes and enclosures conforming to Section 26 05 33 and enclosure schedule on the drawings unless otherwise indicated.

G. Device Plates:

1. Provide device plates suitable for type of outlet boxes and enclosures used. Plates for flush-mounting by device manufacturer. Plates for surface-mounting boxes by either device manufacturer or box manufacturer.

2. Provide flush device plates of high corrosion resistant, Type 302 stainless steel.

3. Provide flush device plates of material and finish indicated, in certain designated areas.

PART 3 - EXECUTION

3.01 GENERAL:

A. Perform all work in accordance with the NEC.

3.02 CONNECTION:

A. Securely and rigidly attach wiring devices in accordance with regulating agency, and as indicated, avoiding interference with other equipment.

B. Securely fasten nameplates using screws, bolts, or rivets and centered under or on the device, unless otherwise indicated.

3.03 GROUNDING:

A. Ground all devices in accordance with NEC.

B. Ground switches and their metal plates through switch mounting yoke, outlet box, and raceway system.

C. Ground flush receptacles and their metal plates through positive ground connection to outlet box and grounding system. Maintain ground to each receptacle by spring-loaded grounding contact to mounting screw, or by grounding jumper, both making positive connection to outlet box and grounding system at all times.

D. Ground explosion proof receptacles and plugs by making contact between the metal shells, and also by using a grounding pin to make contact before power contacts are made.

3.04 LABELING:

A. All wall plates to be engraved with the panelboard alpha-numeric identifier and circuit breaker number.

1. Characters to be 5/16 inch in size and black in color.

2. All engravings to match panelboard typed circuit breaker directories.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide enclosed switches and circuit breakers as indicated and in compliance with Contract Documents.

1. Non-fusible switches

2. Molded-case circuit breakers (MCCBs)

3. Molded-case switches

4. Enclosures

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 7: Wind Loads: Guide to the Wind Load Provisions

B. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

C. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

2. FU1: Low Voltage Cartridge Fuses

3. KS1: Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

E. Underwriters' Laboratories, Inc. (UL):

1. 50: Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations

2. 98: Standard for Safety Enclosed and Dead-Front Switches

3. 489: Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.03 DEFINITIONS:

A. NC: Normally closed

B. NO: Normally open

C. SPDT: Single pole, double throw

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.

2. Current and voltage ratings.

3. Short-circuit current ratings (interrupting and withstand, as appropriate).

4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

C. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.

2. Include wiring diagrams for power, signal, and control wiring.

D. Informational Submittals:

1. Qualification Data: For qualified testing agency.

2. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, accessories, and components, from manufacturer.

   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

3. Field quality-control reports.

E. Closeout Submittals:

1. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

   a. In addition to items specified in Section 01 78 23, include the following:

      (1) Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

      (2) Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and SKM electronic format.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.09 PROJECT/SITE CONDITIONS:

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 degrees F and not exceeding 104 degrees F.

2. Altitude: Not exceeding 4500 feet.

1.10 WARRANTY:

A. Comply with the requirements specified in Section 01 78 26.

B. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

1.11 AREA DESIGNATIONS:

A. General: For purposes of delineating electrical enclosure and installation requirements, certain areas are classified as defined below. Electrical installations within these areas shall conform to the indicated code requirements for the area indicated.

1. General Purpose Locations: Work installed in areas which are not otherwise specifically classified shall be "General Purpose." Enclosures shall comply with the requirements of these Specifications and shall be NEMA Type 1.

2. Outdoor Locations: In outdoor locations, raceway shall be rigid galvanized steel conduit; entrances shall be threaded; and fittings shall have gasketed covers. Fittings and conduit shall be drained. Threaded fastening hardware shall be stainless steel. Mounting brackets shall be galvanized. Attachments or welded assemblies shall be galvanized after fabrication. Instruments and control cabinets, panels, switchboards and motor control centers shall be "Weatherproof NEMA Type 4X." Enclosures shall be mounted 1/4-inch from walls to provide an air space unless specifically shown otherwise.

3. Damp Location: Locations which are indoors and 2 feet below grade elevation or which are indicated as damp locations on the Drawings shall have electrical installations which conform to the requirements for outdoor locations; except, that the air space from walls may be less than 1/4-inch and enclosures shall be NEMA Type 4. "Damp locations" shall include pipe galleries, tunnels, and basements.

Rooms housing liquid handling equipment are also classified as damp locations regardless of grade elevation.

4. Splash Locations: Areas indicated as "splash-proof" locations shall have electrical installations as described for "outdoor locations"; except, that NEMA Type 4X stainless steel enclosures shall be provided for instruments and controls, panels, switchboards, and motor control centers.

5. Corrosive Locations: Areas indicated as "corrosive" locations shall have stainless steel threaded hardware; electrical hardware, fittings, and raceway systems shall be rigid aluminum installed per manufacturer's requirements. Enclosures shall be NEMA Type 4X of fiberglass and reinforced polyester or equal. Corrosive locations include chemical feeder and chemical storage rooms, sodium hypochlorite storage areas, reservoir access, valve structures, and outdoor areas within 10 feet of chemical storage tanks and areas within 10 feet of inlet channels.

6. Hazardous Locations: NEC "Hazardous (Classified) Locations" shall be as indicated and shall comply with NFPA 820 and NEC 500.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.02 GENERAL REQUIREMENTS:

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.03 NON-FUSIBLE SWITCHES:

A. Manufacturers:

1. Eaton

2. ABB

3. Schneider Electric

4. Siemens Industry, Inc.

B. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.

4. Hookstick Handle: Allows use of a hookstick to operate the handle.

5. Lugs: Mechanical type, suitable for number, size, and conductor material.

6. Service-Rated Switches: Labeled for use as service equipment.

2.04 MOLDED-CASE CIRCUIT BREAKERS:

A. Manufacturers:

1. Eaton

2. ABB

3. Schneider Electric

4. Siemens Industry, Inc.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 167 degrees F rated wire, sized according to the 167 degrees F temperature rating in NFPA 70.

G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

K. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

4. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.05 ENCLOSURES:

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with, gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 12), a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel),as indicated on the drawings or suitable for location of equipment.

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts.

D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1), or directly operable through the dead front trim of the enclosure (NEMA 250 Type 12. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.02 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS:

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1

2. Outdoor Locations: NEMA 250, Type 4X

3. Wash-Down Areas: NEMA 250, Type 4X stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.03 INSTALLATION:

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Comply with mounting and anchoring requirements specified in Section 26 05 50.

D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in fusible devices.

F. Comply with NFPA 70 and NECA 1.

3.04 IDENTIFICATION:

A. Comply with requirements in Section 26 05 53.

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.05 FIELD QUALITY CONTROL:

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, grounding, and clearances.

c. Verify that the unit is clean.

d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.

e. Inspect bolted electrical connections for high resistance using one of the two following methods:

(1) Use a low-resistance ohmmeter.

(a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

(a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

f. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.

g. Verify correct phase barrier installation.

h. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the

absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

F. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and clearances.

d. Verify that the unit is clean.

e. Operate the circuit breaker to ensure smooth operation.

f. Inspect bolted electrical connections for high resistance using one of the two following methods:

(1) Use a low-resistance ohmmeter.

(a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

(a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.

h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

e. Determine the following by primary current injection (if applicable):

(1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

(2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

(3) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

g. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed

switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports.

1. Test procedures used.

2. Include identification of each enclosed switch and circuit breaker tested and describe test results.

3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING:

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 70.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide AC motor control devices rated 600 volts and less that are supplied as enclosed units as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

2. AB 1: Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures

3. ICS 2: Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts

4. KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

5. MG 1: Motors and Generators

B. International Electrical Testing Association (NETA):

1. ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Shop Drawings: Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 00.

C. For each controller center specified in this Section. Include dimensioned plans, elevations, and component lists. Show ratings, including short-time and short-circuit ratings.

1. Schedule of features, characteristics, ratings, and factory settings of individual units.

2. Wiring Diagrams: Interconnecting wiring diagrams pertinent to class and type specified for and schematic diagram of each type of controller unit indicated.

D. Product Data: Include dimensions, ratings, and data on features and components.

E. Test Results: Certified reports of field tests and observations.

F. Operation and Maintenance Data (O&M): Maintenance data for motor controllers.

G. Miscellaneous:

1. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Acceptance of equipment specified in this section is contingent upon acceptance of coordination study specified in Section 26 05 73.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Manufacturer Qualifications: Maintain, within 200 miles of Project site, service center capable of providing training, parts, and emergency maintenance and repairs.

C. Source Limitations: Obtain similar motor-control devices through one source from single manufacturer.

D. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term “NRTL” shall be as defined in OSHA Regulation 1910.7.

2. Terms “listed” and “labeled” shall be as defined in National Electrical Code, Article 100.

E. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

1.05 COORDINATION:

A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.

B. Coordinate features, accessories, and functions of each motor controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.06 EXTRA MATERIALS:

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuses and Incandescent Indicating Lamps: Furnish 1 spare for every 5 installed units, but not less than 1 set of 3 of each kind.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Allen-Bradley Co.

B. Eaton, Cutler-Hammer Inc.

C. General Electric Company

D. Siemens Energy & Automation, Inc.

E. Square D Company

2.02 COORDINATION STUDY:

A. Where coordination study specified in Section 26 05 73 recommends changes in types, classes, features or ratings of equipment or devices from those indicated, make written request for instruction. Obtain instructions from Engineer before ordering equipment or devices recommended to be changed.

2.03 ENCLOSURE:

A. Meet environmental conditions of installed location.

1. Provide NEMA-250 Type 1 enclosure in electrical equipment rooms and NEMA-250 Type 12 enclosure for other indoor switches locations unless otherwise indicated.

2. Provide NEMA-250 Type 4X for outdoor and wet location switches with watertight hubs and stainless steel Type 304 enclosure.

3. Provide NEMA-250 Type 7 enclosure for Class 1 hazardous classified location. Provide gaskets for outdoor and wet locations. Heavy cast aluminum enclosure.

2.04 MANUAL MOTOR SWITCHES:

A. Description: NEMA ICS 2, general purpose Class A with toggle action (no overload element).

2.05 MANUAL MOTOR CONTROLLERS:

A. Description: NEMA ICS 2, general purpose, Class A with toggle action and overload element.

2.06 MAGNETIC MOTOR CONTROLLERS:

A. Description: NEMA ICS 2, Class A, full voltage, non-reversing, across line, unless otherwise indicated.

B. Control Circuit: 120 V; obtained from integral control power transformer, unless otherwise indicated. Include control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

C. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses indicated. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by Nationally Recognized Testing Laboratory.

2. Non-fusible Disconnect: NEMA KS 1, heavy-duty, non-fusible switch.

3. Circuit-Breaker Disconnect: NEMA AB 1, motor-circuit protector with field-adjustable short-circuit trip coordinated with motor locked-rotor amperes.

D. Overload Relay:

1. Electronic solid state type with inverse-time-current characteristic, phase loss and phase unbalance protection for size 2 and larger.

2. Provide NEMA Class 20 heaters or sensors in each phase matched to nameplate full load current of specific motor to which connected with appropriate adjustment for duty cycle.

3. Enhanced Protection Overload Relay: Provide overload relays with NEMA Class 10 or better tripping characteristics for submersible equipment or where indicated. Select to protect motor against voltage unbalance and single phasing.

E. When power factor correction capacitors are indicated provide termination lugs on line side of overload relays.

F. Time Delay Restart Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection.

1. Provide in starter enclosure for Size 2 and larger starters.

2. Delay initial motor start.

3. Delay motor restart due to starter dropout caused by undervoltage or starter coil circuit interruption for maintained control circuits.

4. Adjustable on delay from 0.15 to 30.0 sec set at 10.0 sec.

5. Connect control relay in motor starter coil circuit.

6. Coordinate control relay section with motor starter to cause motor starter to drop out at voltage slightly higher than dropout voltage of starter and have dropout time slightly faster than motor starter to ensure if motor starter drops out, relay will drop out.

G. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with standard NEMA MG 1, Design B, polyphase, medium induction motors.

1. Adjustable acceleration rate control uses voltage or current ramp, and adjustable starting torque control has up to 500 percent current limitation for 20 sec.

2. Surge suppressor in solid-state power circuits provides 3 phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.

3. LED indicators show motor and control status, including following conditions:

a. Control power available

b. Controller on

c. Overload trip

d. Loss of phase

e. Shorted silicon-controlled rectifier

4. Motor running contactor operates automatically when full voltage is applied to motor.

2.07 VARIABLE-FREQUENCY CONTROLLERS:

A. Refer to section 26 29 23 for drive requirements.

2.08 ENCLOSURES:

A. Description: Flush or surface-mounted cabinets. NEMA 250, Type 1, unless otherwise indicated to meet environmental conditions at installed location.

1. Wet or Damp Indoor and Outdoor Locations: NEMA 250, Type 4X, stainless steel.

2. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.09 ACCESSORIES:

A. Provide devices when indicated. Factory install in controller enclosure, where indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break push-button station with factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Elapsed Time Meters: Heavy duty with digital readout in hrs.

F. Factory mounted with Nationally Recognized Testing Laboratory listed and labeled mounting device.

PART 3 - EXECUTION

3.01 APPLICATIONS:

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment where indicated.

3.02 INSTALLATION:

A. Install independently mounted motor-control devices according to manufacturer's written instructions.

B. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.

C. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks conforming to Section 26 05 29.

D. Install freestanding equipment on concrete housekeeping bases conforming to Section 03 30 00.

3.03 IDENTIFICATION:

A. Identify motor-control components and control wiring according to Section 26 05 53.

3.04 CONNECTIONS:

A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.05 COORDINATION STUDY:

A. Where coordination study specified in Section 26 05 73 recommends changes in types, classes, features of ratings of equipment or devices from those indicated, make written request for instructions. Obtain instructions from Engineer before ordering equipment or devices recommended to be changed.

3.06 FIELD QUALITY CONTROL:

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by Owner for minimum person-days indicated, travel time excluded, for assistance during plant construction, plant startup, and training of Owner's personnel for plant operation. Include:

a. 2 person-day for Installation Services

b. 2 person-day for Instructional Services

2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process.

3. Manufacturer's Field Services: Provide services of factory-authorized service representative to supervise field assembly and connection of components, including pretesting and adjustment of solid-state controllers.

B. Testing:

1. Reports: Notify Engineer in writing indicating defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made.

2. On completing installation of system, perform following tests.

a. Test insulation resistance of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by manufacturer.

b. Make continuity tests of circuits.

c. Review updating of final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.

d. Review manufacturer's written instructions for installation and testing of motor control devices.

3. Visual and Mechanical Inspection: Include following inspections and related work.

a. Motor Control Device Ratings and Settings: Verify ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective device ratings and settings where differences found. Use accepted revised ratings or settings to make final system adjustments.

b. Inspect for defects and physical damage and nameplate compliance with Drawings.

c. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's written instructions.

d. Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturer's recommended torque values.

e. Clean devices using manufacturer's approved methods and materials.

f. Verify proper fuse types and ratings in fusible devices.

4. Electrical Tests: Perform following in accordance with manufacturer's written instructions.

a. Insulation resistance test of motor control devices conducting parts to extent permitted by manufacturer's written instructions. Insulation resistance less than 100 megohms not acceptable.

b. Make adjustments for final settings of adjustable trip devices.

c. Test auxiliary protective features such as loss of phase, phase unbalance, and undervoltage to verify operation.

d. Check for improper voltages at terminals in controllers having external control wiring when controller disconnect opened. Voltage over 30 V unacceptable.

5. Correct deficiencies and retest motor control devices. Verify by system tests that specified requirements are met.

C. Retesting:

1. Correct deficiencies identified by tests and completely retest equipment.

2. Verify by system test that total system meets specification requirements.

3.07 ADJUSTING:

A. Time Delay Restart Relay:

1. Adjust control relay to cause motor starter to drop out at voltage slightly higher than dropout voltage of starter and have dropout time slightly faster than motor starter to ensure if motor starter drops out, relay will drop out.

B. Perform short-circuit analysis and coordination study. Set field-adjustable pick-up and time-sensitivity ranges accordingly.

3.08 CLEANING:

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

3.09 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Reference Specification 26 29 23.1 for requirements for Variable Frequency Motor Controllers (Also referred to a Variable Frequency Drives, or VFD), where operating on systems of 1kV and higher.

B. Provide complete Variable Frequency Drive (VFD) units and appurtenances including drive reactors, DC chokes, harmonic filters, enclosures, and certain auxiliary items, as indicated and as specified, to provide a complete operating system.

C. Coordinate Variable frequency drive unit sizing by the driven equipment manufacturer (pump, fan, etc.) supplier. Furnish drives from a single manufacturer to minimize maintenance costs for the site. Installation of the units shall be the responsibility of the General Contractor. All conduit and wire installations associated with each VFD shall be provided under Division 26.

D. VFD units shall be manufacturer's standard technology and in production for a minimum of 2 years.

E. Provide control system operation, input and control signals, status signals and devices in accordance with Section 40 61 13.

F. Provide VFD output filter or reactor, when cable length between VFD and motor is greater than 100 feet, to insure motor terminals do not experience overvoltage condition as defined by NEMA Standard MG-1. Except – output filter may be omitted where motor is identified for inverter duty, contains shaft grounding kit, is supplied by cables identified for use on the load side of the inverter, and otherwise meets motor specification requirements for motors supplied by an inverter.

G. Provide front-end harmonic mitigation of the VFD unit to reduce line-side harmonics to 5 percent current total harmonic distortion and less than 3 percent current distortion on each harmonic at their immediate upstream distribution bus as verified by calculation and testing. Harmonic current distortion to be in accordance with Table 26 29 23-1. This bus shall be referred to as the point of common coupling (PCC). For drives smaller than 50HP, use of a 5% reactor is acceptable.

H. Drive supplier shall coordinate with plant control system integrator to setup communication networks, addresses, and data point addresses to facilitate control system programming.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. D178: Standard Specification for Rubber Insulating Matting

B. National Electrical Manufacturers Association (NEMA):

1. ICS 2: Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts

2. AB 1: Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures

3. KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

4. MG 1: Motors and Generators

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

D. Underwriter's Laboratories Inc. (UL):

1. 489: Molded-Case Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

2. 508: Electrical Industrial Control Equipment

3. 1066: Low Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.03 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. It shall be the responsibility of manufacturer and supplier along with the Electrical Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

C. Complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions for all major components.

D. Complete wiring and schematic diagrams for the equipment furnished. Each wiring diagram shall be legible and not reduced from the original design drafted format. Provide a list of equipment on each wiring diagram for which it is applicable.

E. Panel layout and front view drawings.

F. Time versus current curves for protection devices.

G. Data sheets for all devices provided as part of the assembly.

H. All other details required to demonstrate that system has been coordinated and will properly function as a unit.

I. Provide data to verify that drives can be used for motor lead lengths up to 100 feet without output filters. Include information from the VFD manufacturer or output filter or reactor manufacturer (if required) stating that the motor terminal voltage limitations as defined by NEMA Standard MG 1, Part 31 are met. For VFDs located more than a cable length of 100 feet from the motor load, provide drawings which include information demonstrating that an output filter or reactor is included within the VFD.

J. Provide enclosure drawings and details showing all dimensions and construction details.

K. Harmonic Analysis Report: Provide harmonic analysis report. Report to be accepted by Engineer prior to release of drives for fabrication.

    1. Submit voltage THD frequency scan of each type of VFD supplied for use in field testing.

L. Submit information relative to location and expertise of local service office and personnel.

M. Submit a Statement of Compliance indicating conformance to the Seismic Requirements specified. Certificate shall be signed and sealed by a Professional Structural Engineer holding current registration in the state for work of this project.

N. For informational purposes only, provide installation and anchoring details to meet earthquake requirements as specified and indicated on structural drawings.

O. For informational purposes only, submit manufacturer's printed installation instructions.

P. Spare Parts Data: Submit a list of spare parts for the equipment specified.

Q. Operating and Maintenance Instruction Manuals:

1. Furnish:

a. Operating instruction manuals outlining step-by-step procedures required for system startup and operation.

b. Manufacturer's name, model number, service manual parts list.

c. Brief description of equipment and basic operating features.

d. Maintenance instruction manuals outlining maintenance procedures.

e. Troubleshooting guide listing possible breakdown and repairs.

f. Point-to-point connection wiring diagram for the system.

g. Performance Test Reports: Upon completion of installed system, submit in booklet form all shop and field tests performed to prove compliance with specified performance criteria.

R. Submit Pump, Motor, and VFD Statement of Compliance Coordinate Certificate from firm ensuring all three elements will operate together. Refer to Section 01 33 00 for form and fill out complete.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Provide variable frequency drives in accordance with UL 508A, supplement SB, and Article 409 of the National Electrical Code (NEC). All VFD units shall be provided with a UL label.

C. Ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied. Coordinate all design information with the Electrical Contractor. Review the proper installation of each type of VFD unit with the equipment supplier prior to installation.

1. Services of Service Engineer, specifically trained on type of equipment specified. Person-day requirements listed exclusive of travel time.

a. Assist in location of devices, methods of mounting, field erection, etc.

2 person-days

b. Functional Completion Testing:

2 person-days

c. Startup:

1 person-day

d. Commissioning:

1 person-day

e. At the end of start-up service provide for a maximum of six members of the owners staff at the facility site to receive training from the startup/testing service Engineer.

1 person-day

f. Service-inspections during first year of operation, for use at Owner's request, and exclusive of repair, malfunction or other trouble-shooting service calls:

3 person-days

g. Person-day is defined as one 8-hour day, excluding travel time.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with APWA Section 01 66 00 and as specified.

B. Shipping:

1. Ship equipment and materials, except where partial disassembly is required by transportation regulations or for protection, complete with identification and quantity of items.

2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

3. Deliver spare parts after installation but as specified before start-up of drives. Deliver to Owner after completion of work.

C. Storage:

1. Inspect and inventory items upon delivery to site.

2. Store and safeguard equipment, material and spare parts.

a. If the equipment cannot be placed into service after its receipt, store in a closed building or structure, in a clean, dry and ventilated area free from temperature, dirt and moisture extremes. Acceptable storage temperatures are from 32 degrees F to 104 degrees F with temporary heaters provided within enclosures to prevent condensation. Provide heavy plastic envelope

directly over motor control center to protect against dust, dirt, and moisture. Provide lifting angles outside of envelope.

1.07 WARRANTY AND SERVICE:

A. Provide in accordance with Section 01 78 36 and as specified.

B. Guarantee components, parts, and assemblies supplied by manufacturer against defects in materials and workmanship for a period of 24 months after turning the equipment over to the Owner, and in this time period include onsite, parts and labor warranty. All labor to be performed by local factory trained service engineers.

C. Ensure that equipment manufacturer has local branch office staff with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer shall have at least five years commercial experience in the manufacture, operation and servicing of equipment of type, size, quality, performance, and reliability equal to that specified.

B. Variable Frequency Drive Units:

1. ABB Drives

2. Eaton Corporation, Electric Drives Division

3. Schneider Electric / Square D Company

4. Siemens Inc.

5. Toshiba Industrial

C. VFD Input Filters and Output Filters/Reactors:

1. Trans-Coil, Inc.

2. MTE Corporation

3. Power Quality International

2.02 HARMONIC ANALYSIS:

A. Each VFD unit shall be designed such that there is less than 5 percent current total harmonic distortion at the PCC. Current distortion at the PCC will be in accordance with Table 26 29 23-1. For the purpose of the analysis, it will be assumed that the facility transformer feeding the electrical system is at a moderately (70 percent) loaded condition.

Table 26 29 23-1
Maximum Harmonic Current
Distortion In Percent Il

Odd Harmonic

Ratio	5 to 9	11 to 15	17 to 21	23 to 33	35 +	TDD
Less than 20	4.0	2.0	1.5	0.6	0.3	5.0
20 to 50	7.0	3.5	2.5	1.0	0.5	8.0
50 to 100	10.0	4.5	4.0	1.5	0.7	12.0
100 to 1000	12.0	5.5	5.0	2.0	1.0	15.0
1000 +	15.0	7.0	6.0	2.5	1.4	20.0

Notes:
1. Even harmonics are limited to 25 percent of odd harmonics.
2. DC offset distortions not allowed.
3. Ratio = Isc/IL where:
   Isc = Maximum short circuit current at PCC.
   IL = Maximum demand load current at PCC (fundamental frequency component)

B. Provide all harmonic related data to the independent engineering firm identified in Section 26 05 70.

C. For each VFD unit, provide a harmonic analysis study at the point of connection to the immediate upstream distribution bus (PCC), based on pre-submittal data.

Each VFD unit shall be designed such that there is less than 5 percent voltage total harmonic distortion and less than 3 percent voltage distortion on each harmonic at the PCC. Current distortion to be within the limits of Table 26 29 23-1. For the purpose of the analysis, it will be assumed that the electrical system is at a lightly loaded condition, 50 percent load. If the VFD loads exceed 50 percent system loading, assume system is loaded at VFD full load ratings.

1. At each PCC, where more than one type or size VFD unit is to be connected, provide the following:

   a. Contractor shall have the supplier of the largest drive (in Hp) provide a harmonic study for each point of common coupling based on pre-submittal information

2. The Contractor shall supply the following pre-submittal information to the largest VFD supplier to complete the harmonics study.

   a. Full load fundamental current for each variable frequency drive unit.

   b. Harmonic currents on per unit basis of full load fundamental for each VFD unit.

   c. Available fault current information from the electric utility and upstream transformer data.

   d. Distribution transformer sizes and impedances, if any.

   e. VFD input line reactor and/or isolation transformer sizes and impedances from the utility source to the VFD units.

   f. Conductor information between transformer secondary or generator terminals to the distribution buses and VFDs.

   g. Generator kW, impedance, subtransient reactance generator constants for the condition when the electrical system is powered from the generator.

3. The results of the harmonics study shall verify that the levels of total harmonic voltage at each point of common coupling are less than 5 percent and that the voltage distortion on each harmonic is less than 3 percent. In addition, harmonic currents at the PCC will be within the limits of Table 26 29 23-1. The study shall separately consider each VFD distribution bus as points of common connection (PCCs). The study shall specify additional equipment required (e.g., filters) at each harmonic where harmonic reduction is required to insure compliance.

D. The study shall consider the following conditions:

1. The electrical system shall be powered by the electric utility, case 1, or solely by local generation, Case 2.

2. The study shall include an explanation of all assumptions, sources of data, methodologies and formulas used in the study and a summary of the study results.

3. The Contractor shall supply all equipment required as a result of the final accepted harmonics study to comply with the requirements of Paragraph 1.01.F.

2.03 PROVISIONS:

A. Service Conditions:

1. Ambient Temperature Range: 0 degrees C to 40 degrees C

2. Operational Humidity: Up to 90 percent non-condensing

3. Environment: As indicated on enclosure schedule

4. Altitude: Below 4,500 feet above sea level

5. Input Power:

   a. Nominal Voltage: 480 volts (plus 10 percent or minus 10 percent), 3-phase, 3 wire

   b. Nominal Frequency: 60 Hertz (plus or minus 2 Hertz)

   c. Service provided from feeder breaker on distribution bus

6. Performance:

   a. Program drive to operate within motor's allowable turndown.

   b. Provide drive capable of catching a spinning motor.

   c. Provide programming in drive to allow motor to spin down upon loss of power prior to re-starting motor, not to exceed 30 seconds. When starting, provide catching sequence in case motor is still in motion.

B. Drive System: 0-500 HP Units, 480V, 3-phase.

1. General:

   a. Furnish solid state variable frequency, microprocessor type with Pulse Width Modulated (PWM) output wave form converter. The VFD shall employ a full wave rectifier to prevent input line notching, a DC bus choke, DC bus capacitors and Insulated Gate Bipolar Transistors (IGBT) as the output switching device to convert nominal 480 volts, 3 phase, 60 Hertz, 3 wire input power into adjustable-frequency 3 wire system at 0 to 480 volts, 3 phase, 0 to 60 Hertz output power. Provide output speed control of required motor under variable torque load or constant torque as required by the driven equipment.

   b. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard two-wire "start-stop" and the Contractor shall furnish wiring accordingly. Controls shall be designed to allow for automatic re-start when power is returned after a system outage, unless otherwise directed.

   c. Variable frequency drive manufacturer shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining all loads, torque, speed and performance requirements from the

respective sources and integrating these into a variable frequency drive system that fulfills the requirements of this Specification.

d. The Contractor and variable frequency drive system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical examples are circuit breakers, motor circuit protectors, magnetic starters, relays, timers, control and instrumentation products, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment.

e. Provide VFD control which ensures accurate zero to full load torque control at low frequencies, including zero speed, with torque repeatability accuracy of 2 percent or better and torque response time less than 20 ms.

f. Provide on drive, a disconnecting device and fixed diode input rectifier (for a constant power factor).

g. The drive unit shall be of modular design to provide for ease and speed of maintenance.

2. For units rated 50 Hp or less, provide 6 pulse drive with 5 percent impedance input line reactor.

a. Provide trap filters for the drive unit meeting the requirements of the harmonic study under Paragraph 2.02. Filters shall be provided with contactors and controlled by the VFD to remove them from the line when the drive is not operating. Contactors shall be provided with spare contacts for remote alarm and to energize status lamp at VFD enclosure.

3. For units rated 50 and 120 Hp, provide VFD with the following type three phase PWM rectifier section: 18 pules or higher supply-side transformer, or Low-Harmonic Active Front End . Provide multiple secondary integral transformer within enclosure at input bridge to provide appropriate phase shift.

a. Where supplying harmonic mitigation transformer, then as a minimum the transformer shall provide for the cancellation of the 5th, 7th, 17th, 19th, positive and negative sequence harmonic currents at the primary connection.

b. Where supplying harmonic mitigation transformer, the transformer shall reduce voltage and current distortion on the primary side and voltage distortion on the secondary side.

c. Provide active front end technology to meet harmonic content requirements already articulated in this Section.

d. The design shall be optimized for harmonic rich and high neutral current environment.

e. Provide a primary to secondary phase shift by use of multiple secondaries.

4. For VFD units rated 125 horsepower or higher, provide active converter low harmonic drives.

   a. Control high order harmonics with line filtering.

   b. Direct torque control (DTC) AC to AC converter with IGBT technology.

   c. Operational modes of scalar or V/Hertz operation.

   d. AC line reactor and DC choke shall be provided to reduce input harmonic content, and provide protection from power line transients.

5. All components of the drive shall be designed and sized for the abnormal condition of continuous operation of the driven equipment specified herein at loads up to 15 percent above rated full load.

6. RMS harmonic output of the drive not to provide more than 5 percent increase in motor heating over similar operation of the motor with zero harmonics in the current.

7. The unit shall withstand drive output terminal line-to-line and line-to-ground short circuits without component failure during start-up and during operation. Drive to safely shutdown until short is cleared.

8. NEMA type cabinet for each drive unit, as indicated on drawings and enclosure schedule. NEMA 4 and NEMA 4X enclosures to be provided with stainless steel hand operated quick disconnect devices and interior cooling systems. Provide hinged acrylic door with gasketing on front of door for each access to keypad controls.

9. For inverter rated squirrel cage motors, per NEMA Standard MG-1, Part 31.40.4.2, the following limit values at the motor terminals are to be observed:

   a. For motors with base rating voltage less than or equal to 600 volts, the peak instantaneous voltage must be limited to 1600 volts or less, with a voltage rise time greater than or equal to 0.1 micro-seconds.

10. The VFD manufacturer shall guarantee that the required voltage limits will be met with the motor installed up to 300 cable feet from the VFD drive unit. If the VFD manufacturer is not able to guarantee that the above voltage limits will be met, provide a drive output filter or reactor, appropriately rated, located within the VFD enclosure and near the VFD output terminals, which shall ensure that the limitations listed above are maintained. A device located at the motor terminals is not acceptable.

11. When controlling for non-inverter rated squirrel cage motors, provide output filters to limit peak voltage at the motor terminal to less than 1000 V, increase voltage rise time and reduce common mode current.

12. VFD shall be capable of full rated output when powered by incoming voltage with Total Harmonic Distortion (THD) in excess of 10 percent.

13. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.

14. Properly size enclosure to dissipate heat generated by VFD within limits of specified service conditions.

    a. Provide NEMA enclosure type as indicated on drawings.

    b. Provide integral fans or cooling systems as required by the application.

    c. NEMA 4 and 4X type enclosures to use hand-operated locking devices for door closing hardware.

    d. Circuit breaker interlock to be able to be bypassed via lever on front door surface.

    e. NEMA 1 and 12 type enclosures to have keypad controls located on exterior of enclosure.

    f. Provide visual alarm indicator on cabinet door.

    g. Fans shall be located to allow quick removal and replacement without disassembly of drive components.

2.04 PERFORMANCE CHARACTERISTICS:

A. Output amps: 110 percent of rated, continuous.

B. Current limit: Range 0 to 130 percent for constant torque applications, 0 to 110 percent for variable torque applications, for 1 minute minimum.

C. Acceleration time to top speed, 1-300 seconds, minimum, adjustable

D. Deceleration time from top speed, 1-300 seconds, minimum, adjustable

E. Frequency stability: plus or minus 0.5 percent (at 25 degrees C, +10 degrees C) after reaching operating temperature.

F. Output voltage: Proportional to frequency with low speed boost.

G. Combined drive/and filtering efficiency, defined as motor shaft kW divided by VFD input kW, shall meet the following minimum requirements at the specified operating points:

1. 97 percent at 60 Hertz VFD output and 100 percent load

2. 92 percent at 50 Hertz VFD output and 60 percent load

H. VFD fundamental power factor shall be 0.98 or higher at all speeds and loads.

I. The VFD shall be capable of sustaining continued operation with a 30 percent dip in nominal line voltage. Output speed may decline only if current limit rating of the VFD is exceeded.

J. Losses to be utilized in drive system efficiency calculation shall include the input line reactor, phase shifting transformer and, harmonic trap filter with capacitors. Auxiliary controls such as internal VFD control boards and cooling fans shall be included in all loss calculations.

2.05 DRIVE PROTECTION:

A. General:

1. Fault detection and trip circuits shall protect VFD and connected motor against line voltage transients, single-phase, power line overvoltage and undervoltage, output overvoltage and overcurrent, and VFD overtemperature.

a. The VFD shall employ three current limit circuits to provide trip free operation.

b. The slow current regulation limit circuit shall be adjustable to a minimum 125 percent of the VFD's variable torque current rating.

c. The rapid current regulation limit shall be adjustable to a minimum 170 percent of the VFD's variable torque current rating.

d. The current switch off limit shall be fixed at a minimum 225 percent of the VFD's variable torque current rating.

2. Internal Protection: Minimum circuitry as follows:

a. Current limiting, fast acting, semiconductor input fuses for protection of internal power semiconductors

b. Instantaneous output overcurrent trip maximum: 200 percent

c. DC bus and control circuit transformer fusing

d. Grounded control chassis

e. Under and over voltage trip, 3 phases

f. Motor overload protection, with solid state relays

g. Circuit breaker, with door interlocked handle. Provide means to allow entry into panel where required by authorized personnel. Circuit breaker to be rated 65,000 AIC minimum.

h. Fault reset push button

i. Line to ground faults

j. Input metal oxide varistor and input line reactor for transient protection

k. VFD overtemperature

3. Troubleshooting: Diagnostic aids to indicate cause of fault; used to assist in troubleshooting circuit problems. Isolated Form C contacts for remote indication of alarms to include the following:

   a. Over/under voltage indication

   b. Overcurrent trip indication

   c. DC bus charged indication

   d. Fault detection indication

   e. Recycle start indication (to indicate that the unit tried to pick up load for three previous tries and failed)

4. Provide power loss ride through capability which will allow the logic to maintain control due to load inertia without faulting.

5. Provide a programmable automatic restart function which will provide a minimum with time delays between restarts of 3 restarts following a fault condition other than a ground fault, short circuit, internal fault, or user programmable fault condition. Restart type to be programmable for time delay or coasting motor restart.

6. For drives units rated 200 hp or more, provide uninterruptable power supply (UPS) to power control circuits and prevent inadvertent trip due to voltage sag conditions.

   a. The UPS shall be installed within the drive enclosure.

b. The battery backup time of the UPS shall be a minimum of 5 minutes or as recommended by the VFD manufacturer.

c. UPS shall be American Power Conversion Smart-UPS 1400 X LT by MGE or Eaton Powerware.

d. Power source for this UPS and associated control power shall be derived within the VFD enclosure from the same master power source.

2.06 CONTROL INTERFACE:

A. Provide variable frequency drive unit with appropriate power circuitry and auxiliary contacts for energizing and controlling the following devices associated with the motor, if required:

1. Space heaters

2. Solenoid valves

3. Remote indication of motor start and stop (isolated contacts)

B. Minimum Control Features:

1. LOCAL/REMOTE selection of Start/Stop control.

2. LOCAL/REMOTE selection of Speed control.

3. Accept a grounded, isolated, 4-20 mA input remote speed control signal from an external device.

4. Provide a 4-20 mA output signal proportion to VFD output frequency for remote speed indication.

C. Control Devices:

1. Provide operating, monitoring or alarm indicating devices, door mounted, with minimum as follows:

a. Drive System Disconnect Operator.

b. System control selector switch (RUN/OFF/REMOTE) (When in RUN position drive will run). Control switch shall be oil-tight, 30 mm units.

c. System speed control selector switch (LOCAL/REMOTE) (When in LOCAL position, speed controlled by manual speed potentiometer). Control switch shall be oil tight, 30 mm units.

d. Manual keypad controls to set speed in manual mode.

e. Speed indicating meter in percent speed to indicate speed of the converter powered motor.

f. Run time meter, mechanical type, round, UL Certified, non-reset type, with register to indicate hours and tenths of hours up to 99,999.9 hours.

g. Alarm and status lights. Provide LED cluster type, heavy duty, 30 mm oil tight units.

2. Control circuits shall be isolated from power circuits.

a. Unit to accept a 4-20 mA DC speed control signal from an isolated, ungrounded transmitter with unit in remote mode and from local door-mounted micro-processor type keypad with unit in local mode.

b. The input 4-20 mA signal to be optically isolated from the drive run control circuit.

c. Furnish door-mounted switch on the enclosure for local/remote mode.

d. Keypad controls to have adjustable minimum speed setting of 10 to 80 percent of full speed and maximum speed setting of 50 to 100 percent of full speed. The total speed setting to follow a linear time ramp, adjustable from 1-300 seconds for acceleration and deceleration control.

D. Provide a Ethernet network card/port and interface modules to allow serial communications on an Ethernet network.

1. Interface connection cable shall utilize a RJ-45 connector.

2. Network to allow a selection of standard and custom register values to communicate drive parameters, including:

a. Drive fault

b. Overload

c. Trip

d. Loss of control power

e. Speed

f. Power (kW)

g. Amps (Phase A, B and C)

h. Voltage (Phase A-B, B-C, C-A)

3. Provide all components and drive programming to allow network interface with control system. Provide data mapping information to control system integrator to facilitate plant system programming.

2.07 SHOP TESTING:

A. Provide in accordance with Section 01 45 00.

B. Provide a factory performance test for each variable frequency drive unit. The test to consist of simulating the expected load to be driven. The drive to operate the actual motor load through the expected speed ranges. Test length to be a minimum of two hours.

C. Provide a factory burn-in test for 24 hours minimum and a control and alarm test on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.

D. Provide typical prototype factory test data for short circuit testing of each type of drive supplied. Data to verify that each drive can be started into a line-to-line fault and line-to-ground fault on the drive terminals. Each drive can be operating at full load and be subjected to a line-to-line fault and line-to-ground fault on the drive terminals. All phases (A, B & C) to be included in test data.

E. Provide certified documentation of all tests performed.

F. Provide above stated tests in addition to routine factory tests.

G. Owner to have option to witness all factory tests. Notify Owner two weeks before all tests.

2.08 SPARE PARTS:

A. Provide in accordance with Section 01 78 23 and as specified.

B. Provide one spare board or card, three diodes, for each horsepower size drive. Spares will be color-coded or otherwise keyed to their original counterpart such that improper installation of spare cards is impossible. In addition to the cards, the manufacturer shall provide three spares for all expendable items such as pilot lamps, power fuses, and control fuses. Provide one spare keypad for every three VFD of the same model.

PART 3 - EXECUTION

3.01 INSPECTION:

A. Examine VFD location for satisfactory preparation. Check conduits and raceway location for connection to units.

B. Visually inspect delivered unit(s) and accessories for conformance with specification and drawings.

C. Verify availability of appropriate pacing signal.

D. Maintain variable frequency drive in upright position at all times.

E. Protect variable frequency drive against damage. Store drive in clean, dry environment with temperature and humidity within range as specified by drive manufacturer. Energize space heaters during storage as recommended by manufacturer.

3.02 INSTALLATION:

A. Erect, install, and start-up equipment.

B. The VFDs shall be installed as shown on the drawings, in accordance with the manufacturer's installation instructions, and accepted shop drawings.

C. Install VFDs to allow complete door swing required for component removal. This is specifically required where a VFD is set in the corner of a room.

D. Factory-trained service personnel, other than sales representatives, shall supervise field installation, inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes. Adjust control and instrument equipment until this equipment has been field tested.

3.03 RUBBER MATS:

A. Rubber mats are not required.

3.04 FIELD TESTING:

A. Provide in accordance with Section 01 45 00.

B. Perform testing checkout, and start-up for variable frequency drive equipment under technical direction of manufacturer's service engineer. Under no circumstances energize any portion of the drive system without authorization from manufacturer's technical representative.

C. Field Tests:

1. Test each drive over the total speed range that it will be required to operate through for the load being driven for a minimum of two hours. Determine for each drive, motor, and load combination the following at minimum speed, maximum speed, and at 1/3 and 2/3 points between the minimum and maximum speeds:

a. Input power (kW), voltage, current and RMS power factor on the line side of the drive isolation device.

b. Output to the driven load in kilowatts.

c. For each drive, measure the harmonic voltage distortion and harmonic current distortion for each harmonic at the main distribution bus for maximum and minimum load conditions.

d. Measure the total harmonic voltage distortion and total harmonic current distortion at each PCC for maximum and minimum load conditions.

2. Test each drive by using the actual control signal for remote and local operation.

3. Test each drive's alarm functions.

4. Perform all tests in the presence of the Owner's representative.

5. Perform the above test in addition to the manufacturer's normal field tests.

6. Submit final test report with summary comparing field test data with harmonic analysis design calculated values for each drive.

7. Testing determined not in compliance with Contract documents shall be repeated by the Contractor at no additional cost to the Owner.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 29 23.1

MEDIUM VOLTAGE VARIABLE FREQUENCY DRIVE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This specification and related Contract documents define the minimum requirements for design, manufacture, inspection and testing of medium voltage variable frequency drive (VFD) assembly for IPS Electrical Building facility.

B. The VFD shall be capable of continuous operation in an average ambient temperature between 0°F and 104°F at an elevation of 4500 feet above MSL without derating.

C. Delegated design includes programming of protection relay and incorporation of field protection features.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. Z535.4: Product Safety Signs and Labels

2. Z55.1: Gray Finishes for Industrial Apparatus and Equipment

B. Institute of Electrical and Electronics Engineers (IEEE):

1. 18: Shunt Power Capacitors

2. 519: Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

3. 1566: Performance of Adjustable Speed Drives rated 375 kW and Larger

4. C57.13: Standard Requirements for Instrument Transformers

5. C57.13.3: Grounding of Instrument Transformer Secondary Circuits and Cases

C. National Electrical Manufacturers Association (NEMA):

1. ICS 1: General Standards for Industrial Control Systems

2. ICS 3: Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC

3. ICS 3.2: Medium Voltage Controllers rated 1501 to 7200 V AC

4. ICS 4: Industrial Control and Systems: Terminal Blocks

5. ICS 7: Adjustable Speed Drives

6. NEMA 250: Enclosures for Electrical Equipment

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

E. National Electric Safety Code (NESC)

F. Occupational Safety & Health Administration

1.03 SUBMITTALS:

A. For Review/Approval

1. Master drawing index

2. General arrangement drawings with outline dimensions, including locations of all components and devices

3. One-line diagram

4. Wiring/Schematic diagram

5. Nameplate schedule

6. Component list

7. Conduit entry/exit locations

8. Assembly ratings

9. Cable terminal sizes

10. Product data sheets, including full harmonic spectrum data and heat loss data

11. Installation information including anchorage provisions

12. Recommended spare parts

13. Auxiliary load list (fans, control power, etc.)

B. Final Documentation

1. Certified as-built drawings for items listed in paragraph 1.3 A, incorporating all changes made during the manufacturing process

2. Certified production test reports

1.04 QUALITY ASSURANCE:

A. Every variable frequency drive system shall meet the performance, protection, safety, testing, and certification criteria of this specification. This system may include incoming harmonic filter, VFD converter/DC link/inverter, and output filter.

B. The VFD assembly shall be completely factory pre-wired, assembled, and then tested as a complete package by the VFD manufacturer, before delivery, to assure a properly coordinated, fully integrated drive system.

C. Items provided shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

D. Terms “NRTL” shall be as defined in OSHA Regulation 1910.7.

E. Terms “listed” and “labeled” shall be as defined in National Electrical Code, Article 100.

F. The manufacturer of the VFD assembly shall be the manufacturer of the major components within the assembly.

G. The VFD shall be manufactured by the VFD supplier at its own facility which is certified in accordance with ISO Standard 9001.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Equipment shall be handled and stored in accordance with manufacturer’s instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

B. VFD shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

1.06 OPERATION AND MAINTENANCE MANUALS:

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. The VFD manufacturer shall be able to demonstrate at least 15 years of experience in manufacturing VFDs at medium voltage and their capability to provide parts and service

support. A user's list of similar design equipment, complete with contact names and telephone numbers, shall be furnished upon request.

2.02 DESIGN REQUIREMENTS:

A. The VFD described in this specification shall be designed for operation on a 4.16 kV, three-phase, three wire, solidly grounded, 60-Hertz system.

B. The VFD shall be based on applicable standards and in accordance with this specification and drawings

C. The VFD application will be for induction type motor.

D. The VFD shall have a direct-to-drive technology (integral AC line reactor) which allows connection without the requirement of an isolation transformer.

E. The VFD shall have Active Front End (AFE) rectifier for input harmonic mitigation.

F. Inverter design shall have a pulse width modulated (PWM) configuration, with smoothing technologies to avoid reflected wave phenomena and to reduce total harmonic distortion, as measured by current, to less that 5%.

G. Inverter is to be sized for elevation, potential ambient temperatures, and for actual motor power factor or 67% power factor, whichever results in the maximum VFD current rating.

H. Provide on-board processor with programming as required to take over control of pump and to maintain wetwell level as an individual motor controller upon loss of PLC or upon loss of PLC communications.

I. Provide suitable I/O, both analog and discrete, to monitor discharge valves, vibration sensor, level sensors, and similar, as identified in the 40 61 96 Process Control Description.

1. Not limiting the above, the Instrument Loop Diagram (ILD) sheets require two performance modes:

    a. Control of VFD by SCADA.

    b. Control of VFD transferred to level switch control, as signaled by an external dry contact, note key constraint that VFD must be able to change motor speed based on which level switch is high during this mode. Alternately, provide microcontroller as specified later in this Section. Processing requirements to fulfill both control modes is the responsibility of the Medium Voltage Variable Frequency Drive provider, not the Plant Integrator.

J. Provide manufacturer's conformal coating options for all circuit boards where this option is available. This includes, but is not limited to, processor, protective relay, network switch, Modbus/TCP gateway, power electronics, and HMI interface.

2.03 PERFORMANCE:

A. Operating Envelope

1. The VFD shall be capable of producing a variable AC voltage/frequency output to provide continuous operation over the normal system 20-100% speed range.

2. The VFD must be capable of operation at 1/10 speed to facilitate checkout and maintenance of the driven equipment.

3. As a commissioning and troubleshooting feature, the VFD power circuit shall be capable of operating without a motor connected to the VFD output.

4. One-minute overload capability (1 minute every 10 minutes) shall be provided consistent with the application requirements defined in this specification. Overload shall be at least 115% of the full load.

B. Input Voltage Tolerance

1. The VFD shall have input voltage tolerance of ±10% of nominal voltage.

C. Input Frequency

1. The VFD shall have input frequency ±5% at 60 Hz.

D. Input Power Factor

1. The VFD shall maintain greater than 0.95 power factor at all speeds and loads.

E. System Efficiency

1. The VFD efficiency shall be above 95% at all speed and loads.

F. Speed Regulation

1. The VFD speed regulation shall be 0.5% without encoder feedback.

G. Input Harmonics

1. VFDs shall comply with the latest edition of IEEE 519 for total harmonic current distortion, calculation and measurement, and meet the above distortion limits without causing the VFD to operate at a leading input power factor from 30% to 100% of rated speed.

2. Voltage Harmonics: individual or simultaneous operation of the VFDs shall not add more than 3% total harmonic voltage distortion while operating.

3. Total harmonic current distortion limits for each individual VFD shall not exceed 5% as calculated and measured at the point of common coupling, defined as the input connection of each VFD.

H. Motor Compatibility

1. The VFD must provide motor overload protection in any operating condition.

2. The VFD must include top-level contactor to shut down internal power components upon system fault.

3. The VFD output waveform shall be suitable for operating a squirrel cage induction motor without de-rating or requiring additional service factor. To ensure that there are no problems with motor heating, VFD output current waveform, as measured at the motor, shall be inherently sinusoidal at all speeds, with a total harmonic current distortion not exceeding 3% referenced to the full load output current fundamental between 10% and 100% speed.

4. The VFD shall inherently protect motor from high voltage □v/□t stress, independent of cable length to motor. VFD shall not require non-standard insulation systems or insulation ratings above the VFD output voltage rating.

I. Metering

1. Power quality metering shall be inherent to the VFD system to continuously monitor and display input and output power quality. This will allow easy customer verification of power quality and efficiency for the VFD system.

2. As a minimum, the following door mounted digital indications with a resolution of at least ±0.01% and an accuracy of 1%, shall be supplied:

a. Input/output Voltage

b. Input/output Current

c. kW Output

d. Power Factor

2.04 AVAILABILITY:

A. Firing Signals

1. All internal firing signals and other communications with power components, such as status and diagnostic signals, must meet noise immunity and safety requirements as defined by the applicable standards referenced in Section 1.2.

B. Failed Power Electronic Device

1. If any power switching device in both the converter and inverter sections and/or switching device control circuitry fails, the VFD shall initiate a process trip and the VFD shall annunciate and identify the specific location of the failed device.

C. Power Interrupt Ride-Through

1. The VFD system must be capable of continuous operation in the event of a power loss of a minimum of 5 cycles. Beyond this, the VFD must shut down until a user-adjustable time delay has expired, generally as required for motor to spin down.

2. VFD to be capable of catching a spinning motor, for conditions when shut down timer may not be adequate for motor to completely stop.

3. The VFD system must be capable of automatically restarting in the event of a momentary loss of power. The VFD system shall be configured to automatically restart without user intervention, but also provide the user with the choice of automatically restarting or not. A safety device (hard key or password) must be available to allow enabling, disabling, and setting changes to this feature only by authorized personnel. The user shall be able to selectively apply this feature and can set the allowable restart time applicable to some (but not necessarily all) conditions as determined by the user to be appropriate for the specific application.

D. Power Sag Ride-Through

1. The VFD system shall be capable of maintaining continuous operation with a 35% voltage sag on the input power line. Such operation shall be maintained if medium voltage is absent (or below 65%). If enabled, the control shall monitor the motor flux (both magnitude and phase) as it decays based on the motor open circuit time constant. If the drive is restarted and the motor flux is still above 4% of rated, the drive shall re-magnetize the motor and follow the speed ramp without any delay.

E. Auto-Restart Capability

1. The VFD system must be capable of automatically restarting in the event of a process or drive trip if input MV is present. The VFD system shall provide the user with the choice of automatically restarting or not. The user shall be able to selectively apply this feature to some (but not necessarily all) conditions as determined by the user to be appropriate for the specific application. This option shall be hard-key or password protected to avoid unwanted changes by unauthorized personnel.

F. Ground Faults

1. In the event of an input or output ground fault, the VFD shall be capable of annunciating the ground fault condition, safely operating, and by user selection, either trip or continue operation.

2. The VFD shall be capable of detecting output ground fault of 10mA to ensure personal safety. The manufacturer shall provide a valid type test to show that protection and detection works as described.

2.05 SERVICEABILITY/MAINTAINABILITY:

A. Front Access

1. The VFD system should be designed for front access only. VFD manufacturer shall state in their proposal if rear or side access is required. An explanation of reason and specified distance for any required rear or side access shall be given.

B. Voltage Isolation

1. All low voltage components, circuits, and wiring shall be separated with physical barriers from any sources of medium voltage.

C. Mean Time to Repair (MTTR)

1. In the event of a power electronic failure, removal and replacement should take an average of 20 minutes, after capacitors have discharged and safe working conditions have been established.

2.06 PROTECTIVE DEVICES:

A. Drive Protection

1. The VFD shall have built-in short-circuit detection and protection. Software shall include protective functions which detect abnormal conditions due to an internal power circuit sub-component failure(s). And as such, VFD will fault if abnormal conditions are present. Protective functions shall include:

a. Excessive Input Reactive Current Detection (One Cycle Protection)

b. Excessive Drive Losses Protection

2. The VFD shall be protected from VFD overtemperature.

3. The VFD system shall include distribution class surge arrestors to protect the converter and its input transformer against voltage surges.

4. The VFD system shall include power fuses on the input to the converter devices to protect from any potentially harmful fault currents.

5. The VFD system shall be protected from damage due to the following:

    a. Single-phase fault or 3-phase short circuit on VFD system output terminals.

    b. Power device failure to commutate/switch due to severe overload or other conditions.

    c. Loss of input power due to opening of VFD input disconnect device or utility power failure during VFD operation.

    d. Loss of one phase of input power.

6. The VFD shall be able to withstand the following fault conditions without damage to the power circuit components:

    a. Failure to connect a motor to the VFD output.

    b. VFD output open circuit that may occur during operation.

    c. VFD input or output ground fault.

    d. VFD input or output single-phase

B. Motor Protection

1. VFD shall be equipped with motor protection relay for RTD thermal protection. RTD module/cards shall have 10 RTD inputs minimum and shall be compatible with three-wire RTD types.

2. The motor protection relay shall be able to communicate via Modbus TCP/IP using Ethernet switch.

C. Motor Protective Relay:

1. Provide VFD-native protection or SEL-710-5 relay with option cards, as required to:

    a. Monitor overcurrent and time-overccurent parameters to the motor.

    b. To protect the motor from thermal overload, with both mathematical modelling and with 10 RTD option card.

    c. To process Discrete Inputs as required for interlock monitoring and Discrete Outputs to interlock / shutdown drive.

d. Provide Dual Ethernet 10/100 ports, with ModbusTCP protocol as required for SCADA monitoring of Vibration protection system and each RTD.

e. Where relay is provided, incorporate relay into door control of VFD, but ensure VFD dimensions do not exceed those shown in electrical plans.

2. Provide small form factor ethernet switch to route data between VFD processor and protective relay.

3. Provide integral Zelio microcontroller with analog expansion card as required to provide float control mode, unless all required functions are native within the VFD, or are accommodated by manufacturer's standard options. Include programming to accommodate float and PLC control modes within scope of provision for this microprocessor.

2.07 CONTROL INTERFACE:

A. The VFD shall have the availability to do the following control signals, indications, and alarms via ethernet:

1. VFD in Remote

2. VFD Running

3. VFD Warning

4. VFD Fault

5. Motor bearing RTD Alarm

6. Motor winding RTD Alarm

7. Speed indication

8. Current indication

9. Voltage indication

10. Real Power (kW) indication

11. Power indication

12. Remote Start

13. Remote Stop

14. Remote Fault Reset

15. Speed Control

B. The VFD shall be provided with integrated control provisions to operate or trip an incoming power disconnect device.

C. The VFD shall be provided with means to shut down the motor when remote Emergency Stop (E-Stop) signal is sent to the VFD.

2.08 DIAGNOSTICS AND FAULT RECORDING:

A. The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.

B. Fault log data storage memory shall be stored in non-volatile memory or be supported by a UPS sized to provide a minimum of 48-hour data retention.

C. A "fault log" shall record, store, display, and print upon demand, the following for the 256 most recent events:

1. VFD mode (Local/Remote)

2. Date and time of day

3. Type of fault

4. Reset mode (Local/Remote)

D. A "historic log" shall record, store, display, and print upon demand, the following control variables at an adjustable time interval for the 50 intervals immediately preceding a fault trip and 100 intervals following such trip:

1. VFD mode (local/remote/inhibited/tripped/etc.)

2. Speed demand

3. VFD output frequency

4. Demand (output) amps

5. Feedback (motor) amps

6. VFD output volts

7. Type of fault

8. Drive inhibit (On/Off)

9. The fault log record shall be accessible via an ethernet port, as well as, line by line on the keypad display

E. The VFD system shall be provided with the capability for remote diagnostics via ethernet link.

2.09 PROGRAMMING AND COMMUNIATIONS:

A. User Input/Keypad

1. The door of each power unit shall include manual speed device, a mode selector marked “Local/Remote”, a “POWER ON” light, a VFD “FAULT” light, a VFD “RUNNING” light, start pushbutton, stop pushbutton, and reset pushbutton.

2. A door-mounted keypad with integral digital LCD display shall be furnished, capable of controlling the VFD and setting drive parameters. The display must present all diagnostic message and parameter values in standard engineering units when accessed, without the use of codes. The keypad shall allow the operator to enter exact numerical settings in standard engineering units. A plain language (English) user menu (rather than codes) shall be provided in software as a guide to parameter setting. This device shall be fully compliant with applicable Norms related to enclosures.

3. Drive parameters shall be factory set in non-volatile EEPROM registers and re-settable in the field through the keypad. A minimum of 6 levels of password security shall be available to protect drive parameters from unauthorized personnel. The EEPROM stored drive variables must be able to be transferred for programming of new or spare boards.

4. The VFD system shall have the user selectable option of programming up to 3 speed avoidance bands. This gives the user the ability to block out and prevent operation at any undesirable speed, such as one that may be coincident with a mechanical resonance condition. The loss of the keypad or display shall be annunciated as a fault but shall not result in a VFD trip.

B. Serial Communication/Protocols/Modem or Cable

1. The VFD shall be capable of digital communication for setup of parameters, fault diagnostics, trending, and diagnostic log downloading.

2. The VFD shall be provided with ethernet switch(es) to communicate with the facility PLC network.

2.10 MATERIALS AND CONSTRUCTION:

A. The VFD shall be capable of continuous operation in an average ambient temperature between 4°F and 102°F at an elevation of 4400 feet above MSL without derating.

B. The VFD shall be sized to accommodate the continuous current ratings and shall be braced for a minimum symmetrical incoming fault current of 40 kA.

C. Cooling System

1. The VFD shall be forced air-cooled and shall be provided with fan redundancy and automatic switchover in the event of a fan failure for enhanced reliability. If a fan fails, the system must automatically switch to the alternate fan and generate an alarm to notify operator of initial fan system failure. During normal operation, the system must periodically cycle between the redundant fan systems to prevent drying out of bearings, seals, etc.

D. Enclosure

1. The VFD enclosure shall be NEMA Type 1A gasketed, ventilated and rigidly constructed.

2. Ventilated enclosure shall have cleanable filter media covering all air inlets and shall be front replaceable without exposing maintenance personnel to any of the power components.

3. Cabinet and doors shall be heavy gauge formed or structural steel for sturdy construction for dimensional integrity to assure long-term fit and function.

4. Enclosures must be designed to avoid harmonic and inductive heating effects.

5. Finish shall be manufacturer's standard.

6. Enclosure doors shall be hinged and shall be complete with keyed safety interlocks. It shall not be possible for the doors to be opened while the VFD is energized (this requirement is not applicable to the low voltage control cabinet doors).

E. Wiring and Terminal Blocks:

1. Control and indication wiring shall be #14 AWG, current transformer wiring shall be #10 AWG, and potential transformer wiring shall be #12 AWG. Internal power wiring shall be a minimum #12 AWG.

2. All control wiring shall be UL listed and have a VW-1 flame rating.

3. Terminal blocks used for external connections of control and signal circuits shall be provided.

4. Terminals shall be provided for terminating the shields of each shielded cable, immediately adjacent to the signal conductors.

5. Screw type terminal blocks shall be provided for all control wiring. No more than two wires shall be connected to one terminal block point.

6. No more than one wire shall be on any terminal lug, including jumper wires. A minimum of 20 percent spare terminal points shall be provided. Adequate space shall be provided on both sides of the terminal block for connecting wires and for wire markers.

7. Terminal blocks shall be provided with marker strips attached to terminal blocks, not to the covers. Wires numbers shall be marked on these marker strips by engraving or by using indelible ink.

8. All internal interconnecting wiring crossing a shipping split shall be labeled, coiled, and secured for field termination. Sufficient length of wire shall be provided to enable direct connection to the appropriate section, without the need for intermediate terminal blocks or splices.

9. Where wiring passes metal edges or through holes, suitable guards and grommets shall be provided to prevent cutting or scratching insulation.

F. Interlocks

1. Mechanical key interlocks shall be provided on all MV hinged doors.

2. Interlocking shall be fully coordinated to prevent access to all high voltage compartments when line power is applied to the VFD system.

3. Interlocks must be mechanical to provide positive lock-out prevention and safety.

G. Control Power

1. Control voltage shall be 120V AC supplied internally from an integral UPS furnished with VFD, with power supplied from UPS-backed panelboard. Label VFD with indication enclosure is supplied from more than one source, and identify locations required for disconnection.

H. Control Devices and Indicating Lights

1. LED type indicating light shall be provided for each VFD.

2. Each control device, relay, indicating lights, etc. will operate at 120V AC.

I. Nameplates:

1. Permanent engraved lamacoid nameplates with black lettering on a white background for all panels, relays, control switches, instruments and devices, including transformers, circuit breaker, and compartments shall be provided.

2. Safety signs and labels shall be in accordance with ANSI Z535.4.

3. Equipment and terminal blocks within the compartment shall be suitably identified.

4. Nameplates shall be mounted with self-tapping stainless screws.

5. A stainless steel nameplate showing manufacturer's name, type and identification number, year of manufacture, continuous current rating, interrupting rating in amperes, and maximum voltage rating shall be provided.

PART 3 - EXECUTION

3.01 FACTORY TESTING:

A. Standard factory tests and production tests shall be performed on each VFD.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 INSTALLATION:

A. The Contractor shall install all equipment per the manufacturer's recommendations and contract drawings.

B. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

3.03 FIELD ADJUSTMENTS:

A. The relays shall be set in the field by the Contractor in accordance with settings designated by the engineer.

3.04 RELAY INTEGRATION:

A. Delegated design - Program relay to avoid motor operating in conditions that could damage it, as defined by damage curve of motor, RTD sensors, and vibration protection system.

B. Program mathematical model for motor per relay manufacturer instructions.

C. Program appropriate responses to interlock VFD per field interlock devices and permissives.

D. Program option card, if provided, as required to determine sensor values, and to provide user-adjustable warning threshold for SCADA and shutdown parameters for VFD, including notification of SCADA.

E. Program pass-through from ModbusRTU to ModbusTCP protocol for features required by these Contract Documents.

F. Install relay into VFD control cabinet. Separate instrumentation conduits from other electronics.

3.05 FIELD INSPECTION AND TESTING:

A. Upon delivery, the VFD shall be inspected for physical defects and conformance to this specification.

B. Provide testing of system both in PLC and in no-PLC Autonomous Operation Mode.

END OF SECTION

SECTION 26 32 13

ENGINE GENERATORS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test ready for operation, diesel engine-generator set complete with appurtenances, as indicated and specified.

B. The unit shall be provided in an outdoor, weather proof, sound attenuated enclosure. The unit shall be provided with double-walled, sub-base fuel tank, and provisions for circulating fuel between the belly tank and the facility's fuel storage system.

C. Each unit shall have a minimum site rating of 2000 KW, 2500 KVA power rating, standby, at 80 percent lagging power factor, three-phase, 60-Hertz, 4.16kV, four-wire, alternating current generator.

D. The unit shall be arranged for automatic starting and stopping, and load transfer upon failure of the normal source of power through automatic throw over system. The engine generator set shall exhibit less than 20 percent voltage dip and less than 5 percent frequency dip during starting of the loads identified in Attachment A to this Section.

E. The engine-generator package shall be complete in all respects and shall include all equipment and controls necessary for a fully operational standby power supply system.

F. Provide fully enclosed walk-in enclosure suitable for installation on concrete pad as indicated on the drawings. Include any galvanized steel platform and steps, with railing system necessary for normal operation and to allow servicing the units from a raised platform due to the height of the sub-base fuel tank.

G. Provide, as a package system from the engine generator manufacturer, Switchgear 01-SWGR-99110, specified on plans, Single Line Diagrams, and Section 26 13 13, with Sequence of Operations as specified in Section 26 13 13S.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. D975: Standard Specification for Diesel Fuel Oils.

B. Electrical Generating Systems Association (EGSA):

1. 101P: Engine Driven Generator Sets.

C. Institute of Electrical and Electronics Engineers (IEEE):

1. 1: General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation.

2. 43: Recommended Practice for Insulation Testing of Large AC Rotating Machinery

3. 112: Test Procedures for Polyphase Induction Motors and Generators.

4. 120: Master Test Guide for Electrical Measurements in Power Circuits.

D. National Electrical Manufacturers Association (NEMA):

1. AB 1: Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.

2. ICS 2: Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment.

3. ICS 6: Standard for Industrial Controls and System Enclosures.

4. MG 1: Standard for Motors and Generators.

5. PB 1: Standard for Panelboards.

6. SG 6: Standard for Power Switching Equipment.

7. MW36-C: Magnet wire.

E. National Fire Protection Association (NFPA):

1. 30: Flammable and Combustible Liquids Code.

2. 37: Installation and Use of Stationary Combustion Engines and Gas Turbines.

3. 70: National Electrical Code (NEC).

4. 110: Standard for Emergency and Standby Power Systems.

F. Society of Automotive Engineers International (SAE):

1. ARP892: DC Starter-Generator, Engine.

2. J537: Storage Batteries

G. Underwriters Laboratories (UL):

1. 142: Steel Aboveground Tanks for Flammable and Combustible Liquids.

2. 489: Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

3. 508A: Industrial Control Panels.

4. 1236: Standard for Safety Battery Charges for Charging Engine-Starter Batteries.

5. 1446: Systems of Insulations Materials.

6. 2200: Stationary Engine Generator Assemblies.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00 and as specified:

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.

1. Failure to include a copy of the marked-up specification sections will result in return of the entire submittal without further review and consideration until the marked-up specification are resubmitted with the entire package.

D. Outline equipment and enclosure drawings, equipment catalog cuts, wiring and connection diagrams and other documents required to completely describe the systems and equipment being furnished. Elevation drawings with shipping splits and estimated weights identified.

E. Identification, description and dimensions.

F. Engine-generator skid base drawings including spring vibration isolators. Drawings shall indicate size and location of anchor bolts, and conduit electrical device locations.

G. Performance specifications of all items of equipment.

H. Control panel layout drawings, dimensions, and component bill of materials. Outline drawings showing conduit entry areas and anchoring information. Description of control including operation of interface equipment.

I. Complete electrical, instrumentation, control and wiring diagrams in sufficient detail to allow installation of instrumentation and controls and electrical components.

J. Provide certificate of conformance to UL Standard 2200, Stationary Engine Generator Assemblies.

K. Attenuation curve for the silencing equipment as offered to accomplish the required silencing for this installation.

L. Information on the proposed jacket water treatment and procedures for flushing of the cooling systems.

M. Operations and Maintenance Manuals, covering all equipment furnished, annotated to reference only the specific model numbers supplied. Include parts lists and parts prices current to the date of submittal; include information relevant to part supply and ordering. Submit prior to the startup and testing of the engine/generator units. Submit in accordance with Section 01 33 00, Section 01 78 36 and as specified herein.

N. Manufacturer's certified shop test record of complete engine driven generator unit.

O. As-built drawings and material summary shall be shipped with the equipment.

P. Engine generator loading calculation, per the requirements of Attachment A to this section.

Q. Data to be provided by engine generator system supplier:

1. Submit generator loading calculations and data for engine, generator, and accessories: (for rated kW capacity).

    a. Engine Data:

        (1) Manufacturer

        (2) Model

        (3) Number and arrangement of cylinders:

            (a) RPM

            (b) Bore X stroke

            (c) Maximum power at rated RPM

            (d) BMEP at rated kW (including any parasitic loads and generator efficiency)

            (e) Piston speed, feet per minute

(f) Make and model of governor

(g) Make and model of overspeed shutdown device

b. Generator Data:

(1) Manufacturer

(2) Model

(3) Rated kVA

(4) Rated kW

(5) Voltage

(6) Temperature rise above 40 degrees C ambient. Stator by thermometer and field by resistance in degrees C.

(7) Class of insulation

(8) Generator efficiency including excitation losses at 80 percent PF:

(a) Full load

(b) Three quarters load

(c) Half load

(9) Generator subtransient reactance in ohms and Per Unit value.

c. Guaranteed maximum fuel consumption rate at generator terminals at 138,000 BTU/gallon of No. 2 diesel fuel:

(1) Full load, gallons/hour

(2) Three-quarters load, gallons/hour

(3) Half load, gallons/hour

d. Generator unit and accessories

e. Weight of complete unit, with break down by engine-generator set, base tank, and fuel.

f. Exhaust gas emissions data, maximum values at full load, 3/4 load, 1/2 load, and 1/4 load:

(1) Temperature in degrees F

(2) Flow in ACFM (mass and volume)

g. Combustion air requirement in CFM

h. Cold cranking amperes rating of engine starting batteries (CCA) at 0 degrees F.

R. Provide manufacturer's printed installation instructions including anchoring details to meet earthquake requirements as specified and indicated.

S. Performance Test Reports: Upon completion of installed system, submit in booklet form all field tests performed to prove compliance with specified performance criteria including final settings of devices.

1.04 SEISMIC REQUIREMENTS:

A. Contractor shall conform to the seismic requirements as indicated and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified such that units will remain operational after a seismic event or conditions occur as indicated in the referenced seismic specification section.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Contractor to ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied. Contractor to review the proper installation of the equipment and of each type of device with the equipment supplier prior to installation.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with APWA Section 01 66 00 and as specified.

B. Protect all equipment placed into storage from weather, humidity and temperature variations, dirt, dust, and other contaminants.

1.07 REGULATORY REQUIREMENTS:

A. Local State and City Air Pollution Control Laws.

B. Provide all required data and information for a Title V local air pollution control district operating permit.

C. Federal Clean Air Act (42 United States Code (U.S.C.) 7401 et. seq.)

D. Federal Air Pollution Control Regulations: 40 Code of Federal Regulations (CFR) Parts 50-99, as amended by the Federal Register.

E. Furnish to the Owner, within 15 working days of the date of any request, all documents and other information required to verify compliance with permit and applicable air pollution control laws and regulations, including EPA Tier 2 emission requirements in effect at the bid date of the project.

1.08 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide spare parts that are identical to and interchangeable with similar parts installed for each engine-generator set plus following:

1. Two filter for all services

2. Two fuse for each rating

C. Provide a list of recommended spare parts for the first year of operation and for the first five years of operation, including a price list and location of the nearest facility from which all spare parts can be obtained.

D. Provide two sets of acoustic hearing protection, ear-muff devices, industrial grade, with acoustic foam filled cushions.

E. Pack spare parts in suitable containers or boxes bearing labels clearly designating contents and piece of equipment for which they are intended.

F. Deliver spare parts at same time as equipment to which they pertain. Properly store and safeguard spare parts until completion of the work, at which time deliver them where directed by the Engineer.

1.09 WARRANTY AND SERVICE:

A. Provide in accordance with Section 01 78 36.

B. The generator set manufacturer's standard factory warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall

include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor.

C. Ensure that equipment manufacturer has local branch office staff with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Caterpillar Inc.

B. Cummins Power Generation Inc., Onan Products

C. Kohler Co.

D. Or approved equal.

2.02 GENERAL:

A. Engine-generator set and enclosure shall be a factory-assembled unit that is a standard production unit with existing torsional analysis data. Mixing and matching engine and generator by a third party supplier is not acceptable. The engine and generator shall be directly connected with a flexible coupling, shall be free from injurious torsional or other vibration.

B. The engine and generator shall be directly connected.

C. The engine-generator set shall allow easy access to the various parts for maintenance purposes.

D. The engine-generator set shall be pre-piped and pre-wired.

E. The complete engine-generator unit shall be free from harmful torsional or other vibration throughout the entire operating range of speed and load. The engine manufacturer shall provide an analysis of the complete engine-generator unit, which shall show where any critical speed will be encountered, together with the order, the frequency and magnitude of any critical speed.

F. The engine-generator set operating in an ambient temperature of 40 degrees C shall have a standby power capacity of not less than that indicated at 0.80 power factor, and shall operate at a speed not to exceed 1,800 rpm. It shall be rated as previously indicated in this section.

G. Frequency regulation shall not exceed 3 Hertz for step load from no load to rated load. Frequency variation shall not exceed plus or minus 0.3 Hertz for constant loads from no load to rated load.

H. Voltage regulation for step load from no load to rated load shall be within plus or minus 4 percent of rated voltage for units up to and including 25 kW and within plus or minus 5 percent or percent of rated voltage for units rated 30 kW or higher. Voltage variation shall be within plus or minus 1 percent of the mean value for constant loads from no load to rated load.

I. Mount the engine generator on a heavy steel sub-base with spring type vibration isolators.

J. Provide generator set with integral neutral grounding resistor.

K. Provide generator set with internal panelboard for distribution of onboard loads. Delegated Design – design and submit power system for enclosure with generator set. Provide lightning protection system for enclosure and external Surge Protective Device adjacent to panelboard.

2.03 GENERATOR:

A. Generator shall be rated for continuous duty; shall be rotating field, engine-driven, direct-connected, synchronous type with amortisseur winding. Generator frame shall be dripproof with all openings guarded. Bearings shall be sleeve or sealed ball type. The generator shall be mechanically and torsionally matched to the engine driver and shall be provided to withstand inherent pulsating torques of the engine. Full load efficiency of the combined generator, exciter and regulator shall be not less than 95 percent. The generator windings, insulation and excitation system shall be braced to withstand any possible short-circuit stresses.

B. Generator insulation shall be Class H or F in accordance with NEMA Standard MG1-1.65. Stator shall be form wound – random wound is unacceptable. Temperature rise shall be no more than 105 deg C at 40 deg C in accordance with NEMA Standard MG1-22.40 for continuous duty at all output ratings.

C. Design generator system to accept loads without slowing by more than 6 Hz and without decreasing system voltage below 10% of nominal.

D. Voltage regulator shall be an automatic, temperature compensated, solid-state type with a manual adjustment range of plus or minus 5 percent of rated voltage. The generator windings, insulation and excitation system shall be braced to withstand any possible short-circuit stresses.

E. Exciter shall be a solid-state, static type or brushless rotating type utilizing rotating diode rectifiers. Minimum rating of exciter shall be as indicated in NEMA Std. MG-1-22.16.

PMG type exciters, with a minimum exciter rating per NEMA Std. MG-1-22.16, is an acceptable alternative.

F. Include components for field flashing and field discharge. Fast acting fuses or other protective devices shall be incorporated where failure of regulator or exciter components could result in damage to the generator field or exciter windings. Provide spares for fuses and other non-resettable protective devices.

G. Voltage regulator and static exciter shall be mounted in generator control panel or elsewhere so as to protect from and isolate from vibration.

H. The generator shall conform to the applicable parts of the following standards, unless otherwise specified:

1. NEMA MG1, Motors and Generators.

2. IEEE 43, Recommended Practice for Insulation Testing of Large AC Rotating Machinery.

3. CSA C22.2- No. 100, Motors and Generators.

4. Testing shall be in accordance with IEEE-115 and NEMA MG-1 standards

I. The stator frame shall be fabricated bar and plate steel construction.

1. All insulation materials used in the stator shall have a temperature rating of Class H per IEEE Standard 1. The coils shall be of a formed coil construction using a magnet wire meeting NEMA MW36-C specifications.

2. The complete stator shall be wound with a 2/3 stator winding pitch and processed in a vacuum pressure impregnation chamber. Encapsulation of the stator shall be accomplished with a two-part epoxy system.

J. Generator lead terminal box shall be of ample size to accept and terminate connecting cables as indicated on the drawings. Generator leads shall be furnished with terminal connectors suitable for the customers connecting cables.

K. Provide generator stator winding heater with thermostat wired at 120 VAC to prevent formation of condensation.

2.04 DIESEL ENGINE:

A. Heavy-duty compression-ignition, cold-starting diesel type arranged for direct connection to an alternating current generator. It shall be a current model of a type in a regular production by a manufacturer regularly engaged in building this type of diesel engine. Engine shall have at least a published intermittent brake horsepower rating at specified generator speed required by generator at rated full load output and shall operate without undue heating, vibration, or wear.

B. Engine may be a two-cycle or four-cycle and may be naturally aspirated, scavenged, or turbocharged.

C. Engine shall operate satisfactorily on No. 2 fuel oil.

D. Performance, materials, and workmanship shall be in accordance with Diesel Engine Manufacturers Association standard practices.

2.05 ENGINE ELECTRICAL SYSTEM:

A. Electrical system shall include a battery, starting motor, voltage and current-regulated charging generator or alternator, and a separate battery charger. Battery shall be of suitable capacity to start engine at conditions specified and shall be guaranteed for three years.

B. Battery charger shall be automatic, two rate type providing for equalizing charge and continuous taper charging. Output characteristics shall match requirements of battery furnished. Provide charger suitable for operation on 120 volt, single-phase, 60 Hertz current to be rated not less than 10 amp direct current. Furnish battery charger with following features:

1. Direct current voltage regulation: plus or minus 2 percent for variations in line voltage of plus or minus 10 percent.

2. Direct current voltmeter and direct current ammeter, each with suitable scales.

3. Automatic surge suppressor.

4. Automatic current limiting to prevent overloading due to engine cranking, shorted output or reversed battery connections.

5. Alternating current line fusing.

6. Equalize charge rate with manually set timer.

7. Integral protection to prevent battery discharge through charger on loss of alternating current line voltage.

8. Terminal block with terminals for all external connections.

C. Where wall mounting is indicated, enclosures shall be suitable for conduit connection and ventilating openings shall be guarded.

D. Provide battery rack to accommodate starting batteries and supporting rack for battery charger. Racks shall be seismically rated, secured to (and within) the weatherproof enclosure, free-standing type.

E. Provide 120 VAC battery pad heater with thermostat or and provide lead/lad redundant space heaters for the weatherproof enclosure interior instead of using block heater, battery heater, etc.

2.06 ENGINE APPURTENANCES:

A. Furnish engine with following appurtenances:

1. Combustion air cleaner of oil bath type or dry replaceable filter type. A tube shall connect crankcase breather with air cleaner to prevent accumulation of objectionable smoke and fumes.

2. Critical grade exhaust silencers complete with drains and flexible stainless-steel connection. The entire exhaust system shall be insulated.

B. Governors:

1. Provide governor capable of:

a. Maintaining engine speed from no load to full load within 3 percent of synchronous speed.

b. Load sensing and load sharing controls.

c. Electronic control from from paralleling switchgear.

2. Governors shall be controlled electrically from paralleling switchgear.

2.07 CONTROL PANELS:

A. Engine and generator control panels may be separate panels, or a combined panel, and mounted with vibration isolators on the unit. Instruments shall be of direct-reading type, factory mounted and factory connected. Instruments shall be accurate within 3 percent.

B. Provide engine panel with following features and instruments:

C. Three-position engine control switch:

1. Stop/Reset: In this position, the engine shall not be capable of starting and/or running. If the engine was shutdown due to the operation of a protective device, the shutdown malfunction shall be reset when the switch is moved to this position. If the engine is running when the switch is moved to this position, it shall be immediately shutdown. Provide audible alarm when switch is in this position.

2. Automatic: In this position, the engine control shall be in readiness for fully automatic operation upon receipt of a start signal.

3. Test: When placed in this position, the engine shall start and run as if a start signal were received except it shall not be connected to the bus unless a start signal is received. When returned to the automatic position, the engine will shut down.

4. Manual starting switch.

5. Full automatic starting from pilot device initiating start when normal power fails. Automatic cranking shall be interrupted cycle type not affected by ambient temperature with overall time limit. A total of five cranking cycles shall automatically shut down engine after a time delay.

6. Automatic shutdown devices with manual reset and individual indicating lights for:

    a. Low oil pressure

    b. High water temperature

    c. Low coolant level

    d. Engine overspeed

    e. Failure of engine to start

7. Auxiliary contacts on all aforementioned shutdown devices to operate a remote alarm. In addition, provide the following alarm contacts.

    a. Sub-base oil tank rupture

    b. Low fuel

    c. Low battery voltage

    d. Common fault alarm

    e. Not in automatic

    f. Generator run status

    g. Low coolant level

    h. Fuel tank system leak

8. Water temperature gauge

9. Ammeter-charging circuit

10. Tachometer

11. Lubricating oil pressure gauge

12. Fuel pressure gauge

13. Running time meter

14. Contacts and relays to operate exhaust fans and dampers required as part of the enclosure operation.

15. Generator panel shall include following instruments and information displays:

    a. Voltmeter, alternating current and phase selector switch with OFF position

    b. Ammeter, alternating current, and phase selector switch with OFF position

    c. Voltage-adjusting rheostat

    d. Three-phase wattmeter

    e. Frequency meter

    f. Where automatic synchronizing, and paralleling with other generator units is required generator breaker shall be electrically operated low voltage power circuit breaker. Circuit breaker shall conform to the provisions of NEMA Standard SG3.

2.08 FUEL STORAGE SYSTEM:

A. Above ground fuel storage system is specified under separate section.

B. Provide necessary suction and return line connections at pipe openings specified on plans.

C. Fuel piping between storage tank, sub-base tank, and engine shall be type K soft temper copper tubing with flared fittings unless noted otherwise in fuel system design. Where installed underground or embedded in concrete, tubing shall be run in protective conduit made of standard weight black steel pipe.

D. Tapped openings in storage tank shall be bushed to desired size with single- or double-tapped cast-iron tank bushing.

E. Provide foot valve on lower end of suction line in tank, 3 inch above bottom of tank. It shall be an all-bronze, double-poppet combination foot valve and strainer.

F. Sub-base tank vent shall be standard weight, black steel pipe with screwed malleable-iron fittings.

2.09 ENGINE FUEL SYSTEM:

A. Diesel fuel system shall consist of an engine-driven fuel supply pump, fuel filters, and a sub-base tank and lift pump set. Sub-base tank shall provide minimum 4500 gallons of fuel storage at the engine generator enclosure.

B. Fuel filters shall have elements which may be easily replaced without breaking any fuel line connection or disturbing fuel pumps or any other part of engine. Oil filters shall be conveniently located ahead of injection or circulating pump so that fuel is thoroughly filtered before it reaches injectors. Screens or filters requiring cleaning or replacement shall not be used in injection or circulating pump, or in injection valve assemblies.

2.10 ENGINE COOLING SYSTEM (RADIATOR COOLED):

A. Provide a unit-mounted radiator with integral jacket water circulating pump, and thermostatic control for cooling system.

B. Provide radiator of sufficient capacity to operate engine at full rated generator load at 120 degrees F ambient temperature.

C. Provide radiator with flange for connection to exhaust duct specified under Heating and Ventilating.

D. Provide engine coolant heater rated 208V, single phase, with thermostat.

E. Engine cooling system shall be charged with inhibited ethylene-glycol solution to provide antifreeze protection to 0 degrees F.

2.11 ENGINE LUBRICATION:

A. Provide full pressure system, supplying oil to all surfaces requiring lubrication. Circulation shall be by positive displacement pump. Full flow-type filters or filters with bypass feature shall be included. Filter elements shall be replaceable without disconnecting oil piping. Provide an oil cooler, if recommended by engine manufacturer, to properly lubricate engine at full rated generator load. Provide full charge of new oil after tests have been completed.

2.12 ENGINE GENERATOR SET ENCLOSURE:

A. Provide sound attenuated weather-proof outdoor, walk-in type enclosure, including:

1. Corrosion Resistant Construction

2. Stainless steel fasteners.

3. Guards for cooling fan and battery charging alternator.

B. Rigidity wind test equal to 150 mph

C. Roof load equal to 50 psf

D. Rain test equal to 5 inches per hour

E. Certified to meet following codes:

1. BOCA Basic Building Code

2. BOCA Basic Mechanical Code

3. State of Utah Building Code

4. 2018 International Building Code

F. Building to consist of roof, two side walls, and two end walls of prepainted steel stressed-skin construction, door and door frame, lifting rings, mounting frame, insulation, electrical package, louvers, exhaust fan, muffler mounting bracket, and other appurtenances to make complete installation.

1. Roof:

a. One piece combered roof sheet, min. 0.040 inch thick steel alloy, with extruded recessed side and end rails.

b. Roof bows, extruded "I" beams, spaced as required to carry loads.

2. Walls:

a. Posts to be extruded steel sections, sized and spaced as required to carry loads.

b. Panels to be min. 0.045 inch thick steel sheet, mill-prepainted, inside and outside, and riveted to posts.

3. Door and Door Frame:

a. Provide welded steel door frame of extruded steel alloy, riveted to side panels.

b. Provide personnel door gasketed to form weathertight seal, panic bar hardware with three point stainless steel locks and opening from inside in locked condition.

4. Lifting Rings:

a. Provide four lifting rings, two in each side of roof, for lifting shelter only. Capacity of lifting rings to match load.

5. Mounting Frame:

    a. Provide steel perimeter mounting frame for mounting onto concrete pad.

6. Insulation:

    a. Provide semi-rigid fiberglass thermoacoustic insulation. Insulation shall be held into the walls with perforated metal.

    b. Provide Level 1 sound attenuation for a 15 dBA noise reduction up to 23 feet from the enclosure.

7. Electrical Package:

    a. All equipment and devices UL listed. 125-Ampere Main circuit breaker with single phase, 3 wire, 60 Hertz, 125 Ampere bussing/gframe, 20 amp trip, 8-20 amp branch circuit breakers or as required by the auxiliary equipment required by the enclosure and related systems. Panelboards shall conform to the latest NEMA standards, National Electrical Code and Underwriters Laboratories, Inc. Provide equipment suitable for this power system, either identified for supply from 120V single-phase power or 208V single-phase power.

    b. Circuits as follows:

        (1) No. 1 - Lighting

        (2) No. 2 - Receptacles

        (3) No. 3 - Electric Heater

        (4) No. 4 - Exhaust Fan

        (5) No. 5 - Engine and Battery Heaters

        (6) No. 6 - Battery Charger

        (7) No. 7 - Motorized Dampers

        (8) No. 8 - Sub-base Tank

        (9) No. 9 - Spare

    c. Electric heater, control stations, and thermostat shall be as recommended by the manufacturer, subject to review by the Engineer.

d. Receptacles shall be duplex, 20 amp, 125 volt, 3 pole, 2 wire and shall be a ground fault interrupter receptacle unless protected by a ground fault interrupter circuit breaker.

e. Light switch shall be toggle type, 15 amp, 120 volt, single pole.

f. Light fixtures shall be a ceiling or pendant mounted enclosed and gasketed vapor tight LED type with acrylic lens.

g. Provide additional external full-cutoff LED wallpacks to illuminate walkway and stair treads, 4000K Correlated Color Temperature.

8. Manual Motor Starters:

a. Provide manual motor starters where indicated and for 120 volt, 60-Hertz fractional horsepower motors that do not have built-in thermal overload devices.

b. Manual starters within sight of motors, as defined by NEC.

9. Louvers:

a. Provide louvers and dampers for engine generator inlet and exhaust and ventilation air.

b. Fixed louvers, all aluminum construction, riveted into aluminized steel frame to form rigid, water resistant assembly. Motorized dampers as specified hereinafter.

c. Properly size louvers and dampers to allow sufficient engine combustion air, radiator cooling air, and ventilation air with maximum 0.5 inch water restriction. Coordinate with engine generator manufacturer.

10. Exhaust Fan:

a. Provide roof mounted exhaust fan capable of providing six air changes per hour.

11. Muffler Mounting Bracket:

a. Provide suitable bracket to secure critical grade generator silencer within the enclosure.

b. Coordinate with engine generator supplier as required.

G. Provide integral main fuel tank mounted at base of enclosure rated to UL 142.

1. The tank shall be double-walled with leak detection system provided. Coordinate with facility leak protection system, and both provide and integrate sensor into the overall master alarm, including points for notification in the plant SCADA system. Provide means to accommodate this secondary containment leak detection sensor, and associated interconnection(s). Reference 23 13 25, Facility Aboveground Diesel Fuel-Oil Storage Tanks, for additional requirements.

2. Provide means to accommodate 4-position floats, and associated interconnection, as specified in 23 13 25 Facility Aboveground Diesel Fuel-Oil Storage Tanks.

3. Float switch shall alarm on low level and at 95 percent capacity.

4. Tank shall have the capacity for uninterrupted service at 100 percent rated load for a period of 30 hours without being refilled.

2.13 PAINT:

A. Paint for exterior surfaces of equipment shall be two coats of acceptable oil- and heat-resistant paint, applied after surfaces have been thoroughly cleaned and prepared with suitable priming coat.

B. Provide touch-up paint in a quart container to Owner for use in field.

2.14 TOOLS:

A. Provide in accordance with Section 01 78 23.

B. Provide all special tools required for maintenance and repair of unit in metal box complete with lock and keys.

2.15 SHOP TESTING:

A. The complete engine-generator set with enclosure shall be shop tested at full load using a 0.8 power factor reactive load bank to simulate a complete and integrated system prior to shipment.

B. Provide all details of the proposed testing, including arrangements, test instruments and calibration, and procedures to be used to verify controls and alarms. The completed certified test record shall be submitted within 30 days after the completed test.

C. Tests shall verify that unit will operate successfully and meet all specified operational requirements and verify adequate means of enclosure ventilation is provided.

D. The shop test shall include four continuous hours of operation at full load and rated power factor. Voltage and frequency regulation and transient response shall be tested

and recorded to show full compliance with this specification. During the shop test, readings shall be taken and recorded every thirty minutes for each of the following:

1. Time
2. Ambient temperature
3. Volts for each phase
4. Load:
    a. Amps for each phase
    b. kW
    c. Power factor
    d. Frequency
5. Engine jacket water temperature
6. Lubricating oil pressure
7. Exhaust gas temperature
8. Fuel consumption

E. The procedure for the shop test of the diesel engine shall include the engine manufacturer's standard practice.

F. Make arrangements for factory test witnessing by Engineer. Notify Engineer not less than 30 days prior to scheduled test.

2.16 NEUTRAL GROUNDING RESISTOR (NGR):

A. Reference NGR specifications for each engine generator are as indicated on the Single-Line Diagram(s) provided. Locate NGR and NGR enclosure within the generator enclosure. Additional requirements include:

1. The NGR assembly shall comply with IEEE C57.32.
2. Resistor element shall be rated as shown on the drawings.
3. Provide integral Neutral Grounding Resistor monitoring system. Provide voltage divider monitoring to assure bond to ground is intact.
4. Provide the resistor within the generator set, in an expanded galvanized steel enclosure of the personnel-safety type and include any necessary supports and

mounting hardware. Finish the NGR enclosure to be at least as durable as the other electrical finishes within the generator enclosure.

5. Where located outside of the generator set, provide in stainless steel enclosure, including additional stainless steel enclosure with door to cover transparent plastic cover parts that would otherwise be exposed to sunlight.

PART 3 - EXECUTION

3.01 COORDINATION:

A. Coordinate with ventilation, fuel supply, and exhaust, to provide an efficient, well coordinated layout.

3.02 INSTALLATION:

A. Install unit complete and make operational.

B. Install muffler horizontally on spring type compensating hangers as close to unit as practical, within weatherproof enclosure.

C. Provide 1/2-inch copper drain with draincock from bottom of muffler to nearest floor drain for periodic draining of muffler.

D. Install engine at sufficient height above base to permit dropping oil pan without removing unit.

E. Provide vibration isolation of exhaust equipment to prevent transfer of vibration into building components enclosing the standby power system.

F. External conduit and wiring and transfer switch will be furnished and installed under applicable electrical sections, but all conduit, wiring and connections between the engine and its control panel and generator and its control panel, is included herein.

G. Mount engine-generator set on a structural steel frame or skid. Provide vibration isolators suitable to prevent transmission of vibration to building structure between set and frame, and securely anchored to the concrete foundation. Obtain from supplier of engine-generator set a drawing giving location and size of foundation bolts for unit proposed, in sufficient time to be available when needed to place foundation. Galvanized anchor bolts shall be furnished by engine-generator set manufacturer.

H. Electrical equipment and materials shall be listed by UL wherever standards have been established by that agency.

3.03 WIRING AND CONNECTIONS:

A. Provide conduit, wiring, and connections required and recommended by unit supplier. All conduit shall be terminated with flexible conduit. All wiring shall be multi-stranded.

B. Connect neutral point of generator and generator frame to ground by green insulated copper conductor of adequate size.

C. Enclsure to be pre-wired for all auxiliary equipment required for operation of the engine and related systems.

3.04 STARTUP AND TESTING:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Comply with requirements for checkout, startup, and testing in Section 01 78 25.

3. Services of Service Engineer, specifically trained on type of equipment specified. Person-day requirements listed exclusive of travel time.

a. Physical Checkout and Field Testing (Functional Completion Testing): Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connections; certify proper installation: Assist in location of devices, methods of mounting, field erection, etc.

5 person-day

b. Startup and Testing: Calibrate, check alignment and perform a functional test with water or process fluid. Tests to include all items specified.

5 person-day

c. Service-inspections during first year of operation, for use at Owner's request, and exclusive of repair, malfunction or other trouble-shooting service calls:

5 person-day

d. Person-day is defined as one 8-hour day, excluding travel time.

B. Operate the unit to demonstrate ability to operate continuously without vibration, jamming, leaking or overheating and to perform specified functions, after installation and after manufacturer's representative check of installed equipment.

C. Comply with manufacturer's operating and maintenance instructions during start-up and operation.

D. Make all final adjustments necessary to place the equipment in working order. Prior to any testing or operation of the units, the manufacturer's service representative shall inspect the installation, and shall certify, in writing, that the assemblies are, in all ways, ready for operation. Start-up shall not commence without the presence of the manufacturer's representative.

3.05 FIELD TEST:

A. Upon completion of the installation and as soon as conditions permit, the diesel engine driven generator, including the engine, generator, electrical circuit controls, transfer controls other devices shall be tested in the presence of the Owner by the service representative for the manufacturer of the engine driven generator unit to verify that the system functions as specified.

1. Perform load test with 0.8 power factor reactive load bank connected to the generator for a full load nameplate test. Run the test for a duration of four hours. Take system data readings each 20 minutes.

2. The manufacturers' representatives shall make such changes in wiring or connections and such adjustments, repairs or replacements to make the circuit, device or control system function as specified and comply with the Contract Documents.

3. Acceptance of test will be verified when the unit operates without alarm or abnormal conditions for the duration of the entire test. Retest if this requirement is not met until acceptance criteria has been verified.

B. Record in 20 minute intervals during four hour test:

1. Kilowatts

2. Amps

3. Voltage

4. Coolant temperature

5. Air temperature

6. Frequency

7. Oil pressure

C. As part of the field test, each of the automatic shutdown devices shall be tested and the respective values recorded at which the devices will stop engine. Any adjustments

required shall be made in the devices to make the operating values correspond to those recommended by the engine manufacturer and as recorded during the stop test.

D. Take and record octave band sound pressure level readings while the engine driven generator is operating using the station load. These readings shall be within the limits identified in the engine generator data submittals for acceptable sound revel.

E. After completion of testing, provide additional fuel, as required, to fill the fuel system tank.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 33 23

CENTRAL BATTERY EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies the requirements for the design, fabrication, inspection, testing, delivery, and installation of a NiCad battery, two battery chargers, and required battery racks for switchgear 01-SWGR-99100.

B. Battery, battery chargers and associated equipment shall provide power to critical 01-SWGR-99100 loads as indicated on the Contract drawings and documents.

1.02 REFERENCES:

A. American National Standards Institute (ANSI)

B. Institute of Electrical and Electronics Engineers (IEEE):

1. 485: Sizing Large Load Storage Batteries

2. 1106: Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications

3. 1115: Recommended Practice for Sizing Nickel-Cadmium Batteries for Stationary Applications

C. National Electrical Manufacturers Association

D. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC)

E. Underwriter’s Laboratory (UL)

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00 and Section 26 05 10.

B. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems, anchorage and equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped

by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

C. Information to include:

1. Dimensions

2. Data sheets

3. Mounting details

D. Submittals for Information Only:

1. Provide information on operation and maintenance requirements in accordance with Section 01 33 00 and Section 01 78 25.

2. Certified battery sizing and battery charger calculations.

1.04 RELATED SECTIONS:

A. Section 01 33 00: Submittals

B. Section 01 41 20: Seismic and wind Requirements

C. Section 01 78 25: Operations and maintenance Data

D. Section 26 05 10: Electrical Work, General

E. Section 26 05 50: Seismic Controls

F. Section 26 05 53: Electrical Identification

G. Section 26 08 13: Field Inspection and Acceptance Tests

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

1.07 DELIVERY, PROTECTION AND STORAGE

A. Comply with the requirements of Section 01 66 10.

B. Store batteries and chargers in heated, dry, weather-protected area.

1.08 WARRANTY:

A. Comply with the requirements specified in Section 01 78 36.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. SBS

B. Alcad

C. Enersys

2.02 MATERIALS:

A. Steel for battery racks shall conform to Section 05 12 00.

2.03 BATTERY CHARACTERISTICS:

A. Nominal battery voltage, full charge, 125 V.

B. Battery shall be designed to supply total load cycle for charging, closing, and tripping all breakers (including spare cells) plus control and protection panels connected to battery unit.

C. The battery shall be capable of being charged in a period of six (6) hours to not less than 95 percent full charge after being discharged to 100 volts. This charging cycle shall not cause any harmful effects on the battery, including leaking or foaming of electrolyte.

D. Battery to deliver specified output at 25 degrees C.

E. Provide certified calculations for the battery sizing. Include in the sizing calculations the entire 4.16 kV 01-SWGR-99100 switchgear, other required equipment, protection and control systems, and the sustained normal 125 VDC operating load as shown on drawings. . Also include in the battery and rack sizing calculations the 230 kV GIS circuit breaker and other equipment requiring 125 VDC power for operation, control, and protection. The 125VDC control power demand requirements for the equipment and components are not known at this time. Request the 125 VDC requirements from the Prime Contractor (entity responsible for the overall construction and installation of the project) and include the information in the sizing calculations. The overall system capacity of the batteries and racks shall accommodate the normal sustained operating load plus the demand loads of equipment. Batteries shall be capable of supplying the duty cycle with a minimum of 20 percent spare capacity.

F. Battery and battery chargers to be supplied by one manufacturer.

2.04 NICKEL CADMIUM BATTERIES:

A. Plates: Perforated sheet steel, pocket type

B. Cell Containers: Impact resistant translucent plastic

C. Electrolyte: 20 percent solution of potassium hydroxide in water with special additives

D. Vents: Spring loaded flap type

E. Inter-cell Connectors: Removable bolted type, plated copper, sized to carry battery maximum discharge current and clearance in fit to facilitate replacement of cells.

F. Cells identical construction and from same production run.

G. Cells and battery parts in clean state, with no evidence of electrolyte on cell cases or crystallization at vents. Clean cells prior to assembly into crates and apply coating of Vaseline to cell tops.

H. Battery Accessories: Thermometer, plastic topping-up bottle, level testing tube, self-adhesive numbers for cell identification. Accessories required for normal maintenance.

2.05 BATTERY CHARGER:

A. Two battery chargers shall be provided for 100 percent redundancy; each capable of charging the battery in a period of six (6) hours to not less than 95 percent full charge after being discharged to 100 volts.

B. Each battery charger shall be capable of charging battery as stated Paragraph 2.05A with a spare capacity of 20 percent. Charger size can be the next highest industry normally available rated unit.

C. Chargers to be supplied by same manufacturer as battery.

D. Provide certified calculations for the charger sizing.

E. Chargers shall be rated for 120/208 VAC three phase input.

F. Accessories:

1. Input and output circuit breakers

2. LCD displays: Volts DC, Amps DC, Timer Hrs., Fault Codes and Charger Settings

3. LEDs on cabinet front: AC On/Off, DC On,/Off, Float, and Equalize

4. Summary Form C alarm contact/relay for DC Failure, High VDC, Low VDC, AC Failure, High VAC, Low VAC, Pos/Neg Ground Fault and End of Discharge Alarms for customer use.

5. LEDs on cabinet front: To indicate each listed condition in Paragraph 2.05E4.

6. Local summary flashing LED and audible alarm on cabinet front with pushbutton acknowledge and reset for all conditions listed in Paragraph 2.05E4.

7. Equalize timer.

8. Charging mode selector switch on cabinet front.

9. Recommended spare parts list for first five years of operation.

2.06 BATTERY CHARGER CABINETS

A. Provide battery chargers in separate individual free-standing enclosures.

B. Suitable for top entry of cables.

C. Enclosures shall be NEMA 12 , ANSI 61, light gray.

D. Ground pad with compression ground lug; capable of accepting bare copper ground cable; size to recommended by manufacturer, but no smaller than No. 2 AWG.

E. Dimensions of space allowable as indicated on Contract Drawings.

F. Provide seismic restraint as required. Ref: Sections 01 41 20 and 26 05 50.

2.07 BATTERY RACK:

A. Rack shall be maximum five (5) tier, size as required. Bottom tier minimum 6 inches above floor, top of battery cells on highest tier not more than 78 inches above floor.

B. Frames: Angle iron with welded joints ground smooth.

C. Rails: Steel channels, bolted to frames.

D. Rubber strips to insulate rails from cells.

E. Insulated from ground and floor.

F. Free standing.

G. Primed and epoxy painted to prevent corrosion.

H. Corrosion resistant bolts and hardware.

I. Configuration permitting any one cell to be removed without removing any other cell.

J. Dimensions of space allowable as indicated on Contract Drawings.

K. Provide seismic restraint as required. See Section 01 41 20 and Section 26 05 50.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Locate and erect battery rack and battery chargers.

B. Install battery cells on rack.

C. For nickel cadmium batteries, arrange vent flaps to open away from access side when cells placed in battery rack.

D. Clean posts and connectors and apply no-oxide grease.

E. Install inter-cell connectors and hand tighten nuts in accordance with manufacturer's instructions.

F. Using torque wrenches, tighten nuts in accordance with manufacturer’s recommend value.

G. Perform required field tests per IEEE 1106.

H. Connect battery and battery chargers to load circuit.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 33 53

UNINTERRUPTIBLE POWER SUPPLY SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide 3-phase, on-line, static-type, nonredundant, uninterruptible power supply system (UPS), including following principal component parts: as indicated and in compliance with Contract Documents.

1. Rectifier/Battery Charger

2. Battery

3. Inverter

4. Static Bypass Transfer Switch

5. Maintenance Bypass Isolation Switch

1.02 REFERENCES:

A. ASTM International (ASTM):

1. E699: Standard Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components

B. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

2. PB2: Deadfront Distribution Switchboards

C. Underwriters' Laboratories, Inc. (UL):

1. 891: Standard for Safety Switchboards

2. 1449: Standard for Safety Surge Protective Devices

3. 1778: Standard for Safety Uninterruptible Power Systems

1.03 DEFINITIONS:

A. Rated Full-Load: Load corresponding to full-rated kVA at 80 percent power factor.

B. Static: Containing no moving electrical parts and using solid-state components for switching and control.

C. Transient: That part of change in variable such as voltage or current that disappears during transition from one steady-state operating condition to another.

D. Uninterruptible Power Supply (UPS): System that automatically provides power, without delay or transients, during any period when normal power supply is incapable of performing acceptably.

1.04 SYSTEM DESCRIPTION:

A. Configuration: Factory-fabricated, in single modular cabinet. Automatic operational features include following:

1. Normal Conditions: Supply load with power flowing from normal a.c. power input terminals, through rectifier/battery charger and inverter, with battery connected in parallel with rectifier output.

2. Abnormal Supply Conditions: When normal ac supply deviates from specified voltage, waveform, or frequency limits, battery supplies energy to maintain constant inverter output to load.

3. When normal power fails, energy supplied by battery through inverter continues supply to load without switching or disturbance.

4. When power is restored at normal supply terminals of system, rectifier/battery charger supplies power to load through inverter and simultaneously recharges battery. Inverter is synchronized with external source before load is transferred.

5. When battery becomes discharged and normal supply is available, battery is charged by rectifier/charger. Upon reaching full charge, rectifier/charger automatically shifts to float-charge mode.

6. When any element of UPS system fails, and power is available at normal supply terminals of system, static bypass transfer switch switches load to normal source with less than 1/4 cycle interruption of supply.

7. If fault occurs in system supplied by UPS and current flows in excess of overload rating of UPS system, static bypass switch operates to bypass fault current to normal supply circuit of UPS system for fault clearing.

8. When fault has cleared, static bypass switch returns load to UPS system.

B. Functional Description of Manual Operation: Manual operation features include following:

1. Turning inverter off causes load to be transferred by static bypass switch directly to normal ac input source without interruption.

2. Turning inverter on causes static bypass switch to transfer load to inverter.

C. Maintenance Bypass Isolation Switch: Interlocked so it cannot be operated unless static bypass switch is in bypass mode. Device has 3 settings that produce following conditions without interrupting supply to load during switching:

1. Full Isolation: Load is supplied bypassing UPS system. UPS system ac supply input, static bypass switch, and load terminals are completely disconnected from external circuits.

2. Maintenance Bypass: Load is supplied bypassing UPS system. UPS system ac supply terminals are energized to permit operational checking, but system load terminals are isolated from load.

3. Normal: UPS system ac supply terminals are energized and load is being supplied through either static bypass switch or UPS rectifier and inverter.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data:

1. Submit for products specified.

2. Include data on features, components, ratings, and performance.

C. Shop Drawings:

1. Detail fabrication, internal and interconnecting wiring, and installation of UPS system.

2. Include dimensioned plan, elevation views, and details of control panels.

3. Show access and clearance requirements.

4. Differentiate between field-installed and factory-installed wiring and components.

D. Operating and Maintenance Data:

1. Lists of spare parts and replacement components recommended to be stored at site for ready access.

2. Detailed operating instructions covering operation under both normal and abnormal conditions.

E. Miscellaneous:

1. Qualification data for manufacturer to demonstrate their capabilities and experience. Include list of completed projects with Project names, addresses, and names of Engineers and Owners, plus other information specified.

F. Test Results:

1. Factory Test Plan: Detailed list, schedule, or tabulation of events for each factory test requirement. Include following:

a. Description of input source and output loads to be used. Describe actions required to simulate source load variation and simulation of various operating conditions and malfunctions.

b. List of indications, parameter values, and system responses considered satisfactory for each test action. Provide space for tabulation of actual observations during test.

c. Description of Instruments and Test Equipment Required: Provide adequate detail to make test plan reusable in field for those tests required to be repeated there.

2. Factory test reports evidencing compliance with specified requirements.

3. Field test reports for tests.

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Manufacturer Qualifications: Firms experienced in manufacturing equipment of types and capacities indicated with record of successful in-service performance.

1. Service Center: UPS system manufacturer maintains service center capable of providing training, parts, and emergency maintenance and repairs at Project site with 4 hours maximum response time.

C. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term “NRTL” shall be as defined in OSHA Regulation 1910.7.

2. Terms “listed” and “labeled” shall be as defined in National Electrical Code, Article 100.

D. Single-Source Responsibility: Obtain UPS system components from single manufacturer with responsibility for entire system.

1.09 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver equipment in fully enclosed vans after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

C. Store equipment in spaces with noncondensing environments that are controlled within manufacturer’s ambient tolerances for nonoperating equipment.

1.10 WARRANTY:

A. Special Project Warranty for Batteries: Submit written warranty, mutually executed by manufacturer and Principal Installer, agreeing to replace UPS system storage batteries that fail in materials or workmanship within special project warranty period specified below. This warranty will be in addition to, and not limitation of, other rights and remedies Owner may have against Contractor under Contract Documents.

1. Special Project Warranty Period for Batteries: 10 years beginning on date of Substantial Completion. Full warranty applies to first year of period, and pro rata warranty for last 9 years.

1.11 MAINTENANCE:

A. Extra Materials:

1. Furnish extra materials matching products installed as described below, packaged with protective covering for storage, and identified with labels describing contents. Deliver extra materials to Owner.

2. Fuses: 1 for every 10 of each type and rating, but not less than 1 of each.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Best Power Technology, Inc.

B. EPE Technologies, Inc.

C. HDR Power Systems, Inc.

D. Eaton/Liebert Corp.

E. Mitsubishi Electric Sales America, Inc.

F. APC Schneider

2.02 SYSTEM SERVICE CONDITIONS:

A. Environmental Conditions Capabilities: Operate in following environmental conditions without mechanical or electrical damage or degradation of operating capability.

1. Ambient Temperature: 0 degrees°C to 40 degrees°C.

2. Relative Humidity: 0 to 95 percent, non-condensing.

3. Altitude: Sea level to 5,000 feet.

2.03 SYSTEM CHARACTERISTICS:

A. Input Power Nominal Supply Voltage and Supply Connections: As indicated.

B. Output kVA and kW Ratings: 20KVA/18KW

C. Minimum Duration of Supply: 20 minutes, where rated full load is being supplied solely from battery.

D. System Performance when Supplied from Battery: Performance under steady-state and transient load conditions remains within specified tolerances throughout minimum duration of supply from battery specified.

E. Input Voltage and Frequency Tolerance: System steady-state and transient performance remains within specified tolerances with steady-state a.c. input voltage varying plus or minus 10 percent from nominal voltage, with steady-state input frequency varying plus or minus 5 percent from 60 Hertz, and with harmonic content of load anywhere within specified envelope.

2.04 LOAD COMPATIBILITY:

A. UPS system operates within specified tolerances serving distribution components as indicated and loads with following characteristics:

1. Electronic equipment with switch mode power supplies drawing load current with minimum of 15 percent total harmonic distortion and with individual harmonics as great as 5 percent of fundamental. Aggregate load is 60 percent of UPS capacity.

2. Future Loads: Unknown characteristics, 20 percent of UPS system capacity.

2.05 SYSTEM PERFORMANCE:

A. Overall system efficiency, when operated within indicated nominal input and output voltage and frequency limits, is within following minimums:

1. Up to 20 kVA Systems: 98 percent at 100 percent load.

2. Up to 20 kVA Systems: 97.5 percent at 50 percent load.

B. Maximum Acoustical Noise: 58 dB, "A" weighting, emanating from system under any condition of normal operation, measured 3 feet from nearest surface of enclosure.

C. Overload Capacity of System at Rated Voltage: 125 percent of full-load rating for 10 minutes and 150 percent for 10 seconds.

D. Maximum Output Voltage Transient Excursions from Rated Value: Voltage shall recover to within plus or minus 2 percent of rated value within 100 milliseconds. Following instantaneous load changes are relative to full load:

1. 50 percent: Plus or minus 8 percent.

2. 100 percent: Plus or minus 10 percent.

3. Loss of A.C. Input Power: Plus or minus 5 percent.

4. Restoration of Input Power: Plus or minus 5 percent.

2.06 SYSTEM COMPONENTS:

A. Components: Solid-state devices using semiconductor elements of hermetically sealed type. Devices include rectifier/battery charger, inverter, static bypass switch, and system controls.

B. Enclosure: Major components such as static bypass switch, rectifier, battery, inverter, and maintenance bypass in separate compartments of enclosures or in separate cabinets.

C. Control Assemblies: Mount on modular plug-ins, arranged for easy maintenance.

D. Surge Suppression: Protect UPS system input elements, rectifier/charger, inverter, controls, and output components against voltage transients with surge suppressors conforming to UL 1449.

E. Design and fabricate internal supports for assemblies, subassemblies, components, supports, and fastenings for batteries, to withstand static, anticipated seismic forces, or both in any direction with minimum force value used being equal to equipment weight.

2.07 RECTIFIER/BATTERY CHARGER:

A. Capacity: Adequate to supply inverter during full output load conditions and simultaneously recharge battery from fully discharged condition to 95 percent of full charge within 10 times rated discharge time for duration of supply under battery power at full load.

B. Harmonic suppression inherent in rectifier/battery charger design reduces total harmonic content of current drawn from input power source by system to less than 10 percent for sources with X/R ratios from 2 to 30. This applies for all load currents from 0 to 100 percent of full load.

C. Battery float charging conditions, in terms of voltage and charging current under normal operating conditions, are within battery manufacturer's recommendations for maximum battery life.

2.08 BATTERY:

A. Manufacturers:

1. C&D Charter Power Systems.

2. SAFT America, Inc.

3. Chloride Systems.

4. Exide Corp.

5. Hoppecke Battery Systems, Inc.

6. Mitsubishi Electric Sales America, Inc.

7. Nife, Inc.

8. Sonnenschein Batteries, Inc.

9. Yuasa Battery (American), Inc.

B. Type: Valve-regulated, recombinant, lead-calcium units, factory-assembled in an isolated compartment of UPS system cabinet, and complete with battery disconnect.

2.09 INVERTER:

A. Type: Pulse-width modulated, with sinusoidal output.

2.10 STATIC BYPASS SWITCH:

A. Switch Rating: Continuous-duty at rated full load. Switch provides make-before-break transfer. Contactor or electrically operated circuit breaker in inverter output provides electrical isolation.

2.11 MAINTENANCE BYPASS ISOLATION SWITCH:

A. Comply with NEMA PB2, and UL 891.

B. Switch Rating: Continuous-duty at rated full load of system.

C. Mounting Provisions: Locate inside one of modular system cabinets, behind lockable door.

D. Key interlock requires unlocking maintenance bypass isolation switch before switching from normal position with key that is released only when UPS is bypassed by static bypass switch. Lock is type designed specifically for electrical component interlocking.

2.12 INDICATION AND CONTROL:

A. General: Group displays, indications, and basic system controls on common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. An audible signal sounds for all alarms in addition to visual indication.

C. Indications: Plain-language messages on liquid crystal or digital LED display.

1. Quantitative Indications: Include following:

a. Input voltage, each phase, line-to-line.

b. Input current, each phase, line-to-line.

c. Bypass input voltage, each phase, line-to-line.

d. Bypass input frequency.

e. System output voltage, each phase, line-to-line.

f. System output current, each phase.

g. System output frequency.

h. D.C. bus voltage.

i. Battery current and direction (charge/discharge).

j. Elapsed time-discharging battery.

2. Status Indications: Include following:

a. Normal operation.

b. Load on bypass.

c. Load on battery.

d. Inverter off.

e. Alarm condition exists.

3. Alarm Indications: Include following:

a. Bypass a.c. input overvoltage or undervoltage.

b. Bypass a.c. input overfrequency or underfrequency.

c. Bypass a.c. input and inverter out of synchronization.

d. Bypass a.c. input has wrong-phase rotation.

e. Bypass a.c. input has single-phase condition.

f. Bypass a.c. input filter fuse blown.

g. Internal frequency standard in use.

h. Battery system alarm.

i. Control power failure.

j. Fan failure.

k. UPS overload.

l. Battery charging control faulty.

m. Input overvoltage or undervoltage.

n. Input transformer overtemperature.

o. Input circuit breaker tripped.

p. Input has wrong-phase rotation.

q. Input has single-phase condition.

r. Approaching end of battery operation.

s. Battery undervoltage shutdown.

t. Maximum battery voltage.

u. Inverter fuse blown.

v. Inverter transformer overtemperature.

w. Inverter overtemperature.

x. Static bypass switch overtemperature.

y. Inverter power supply fault.

z. Inverter transistors out of saturation.

aa. Identification of faulty inverter section/leg.

bb. Inverter output overvoltage or undervoltage.

cc. UPS overload shutdown.

dd. Inverter current sensor fault.

ee. Inverter output contactor open.

ff. Inverter current limit.

4. Controls: Include following:

a. Inverter on-off.

b. UPS start.

c. Battery test.

d. Alarm silence/reset.

e. Output voltage adjustment.

D. Dry Form “C” Contacts: Available for remote indication of following conditions:

1. UPS on battery

2. UPS on-line

3. UPS load on bypass

4. UPS in alarm condition

2.13 REMOTE UPS CONTROL AND MONITORING SYSTEM:

A. Description: Make available indication and control functions specified above for unit control panel at remote microcomputer. Record power-line transients and provides analytical capability. Include items described below, but do not include remote computer or connecting signal wiring. System includes:

1. Software that permits secure monitoring and controlling of UPS functions; and provides on-screen explanations, interpretations, and action guidance for monitoring indications. Include on-screen descriptions of control functions and guidance for their use. Permit storage and analysis of power-line transient records. Design for IBM-compatible microcomputer systems.

2.14 MECHANICAL FEATURES:

A. Enclosures: NEMA Class 1 conforming to NEMA 250.

B. Ventilation: Redundant fans or blowers draw in ambient air near bottom of cabinet and discharge it near top rear.

2.15 SOURCE QUALITY CONTROL:

A. Factory test complete UPS system, including battery, prior to shipment. Include following tests:

1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.

2. Full-load test.

3. Transient load response test.

4. Overload test.

5. Power failure test.

6. Efficiency test at 50 percent, 75 percent, and 100 percent load.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install system components on 4 inches-high concrete housekeeping bases. Cast-in-place concrete, reinforcing, and formwork are specified in Section 03 30 00. Install systems according to manufacturer's printed instructions.

B. Maintain minimum working space at equipment according to Shop Drawings and NEC.

C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams and as indicated.

3.02 IDENTIFICATION:

A. Identify components according to Section 26 05 53.

3.03 FIELD QUALITY CONTROL:

A. Supervised Adjustment and Pretesting: Under supervision of factory-authorized service representative, pretest system functions, operations, and protective features. Adjust to ensure operation complies with specifications. Load system using variable load bank simulating kVA, kW, and power factor of loads for which unit is rated.

B. Tests: Provide services of qualified testing agency to perform tests listed below according to manufacturer's recommendations upon completion of installation of system. Load system using variable load bank simulating kVA, kW, and power factor of load for which unit is rated. Use instruments that have been recently calibrated according to NIST standards.

1. Simulation of malfunctions to verify protective device operation.

2. Tests of duration of supply on emergency, demonstrations of low-battery voltage shutdown, and transfers due to normal source failure and restoration.

3. Tests of harmonic content of input and output current under 25 percent, 50 percent, and 100 percent of rated load.

4. Tests of voltage output under specified transient-load conditions.

5. Tests of efficiency at 50 percent, 75 percent, and 100 percent rated load.

C. Retest: Correct deficiencies and retest until specified requirements are met.

3.04 CLEANING:

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars of finish to match original

finish. Clean components internally using methods and materials recommended by manufacturer.

3.05 DEMONSTRATION:

A. Training: Arrange and pay for services of factory-authorized service representative to demonstrate adjustment, operation, and maintenance of system and to train Owner's personnel.

3.06 COMMISSIONING:

A. Battery Equalization: Equalize charging of battery cells according to manufacturer's instructions. Record individual cell voltages.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide lightning protection system on each building and structure consisting of air terminals, conductors, ground terminals, interconnection conductors, arresters, and other connectors or fittings required for a complete system. Buildings requiring delegated design and installation of NFPA 780-compliant and UL 96A master-labelled lighting protection systems, with certifications include, but are not limited to, the following:

1. IPS Building:

a. Exterior above-grade piping and valve actuators

2. IPS Electrical Building:

a. Building

b. 4 pad-mount transformers

c. 2 RTU-style ground-mounted HVAC units and associated ducting.

3. Standby Power and Fuel Storage:

a. Fuel tanks

b. Generator Enclosures

c. Switchgear Enclosure

d. Electrical Rack

e. Dry type transformer.

4. IPS Odor Control:

a. Tank

b. Odor Control Media

c. Exhaust stack

d. Electrical Rack

e. Freestanding Control Panel Enclosure.

B. All systems are to be designed, furnished and installed by a Lightning Protection Contractor.

1.02 REFERENCES:

A. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

2. 780: Lightning Protection Code.

B. Underwriters' Laboratories, Inc. (UL):

1. 96: Lightning Protection Components.

2. 96A: Installation Requirements for Lightning Protection Systems.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 00.

C. Shop Drawings:

1. Consisting of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts, installation instructions.

2. Shop drawings indicating type, placement, and location of protection devices, including cable attachments, grounding, mounting and any other details integral with the system.

D. Spare Parts Data: Provide a list of recommended spare parts for the material and equipment to be provided, including current unit prices and source of supply (indicate which supplies are furnished at no extra cost with purchase of equipment).

E. Inspection and Maintenance: Provide a written recommended inspection and maintenance procedure, including periodicity of inspections.

F. Record Drawings: Provide a complete set of "as-constructed" drawings showing the location of all grounds as well as a detailed layout of type, size, location and method of installation of all downleads, roof cables, bonding leads and connections, air terminals, etc., and in the case where structural steel is used for downleads, the method and location of all roof and ground connections to the steel must be clearly detailed.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied.

C. Services of Manufacturer's Representative as stated in Section 01 45 00 and as specified herein.

D. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:

a. 1 person-day

3. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.

a. 0.5 person-day

4. Performance Testing: Field performance test equipment specified.

a. 0.5 person-day

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

a. 1 person-day.

6. Service inspections during first two years of operation, for use at Owner's request, and exclusive of repair, malfunction or other troubleshooting service calls.

a. 2 person-days, 2 trips

7. Credit to the Owner, all unused service person-days specified above, at the manufacturer’s published field service rate.

8. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in

installation, equipment or material shall be provided at no additional cost to the Owner.

E. Provide systems designed, furnished and installed by a Lightning Protection Contractor.

F. Provide a "Certificate of Compliance" for work performed after completion. The certificate should state that the following has been done:

1. The Contractor has complied with all requirements of Underwriters' Laboratories, Inc. Master Label Service as outlined in UL 96A including the completion and execution of the Master Label application form and the procurement and delivery of the U/L "C" plate to the Owner or his representative.

2. The lightning protection system ground system has been tested and interconnected to the facility grounding system as required by NFPA 70.

3. Record drawings have been turned over to the Owner or his representative.

G. Use UL listed components.

1.05 REQUIREMENTS OF REGULATORY AGENCIES:

A. Conform to UL 96 and 96A and NFPA 780.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Shipping:

1. Ship equipment and materials, complete with identification and quantity of items.

2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

3. Deliver spare parts at same time as pertaining equipment. Delivery to Owner after completion of work.

C. Storage:

1. Inspection and inventory items upon delivery to site.

2. Store and safeguard equipment, material and spare parts.

1.07 WARRANTY AND SERVICE:

A. Guarantee components, parts, and assemblies supplied by manufacturer against defects in materials and workmanship for a period of 12 months.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Thompson Lightning Protection Company, St. Paul, MN

B. Heary Brothers Lightning Protection Company, Springville, NY

C. American Lightning Rod Co., Dover, NH

2.02 MATERIALS:

A. Class I Materials: Provide conductors, fittings, and fixtures necessary to protect ordinary buildings and structures not exceeding 75 feet in height.

B. Materials, Class I. Table I gives minimum sizes and weights for air terminals, and main and secondary conductors. Secondary conductors which are used for bonding and interconnecting metallic bodies to the main conductor, and which will not be required to carry the main lightning current, may be reduced in size but not less than No. 6 AWG copper or equivalent. Provide main conductor size for interconnection to metal water systems, steam or hot water heating systems, or other metallic masses having a low resistance to ground.

C. Table I: Class I Material Requirements.

Type of Copper Conductor		**Standard**
Air Terminal, Solid	Min. Diameter	3/8-inch
Air Terminal, Tubular	Min. Diameter Min. Wall Thickness	 0.032 inch
Main Conductor, Cable	Min. Size ea. Strand Wgt. per Length Cross Sect. Area	17 AWG 187 lbs/1000 ft. 57,400 cm
Main Conductor, Solid Strip	Thickness Width	16 AWG 1 inch
Secondary Conductor Cable	Wire Size Number of Wires	17 AWG 14
Secondary Conductor Solid Strip	Thickness Width	16 AWG 1/2 inch

D. Where any part of a protection system is exposed to mechanical injury, provide protection by covering it with molding or tubing. If ferrous metal pipe or tubing is used

around the conductor, connect the conductor electrically to the pipe or tubing at both ends.

E. Furnish conductors made of stranded copper. Except where copper would otherwise cause a material compatibility problem, in which case, aluminum may be used for such locations.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Provide all material, equipment, and labor to install the lightning protection system as indicated and as specified.

B. No bend of conductor is to form an included angle of less than 90 degrees nor have a radius of bend less than 8 inches.

C. Interconnect all conductors, air terminals to form a two-way path from each air terminal horizontally or downward to connections with ground terminals.

D. Conductors may be coursed through air without support for a distance of 3 feet or less. With a 5/8-inch rod or its equivalent as a support, securely fastened at each end, a conductor may be coursed through air for a distance not to exceed 6 feet.

E. Install roof conductors to interconnect all air terminals and provide a two-way path to ground horizontally or downward from the base of each terminal.

F. Install at least two down conductors on any kind of structure. Location depends on placement of air terminals, size of structure, most direct coursing, security against displacement and location of metallic bodies, water pipes, and ground conditions. Separate down conductors as widely as practicable. For structures over 200 feet in perimeter, install one additional down conductor for each additional 100 feet of perimeter or fraction thereof.

G. Terminate each down conductor at a ground terminal.

H. Bond radio and television masts of metal, located on a protected building, to the lightning protection system with a main-size conductor and fittings.

I. Use connector fittings on all lightning conductors at "end-to-end" "tee" or "Y" splices. Attach them so as to withstand a pull test of 200 pounds. Make fittings for connection to metal tracts, gutters, downspouts, ventilators, chimney extensions, or other metal parts about the structure tight to the object by compression under bolt heads. Both crimp type and exothermic weld splicers of stamped or cast metal are acceptable under Class I requirements.

J. Securely attach conductors to the building or other object upon which they are placed. Use fasteners not subject to breakage. Furnish nails, screws and bolts, with which fasteners are secured, of the same material as the conductor or of such nature that there will be no electrolytic corrosion in the presence of moisture because of contact between the different parts. Space conductor fasteners not more than 3 feet apart on all conductors.

K. All requirements covering exposed systems apply to concealed installations. Conductors are coursed the same except that they may be coursed behind the exterior wall facing, in concealed or embedded conduit, or embedded directly in concrete.

L. In a concealed installation where conductors are embedded in concrete, bond the reinforcing steel to the cable with a main size conductor. Bond reinforcing steel at the top and bottom of each embedded downlead.

M. Materials, installation methods and procedures are to be in accordance with UL 96 and 96A, NFPA 780, NEC and local electrical codes. Provide for and obtain a "Certificate of Compliance" for the work performed.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 26 43 13

SURGE PROTECTION DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Section Includes:

1. Type 2 surge protective devices (SPDs).

2. Enclosures.

B. Related Requirements:

1. Section 262416 "Panelboards" for integral SPD units installed by panelboard manufacturer.

2. Section 262419 “Motor Control Centers” for integral SPD units installed by MCC manufacturer.

3. Section 262726 "Wiring Devices" for integral SPD units installed by receptacle manufacturer.

1.02 DEFINITIONS:

A. I_n: Nominal discharge current.

B. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.03 ACTION SUBMITTALS:

A. Product Data:

1. For each type of product.

a. Include electrical characteristics, specialties, and accessories for SPD units.

b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:

(1) Tested values for VPRs.

(2) I_n ratings.

(3) MCOV, type designations.

(4) OCPD requirements.

(5) Manufacturer's model number.

(6) System voltage.

(7) Modes of protection.

B. Field quality-control reports.

1.04 INFORMATION SUBMITTALS:

A. Sample warranty.

1.05 WARRANTY:

A. Provide in accordance with Section 01 74 13 and as specified.

B. The Surge Protective Device (SPD) manufacturer is to warranty the components against defective materials and workmanship for a period of five (5) years following delivery from the manufacturer.

PART 2 - PRODUCTS

2.01 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs):

A. Manufacturers:

1. ABB

2. Intermatic

3. Mersent

4. Eaton

5. Square D

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. General Characteristics:

1. Reference Standards: UL 1449, Type 2

2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.

3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.

4. Protection modes and UL 1449 VPR for neutralless grounded wye circuits with 480V, three-phase, three-wire circuits must not exceed the following

    a. Line to Ground: 1200 V for 480Y/277 V.

    b. Neutral to Ground: 1200 V for 480Y/277 V.

    c. Line to Line: 2000 V for 480Y/277 V.

5. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits must not exceed the following:

    a. Line to Neutral: 700 V for 208Y/120 V.

    b. Line to Ground: 700 V for 208Y/120 V.

    c. Neutral to Ground: 700 V for 208Y/120 V.

    d. Line to Line: 1200 V for 208Y/120 V.

6. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

    a. Line to Neutral: 700 V.

    b. Line to Ground: 700 V.

    c. Neutral to Ground: 700 V.

    d. Line to Line: 1200 V.

7. SCCR: Equal or exceed 200 kA.

8. I_n Rating: 20 kA for 208Y/120V and 120/240V systems, 65kA for 480V systems.

D. Options:

1. Include LED indicator lights for power and protection status.

2. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 120 V(ac) for remote monitoring of protection status.

3. Include surge counter.

2.02 ENCLOSURES:

A. Indoor Enclosures: Type 1.

B. Outdoor Enclosures: Type 4X.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

3.02 FIELD QUALITY CONTROL:

A. Field tests and inspections must be witnessed by Owner and/or Engineer, or their representatives. Repeat test as required to satisfy Owner or Engineer’s requirements.

B. Tests and Inspections:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.

2. Inspect anchorage, alignment, grounding, and clearances.

3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

C. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.

2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

3.03 STARTUP SERVICES:

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION

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SECTION 26 50 00

INTERIOR LIGHTING

1.01 DESCRIPTION:

A. Provide complete indoor lighting systems as indicated and in compliance with Contract Documents .

B. Light fixture schedules are provided on the Contract Drawings. These Specifications are to be considered supplementary to the information contained in the light fixture schedule. In areas of conflict the scheduled items shall be provided.

C. Fixtures shall be “Energy Star” rated.

1.02 DEFINITIONS:

A. Emergency Lighting Unit: Fixture with integral emergency battery-powered supply and means for controlling and charging battery. Also known as an emergency light set.

B. Fixture: Complete lighting unit, exit sign, or emergency lighting unit. Fixtures include lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply. Internal battery-powered exit signs and emergency lighting units also include battery and means for controlling and recharging battery. Emergency lighting units include ones with and without integral lamp heads.

1.03 REFERENCES:

A. American National Standards Institute (ANSI):

1. C78.377: Chromaticity of Solid State Lighting Products.

2. C81.10: Electric Lamp Bases and Holders, Screw-Shell Types.

3. C81.20: Electric Lamp Bases and Holders, Fluorescent types.

4. C82.1 and Supplement C82.1a: Fluorescent Lamp Ballasts.

5. C82.4: High Intensity Discharge and Low Pressure Sodium Lamps.

6. C82.5: High Intensity Discharge Lamp Reference Ballasts.

B. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

2. 101: Life Safety Code.

C. Underwriters' Laboratories, Inc., (UL):

1. 1598: UL Standard for Safety Luminaires

2. 8750: Light Emitting Diode (LED) Equipment for Use in Lighting Products.

D. Illuminating Engineering Society of North America (IESNA or IES):

1. LM-79: IESNA Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products

2. LM-80: IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources

1.04 SUBMITTALS:

A. Submit shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturer's product data with installation instructions in accordance with the requirements of Section 26 05 10.

C. Submit manufacturer's shop drawings including photometric laboratory test data to show that luminaires proposed are of same type, construction and quality as those indicated. Luminaires are to be listed and labeled by Underwriters' Laboratories.

D. Submit manufacturer’s data for each ballast provided. Include detailed information for each luminaire showing wattage, voltage, and full load amp draw for each.

E. Submit photometric calculations based on maintained lighting foot candle levels for areas where lighting fixtures are substituted. Substituted fixtures must provide similar lighting performance and energy usage as those scheduled, and must be constructed of similar quality and materials.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Provide hangers and supports to resist failure from earthquake damage in accordance with NEC and all local and State codes.

C. Lighting fixtures to be provided with dedicated supporting systems.

D. Comply with the Code for Buildings and all local and State energy laws and regulations.

1.06 EXTRA MATERIALS:

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Lamps: 10 lamps for every 100 of each type and rating installed. Furnish at least 1 of each type.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, except as indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

D. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

4. Laminated Silver Metallized Film: 90 percent.

E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or water white, annealed crystal glass, except as otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2. Lens Thickness: 0.125 inches minimum; except where greater thickness is indicated.

F. Fixture Support Components:

1. Single Stem Hangers: 1/2 inches steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

2. Twin Stem Hangers: Two, 1/2 inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

3. Rod Hangers: 3/8 inch minimum diameter, zinc plated, threaded steel rod.

4. Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking type plug.

2.02 LED FIXTURES:

A. Provide fixtures on the Design Lights Consortium (DLC) Qualified Products List.

B. Thermal Management: Liquids or other moving parts shall be clearly indicated in submittals, and shall be consistent with product testing.

C. Color Rendering Index (CRI): >70.

D. Correlated Color Temperature: 4000K.

E. Minimum luminaire efficacies: 85 lumens per watt. Nominal input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.

F. Fully enclosed wiring and LED diodes enclosed to prevent penetration of dust, insects, and other debris into the lamp and driver compartment.

G. Driver/LED combined system shall have rated life based on IESNA LM-80-2008 (or latest) of 50,000 hours at 70 percent lumen maintenance.

H. Driver is high efficiency type with THD < 20 percent and power factor > 0.90.

2.03 EMERGENCY LIGHTING AND EXIT LIGHTING UNITS:

A. Exit Signs: Conform to UL 924 and following:

1. Sign Colors: Conform to local code.

2. Minimum Height of Letters: Conform to local code.

3. Arrows: Include as indicated.

B. Emergency Lighting Units: Conform to UL 924. Provide self-contained units with following features:

1. Battery: Sealed, maintenance free, lead acid type with minimum 10 year nominal life and special warranty.

2. Charger: Minimum 2 rate, fully automatic, solid state type, with sealed transfer relay.

3. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep discharge level. Relay disconnects lamps and battery and automatically recharges and floats on trickle charger when normal voltage is restored.

4. Wire Guard: Where indicated, provide heavy chrome plated wire guard arranged to protect lamp heads or fixtures.

5. Time Delay Relay: Provide time delay relay in emergency lighting unit control circuit arranged to hold unit ON for fixed interval after restoration of power after outage. Provide adequate time delay to permit HID lamps to restrike and develop adequate output.

2.04 LIGHTING CONTROLS:

A. Reference Specficiation 26 09 29, Lighting Control Systems, for additional lighting control requirements.

PART 3 - EXECUTION

3.01 LUMINAIRES AND LAMPS:

A. Install types and sizes indicated, complete. Deliver lamps of proper type, wattage and voltage rating to site and install in luminaires prior to completion of project.

B. Install all luminaires to comply with applicable provisions of National Electrical Code. Suspend pendant luminaires by means of suitable outlet box cover-type aligners, each having flexible joint permitting unit to hang plumb.

1. Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers.

2. Provide with swivel hangers to ensure a plumb installation. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated.

3. Brace pendants 4 feet or longer to limit swinging.

4. Single-unit suspended fixtures shall have twin-stem hangers.

5. Multiple-unit or continuous row fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end.

6. Rods shall be a minimum 3/8-inch diameter.

C. Use aligners of shock absorbing type, where indicated.

D. Install accessories such as straps, mounting plates, nipples, or brackets necessary for proper installation.

E. Connect emergency light units to the unswitched branch circuit powering the luminaires in the same space.

3.02 CONTRACT CLOSEOUT

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 56 00

EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide complete outdoor lighting systems as indicated and in compliance with Contract Documents.

B. Light fixture schedules are provided on the Contract Drawings. These Specifications are to be considered supplementary to the information contained in the light fixture schedule. In areas of conflict the scheduled items shall be provided.

C. Fixtures shall be “Energy Star” rated and full cut-off.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. C78: Fluorescent Lamps - Rapid-Start Types

B. ASTM International (ASTM):

1. A500: Cold Formed Welded and Seamless Carbon Steel Structural Tubing.

2. B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

3. B429: Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

C. Institute of Electrical and Electronics Engineers (IEEE):

1. C62.41.1: IEEE Guide on the Surges Environment in Low-Voltage (1000V and Less) AC Power Circuits

2. C62.41.2: IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

3. C136.20: Roadway Lighting Equipment - Fiber-Reinforced Plastic (FRP) Lighting Poles

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

E. Underwriters' Laboratories, Inc. (UL):

1. 773: UL Standard for Safety Plug-In Locking Type Photocontrols for Use with Area Lighting-Fourth Edition

2. 844: UL Standard for Safety Luminaires for Use in Hazardous (Classified) Locations-Twelfth Edition

3. 1598: UL Standard for Safety Luminaires

1.03 DEFINITIONS:

A. Fixture: Complete lighting device. Fixtures include lamp or lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply.

B. Lighting Unit: Fixture or assembly of fixtures with common support, including pole or bracket plus mounting and support accessories.

C. Luminaire: Fixture.

D. CCT: Correlated color temperature.

E. CRI: Color rendering index.

F. Fixture: An enclosed apparatus with all elements required to illuminate a space, using the optical distribution specified, with points for power connection.

G. IP: International Protection or Ingress Protection Rating.

H. Lumen: Measured output of lamp and luminaire, or both.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturer's product data with installation instructions in accordance with the requirements of Section 26 05 00.

C. Submit manufacturer's shop drawings including photometric laboratory test data to show that luminaires proposed are of same type, construction and quality as those indicated. Luminaires are to be listed and labeled by Underwriters' Laboratories.

D. Submit manufacturer’s data for each ballast / driver provided. Include detailed information for each luminaire showing wattage, voltage, and full load amp draw for each.

E. Submit photometric calculations based on maintained lighting foot candle levels for areas where lighting fixtures are substituted. Substituted fixtures must provide similar

lighting performance and energy usage as those scheduled, and must be constructed of similar quality and materials.

F. Product Data:

1. Describe fixtures, lamps, ballasts, poles, and accessories. Arrange Product Data for fixtures in order of fixture designation. Include data on features, poles, accessories, finishes, and following:

a. Outline drawings indicating dimensions and principal features of fixtures and poles.

b. Electrical Ratings and Photometric Data: Certified results of laboratory tests for fixtures and lamps.

G. Shop Drawings:

1. Detail non-standard fixtures and poles and indicating dimensions, weights, method of field assembly, components, and accessories.

2. Wiring diagrams detailing wiring for control system showing both factory installed and field installed wiring for specific system of this Project, and differentiating between factory installed and field installed wiring.

3. Anchor-Bolt Templates: Keyed to specific poles and certified by manufacturer.

H. Operating and Maintenance Data (O&M): Maintenance data for products to include operation and maintenance information.

1.05 QUALITY ASSURANCE:

A. Comply with IEEE C2.

B. Items provided under this section shall be listed or labeled labelled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term “NRTL” shall be as defined in OSHA Regulation 1910.7.

2. Terms “listed” and “labeled” shall be as defined in National Electrical Code (NEC), Article 100.

C. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

D. Fixtures for Hazardous Locations: Conform to UL 844. Provide units that have Factory Mutual Engineering and Research Corporation (FM) certification for indicated class and division of hazard.

1.06 STORAGE AND HANDLING OF POLES:

A. Store poles on decay-resistant treated skids at least 12 inches above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.

B. Metal Poles: Retain factory applied pole wrappings until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.07 EXTRA MATERIALS:

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. LED Arrays: 1 for every 100 of each type provided – including each optic.

2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

3. Ballasts / Drivers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and 2018 International Building Code (IBC) Section 1613.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.02 FIXTURES AND FIXTURE COMPONENTS:

A. Metal Parts: Free from burrs, sharp edges, and corners.

B. Sheet Metal Components: Corrosion resistant aluminum, except as otherwise indicated. Form and support to prevent warping and sagging.

C. Housings: Rigidly formed, weather and light tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed fixtures.

D. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnect ballast.

E. Exposed Hardware Material: Stainless steel.

F. Reflecting Surfaces: Minimum reflectances as follows, except as otherwise indicated:

1. White Surfaces: 85 percent

2. Specular Surfaces: 83 percent

3. Diffusing Specular Surfaces: 75 percent

G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

H. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.

I. Photoelectric Relays: Conform to UL 773.

1. Contact Relays: Single throw, arranged to fail in ON position and factory set to turn light unit on at 1.5 to 3 foot-candles and off at 4.5 to 10 foot-candles with 15 second minimum time delay.

2. Relay Mounting: In fixture housing.

J. Electronic Timer Switch:

1. Programmable for 24-hour or 7 day schedules with resolution to the minute.

2. Automatic daylight savings changeover

3. Lithium Ion battery maintains program for 2 weeks or more

4. Intermatic Model Digi 42/2-120

K. LED Fixtures: Conform to ANSI/UL 8750.

2.03 LED ARRAYS:

A. Furnish optics, CCT, lumen output, and other salient features as identified in the luminaire schedule.

2.04 LED FIXTURES:

A. Provide fixtures on the DesignLights Consortium (DLC) Qualified Products List.

B. Thermal Management: Liquids or other moving parts shall be clearly indicated in submittals, and shall be consistent with product testing.

C. Color Rendering Index (CRI): >80.

D. Correlated Color Temperature: 3000K or as indicated on the fixture schedule.

E. Minimum luminaire efficacies: 85 lumens per watt. Nominal input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.

F. Fully enclosed wiring and LED diodes enclosed to prevent penetration of dust, insects, and other debris into the lamp and driver compartment.

G. Driver/LED combined system shall have rated life based on IESNA LM-80-2008 (or latest) of 100,000 hours at 70 percent lumen maintenance.

H. Driver is high efficiency type with THD < 20 percent and power factor > 0.90.

I. Outdoor fixtures capable of reliable operation in temperature range of minus 30 degrees C to plus 40 degrees C minimum.

J. Luminaires are to be full cut-off type.

K. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

L. L70 lamp life of 90,000 hours, minimum.

M. Nominal Operating Voltage: As identified on fixture schedule.

N. In-line Fusing: Separate in-line fuse for each luminaire.

O. Source Limitations:

1. Obtain luminaires from single source from a single manufacturer.

P. For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.05 FIXTURE SUPPORT COMPONENTS:

A. Pole-Mounted Fixtures: Conform to AASHTO LTS-6.

B. Wind-load strength of total support assembly, including pole, arms, appurtenances, base, and anchorage, is adequate to carry itself plus fixtures indicated at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 109 miles/hour with gust factor of 1.3, or as otherwise appropriate for this location, assuming ASCE Risk Category III

C. Arm, Bracket, and Tenon Mount Materials: Match poles' finish.

D. Mountings, Fastenings, and Appurtenances: Corrosion-resistant items compatible with support components. Use materials that will not cause galvanic action at contact points. Use mountings that correctly position luminaire to provide indicated light distribution.

E. Pole Shafts: Round, tapered.

F. Pole Bases: Hinged-anchor type with steel hold-down or anchor bolts, leveling nuts, and bolt covers.

G. Poles: Steel tubing conforming to ASTM A500, Grade B, carbon steel with minimum yield of 46,000 psi. Poles are 1 piece construction up to 40 feet in length and have access handhole in wall.

H. Aluminum Poles: ASTM B209, 5052-H34 alloy. Provide access handhole in pole wall.

I. Metal Pole Grounding Provisions: Welded 1/2 inch threaded lug, accessible through handhole.

J. Aluminum Mast Arms: Tapered oval arms continuously welded to pole attachment plate with span and rise as indicated.

K. Metal Pole Brackets: Designed to match pole metal. Provide cantilever brackets without under-brace, in sizes and styles indicated, with straight tubular end section to accommodate fixture.

L. Pole Top Tenons: Fabricated to support fixture or fixtures and brackets indicated and securely fastened to pole top.

M. Concrete for Pole Foundations:

1. Comply with Section 03 30 00

2. Use 3000 psig strength, 28 day concrete

2.06 FINISHES:

A. Metal Parts: Manufacturer's standard finish, except as otherwise indicated, applied over corrosion resistant primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

B. Other Parts: Manufacturer's standard finish, except as otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Set units plumb, square, level, and secure according to manufacturer's written instructions and accepted submittals.

B. Concrete Foundations: Construct according to Section 03 30 00.

1. Comply with details and manufacturer's recommendations for reinforcing, anchor bolts, nuts, and washers. Verify anchor bolt templates by comparing with actual pole bases furnished.

2. Finish: Trowel and rub smooth parts exposed to view.

C. Pole Installation: Use web fabric slings (not chain or cable) to raise and set poles.

D. Fixture Attachment: Fasten to indicated structural supports.

E. Lamp fixtures with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.02 GROUNDING:

A. Ground fixtures and metal poles according to Section 26 05 26.

1. Poles: Install 3/4"-nominal x10 feet driven ground rod at each pole.

3.03 FIELD QUALITY CONTROL:

A. Inspect each installed unit for damage. Replace damaged fixtures and components.

B. Tests and Observations:

1. Give advance notice of dates and times for field tests.

2. Provide instruments to make and record test results.

3. Replace or repair damaged and malfunctioning units, make necessary adjustments, and retest. Repeat procedure until units operate properly.

3.04 ADJUSTING AND CLEANING:

A. Clean units after installation. Use methods and materials recommended by manufacturer.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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DIVISION 27

COMMUNICATIONS

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SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide grounding conductors, connectors, busbars, rods, and labeling as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. B3: Standard Specification for Soft or Annealed Copper Wire

2. B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

3. B33: Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes

B. Institute of Electrical and Electronics Engineers (IEEE):

1. C2: National Electrical Safety Code.

C. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

E. Telecommunications Industry Association (TIA):

1. 568: Generic Telecommunications Cabling for Customer Premises

2. 607B: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

F. Underwriters' Laboratories, Inc. (UL):

1. 467: Standard for Safety Grounding and Bonding Equipment

2. 486A: Standard for Safety Wire Connectors and Soldering Lugs for Use with Copper Conductors

3. 486B: Standard for Safety Wire Connectors

4. 891: Standard for Safety Switchboards

1.03 DEFINITIONS:

A. BCT: Bonding conductor for telecommunications.

B. TGB: Telecommunications grounding busbar.

C. TMGB: Telecommunications main grounding busbar.

D. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

C. Record Drawing Data: Plans showing record drawing locations of grounding and bonding infrastructure, including the following:

1. Ground rods.

2. Ground and roof rings.

3. BCT, TMGB, TGBs, and routing of their bonding conductors.

D. Qualification Data: For installation supervisor, and field inspector.

E. Qualification Data: For testing agency and testing agency's field supervisor.

F. Field quality-control reports.

G. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23, include the following:

a. Result of the ground-resistance test, measured at the point of BCT connection.

b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

c. Field quality-control test results.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.

2. Field Inspector: Currently registered by BICSI as a designer RCDD to perform the on-site inspection.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-B.

2.02 CONDUCTORS:

A. Manufacturers:

1. Harger Lightning & Grounding

2. Panduit Corp.

3. TE Connectivity Ltd.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

2. Not smaller than No. 10 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with one hole and standard barrel for one crimp. If jumper is a flexible braid, it shall have a one- or two-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.

2. Stranded Conductors: ASTM B8.

3. Tinned Conductors: ASTM B33.

4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.03 CONNECTORS:

A. Manufacturers:

1. Brundy; Hubbel Incorporated, Construction and Energy

2. Chatsworth Products, Inc.

3. Harger Lightning & Grounding

4. Panduit Corp.

5. TE Connectivity Ltd.

B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

E. Busbar Connectors: Cast silicon bronze, solderless exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.04 GROUNDING BUSBARS:

A. Manufacturers:

1. Harger Lightning & Grounding

2. Panduit Corp.

3. TE Connectivity Ltd.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide at least a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.

2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.05 GROUND RODS:

A. Manufacturers:

1. Harger Lightning & Grounding

2. TE Connectivity Ltd.

B. Ground Rods: Copper-clad Zinc-coated Stainless steel 3/4 inch by 10 feet 5/8 by 96 inches in 3/4 inch diameter.

2.06 IDENTIFICATION:

A. Comply with requirements for identification products in Section 27 05 53.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Inspect the test results of the ac grounding system measured at the point of BCT connection.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-B.

3.03 APPLICATION:

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.

2. Install without splices.

3. Support at not more than 36-inch intervals.

4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 05 28, and bond both ends of the conduit to a TGB.

3.04 GROUNDING ELECTRODE SYSTEM:

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 4/0 AWG.

3.05 GROUNDING BUSBARS:

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 4 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.06 CONNECTIONS:

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.

2. Pre-twist the conductor.

3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted, vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the TGB.

L. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.

1. Install the conductors in grid pattern on 4-foot centers, allowing bonding of one pedestal from each access floor tile.

2. Bond the TGB of the equipment room to the reference grid at two or more locations.

3. Bond all conduits and piping entering the equipment room to the TGB at the perimeter of the room.

M. Towers and Antennas:

1. Ground Ring: Buried at least 30 inches below grade and at least 24 inches from the base of the tower or mounting.

2. Bond each tower base and metallic frame of a dish to the ground ring, buried at least 18 inches below grade.

3. Bond the ground ring and antenna grounds to the equipment room TMGB or TGB, buried at least 30 inches below grade.

4. Bond metallic fences within 6 feet of towers and antennas to the ground ring, buried at least 18 inches below grade.

5. Special Requirements for Roof-Mounted Towers:

a. Roof Ring: Meet requirements for the ground ring except the conductors shall comply with requirements in Section 26 41 13.

b. Bond tower base footings steel, the TGB in the equipment room, and antenna support guys to the roof ring.

c. Connect roof ring to the perimeter conductors of the lightning protection system.

6. Waveguides and Coaxial Cable:

a. Bond cable shields at the point of entry into the building to the TGB and to the cable entrance plate, using No. 2 AWG bonding conductors.

b. Bond coaxial cable surge arrester to the ground or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

3.07 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS:

A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

B. Comply with IEEE C2 grounding requirements.

C. Grounding Maintenance Holes and Handholes: Install a driven ground rod through maintenance hole or handhole floor, close to wall, and set rod depth so 4 inches extends

above finished floor. If necessary, install ground rod before maintenance hole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into maintenance hole through a waterproof sleeve in maintenance hole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

D. Grounding Connections to Maintenance Hole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each maintenance hole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors' level or plumb around corners and fasten to maintenance hole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.08 IDENTIFICATION:

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.

2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.

3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.09 FIELD QUALITY CONTROL:

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide pathways for communications systems as indicated and in compliance with Contract Documents.

1. Metal conduits and fittings.

2. Nonmetallic conduits and fittings.

3. Optical-fiber-cable pathways and fittings.

4. Metal wireways and auxiliary gutters.

5. Nonmetallic wireways and auxiliary gutters.

6. Metallic surface pathways.

7. Nonmetallic surface pathways.

8. Boxes, enclosures, and cabinets.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. C80.1: Electrical Rigid Steel Conduit

2. C80.3: Electrical Metallic Tubing – Steel

3. C80.5: Electrical Rigid Metal Conduit – Aluminum

4. C80.6: Electrical Intermediate Metal Conduit

B. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

2. 101: Standard for Installing Steel Conduits (Rigid, IMC, EMT)

3. 102: Standard for Installing Rigid Metal Conduit

4. 105: Standard for Installing Metal Cable Tray Systems

5. 111: Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)

6. 568: Standard for Installing Commercial Building Telecommunications Cabling

C. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

2. FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

3. FB 2.10: Selection and Installation Guidelines For Fittings for Use With Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing)

4. OS 1: Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

5. OS 2: Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports

6. RN 1: Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit

7. TC 2: Electrical Polyvinyl Chloride (PVC) Conduit

8. TC 3: Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

9. TC 14: Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

E. Society of Cable Telecommunication Engineers (SCTE):

1. 77: Specifications for Underground Enclosure Integrity

F. Telecommunications Industry Association (TIA):

1. 569-D: Telecommunications Pathways and Spaces

G. Underwriters' Laboratories, Inc. (UL):

1. 5: Standard for Safety Surface Metal Raceways and Fittings

2. 5A: Standard for Safety Nonmetallic Surface Raceways and Fittings

3. 6: Standard for Safety Electrical Rigid Metal Conduit – Steel

4. 6A: Standard for Safety Electrical Rigid Metal Conduit - Aluminum, Red Brass and Stainless Steel

5. 50: Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations

6. 94: Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

7. 467: Standard for Safety Grounding and Bonding Equipment

8. 514A: Standard for Safety Metallic Outlet Boxes

9. 514B: Standard for Safety Conduit, Tubing, and Cable Fittings

10. 514C: Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

11. 651: Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

12. 651A: Standard for Safety Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit

13. 797: Standard for Safety Electrical Metallic Tubing – Steel

14. 870: Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings

15. 1203: Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations

16. 1242: Standard for Safety Electrical Intermediate Metal Conduit – Steel

17. 1773: Standard for Safety Termination Boxes

18. 2024: Standard for Safety Cable Routing Assemblies and Communications Raceways

19. 2515A: Standard for Safety Supplemental Requirements for Extra Heavy Wall Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

1.03 DEFINITIONS:

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid conduit.

C. IMC: Intermediate metal conduit.

D. RTRC: Reinforced thermosetting resin conduit.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product data for the following:

1. Surface pathways

2. Wireways and fittings

3. Tele-power poles

4. Boxes, enclosures, and cabinets

5. Underground handholes and boxes

C. Shop Drawings: For custom enclosures and cabinets and custom underground handholes and boxes. Include plans, elevations, sections, and attachment details.

D. Samples: For wireways, nonmetallic wireways, surface pathways, tele-power poles and for each color and texture specified, 12 inches long.

E. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

3. Underground ducts, piping, and structures in location of underground enclosures and handholes.

F. Qualification Data: For professional engineer.

G. Seismic Qualification Data: Provide seismic bracing for all pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

H. Source quality-control reports.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS:

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. Manufacturers:

1. Alpha Wire

2. Electri-Flex Company

3. Plasti-Bond

4. Republic Conduit

5. Southwire Company

C. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2. Comply with TIA-569-D.

D. GRC: Comply with ANSI C80.1 and UL 6.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated GRC, IMC.

1. Comply with NEMA RN 1.

2. Coating Thickness: 0.040 inch, minimum.

G. SS IMC: Type 304 or 316 Stainless Steel conduit. Comply with ANSI and UL for intermediate metallic conduit.

H. EMT: Comply with ANSI C80.3 and UL 797.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.

2. Fittings for EMT:

a. Material: Steel or die cast.

b. Type: Set screw or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS AND FITTINGS:

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

B. Manufacturers:

1. ABB (Electrification Products Division)

2. Cantex Inc.

3. Dura-line

4. Electric-Flex Company

5. Kraloy Fittings

C. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2. Comply with TIA-569-D.

D. RNC: Type EPC-40-PVC, Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. Rigid HDPE: Comply with UL 651A.

F. Continuous HDPE: Comply with UL 651A.

G. RTRC: Comply with UL 2515A and NEMA TC 14.

H. Solvents and Adhesives: As recommended by conduit manufacturer.

2.03 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS:

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum riser or general-use installation unless otherwise indicated.

B. Manufacturers:

1. Alpha Wire

2. Carlon; a brand of Thomas & Betts Corporation

3. Dura-line

4. Endot-Industries Inc.

5. IPEX USA LLC

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.04 METAL WIREWAYS AND AUXILIARY GUTTERS:

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

B. Manufacturers:

1. Eaton (B-line)

2. MonoSystems, Inc

3. nVent (Hoffman)

4. Schneider Electric USA (Square D)

C. General Requirements for Metal Wireways and Auxiliary Gutters:

1. Comply with UL 870 and NEMA 250, Type 1, Type 3R, Type 4, Type unless otherwise indicated, and sized according to NFPA 70.

2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

3. Comply with TIA-569-D.

D. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

E. Wireway Covers: Hinged type, Screw-cover type, Flanged-and-gasketed type unless otherwise indicated.

F. Finish: Manufacturer's standard enamel finish.

2.05 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS:

A. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

B. Manufacturers:

1. Allied Moulded Products, Inc.

2. Carlon; a brand of Thomas & Betts Corporation

3. Niedax Inc.

4. nVent (Hoffman)

C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2. Comply with TIA-569-D.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.06 SURFACE METAL PATHWAYS:

A. Description: Galvanized steel with snap-on covers, complying with UL 5. Manufacturer’s standard enamel finish.

B. Manufacturers:

1. MonoSystems, Inc.

2. Niedax Inc.

3. Panduit Corp.

4. Wiremold; Legrand North America, LLC.

C. Finish: Manufacturer's standard enamel finish in color selected by Architect, Prime coated, ready for field painting.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

2.07 SURFACE NONMETALLIC PATHWAYS:

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

B. Manufacturers:

1. Carlon; a brand of Thomas & Betts Corporation

2. MonoSystems, Inc.

3. Panduit Corp.

4. Quazite; Hubbell Incorporation, Power Systems

5. Wiremold; Legrand North America, LLC.

C. Finish: Texture and color selected by Architect from manufacturer's standard custom colors.

D. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

F. Comply with TIA-569-D.

2.08 BOXES, ENCLOSURES, AND CABINETS:

A. Description: Enclosures for communications.

B. Manufacturers:

1. ABB (Electrification Products Division)

2. Carlon; a brand of Thomas & Betts Corporation

3. Erikson Electrical Equipment Company

4. MonoSystems, Inc.

5. Wiremold; Legrand North America, LLC.

C. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.

2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.

3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

5. Gangable boxes are allowed.

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

F. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.

2. Type: Fully adjustable

3. Shape: Rectangular.

4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

J. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4, Type 12, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Nonmetallic Enclosures:

a. Material: Fiberglass.

b. Finished inside with radio-frequency-resistant paint.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 3R, Type 4, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.01 PATHWAY APPLICATION:

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC, IMC, RNC, Type EPC-40-PVC RNC, Type EPC-80-PVC.

2. Corrosive / Wet Areas: SS IMC or PVC-coated GRC, IMC.

3. Concealed Conduit, Aboveground: GRC, IMC, EMT, RNC, Type EPC-40-PVC.

4. Underground Conduit: RNC, Type EPC-40-PVC Type EPC-80-PVC, direct buried concrete encased.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT or RNC.

2. Exposed, Not Subject to Severe Physical Damage: EMT, RNC identified for such use.

3. Exposed and Subject to Severe Physical Damage: GRC, IMC. Pathway locations include the following:

    a. Loading dock.

    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

    c. Mechanical rooms.

    d. Gymnasiums

4. Concealed in Ceilings and Interior Walls and Partitions: EMT, RNC, Type EPC-40-PVC or innerduct.

5. Damp or Wet Locations: GRC, IMC.

6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway Plenum-type, communications-cable pathway EMT.

7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway Riser-type, communications-cable pathway EMT.

8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway Riser-type, optical-fiber-cable pathway Plenum-type, optical-fiber-cable pathway General-use, communications-cable pathway Riser-type, communications-cable pathway Plenum-type, communications-cable pathway EMT.

9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 1-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3. EMT: Use compression, steel cast-metal fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete .

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 degrees F.

3.02 INSTALLATION:

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this section are stricter:

1. NECA 1.

2. NECA/BICSI 568.

3. TIA-569-D.

4. NECA 101

5. NECA 105.

6. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 27 05 29 for hangers and supports.

D. Comply with requirements in Section 27 05 44 for sleeves and sleeve seals for communications.

E. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

F. Complete pathway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

I. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches of enclosures to which attached.

K. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.

2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.

3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

5. Change from nonmetallic conduit and fittings to RNC, Type EPC-40-PVC, GRC or IMC and fittings before rising above floor.

L. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

P. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

R. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

S. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-pound tensile strength. Leave at least 12 inches of slack at each

end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

T. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.

2. Install surface pathway with a minimum 2-inch radius control at bend points.

3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

U. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.

2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

V. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where an underground service pathway enters a building or structure.

3. Where otherwise required by NFPA 70.

W. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

X. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 degrees F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 degrees F, and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 degrees F temperature change.

   b. Outdoor Locations Exposed to Direct Sunlight: 155 degrees F temperature change.

   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 degrees F temperature change.

   d. Attics: 135 degrees F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degrees F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per degrees F of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Y. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.

2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.

3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.

4. Space hooks no more than 5 feet o.c.

5. Provide a hook at each change in direction.

Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

BB. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

EE. Set metal floor boxes level and flush with finished floor surface.

FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS:

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 44.

3.04 FIRESTOPPING:

A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.05 PROTECTION:

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 27 05 29

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide hangers and supports for communication systems as indicated and in compliance with Contract Documents.

1. Steel slotted support systems for communication raceways.

2. Aluminum slotted support systems for communication raceways as indicated.

3. Stainless steel supports as indicated.

4. Nonmetallic slotted support systems for communication raceways.

5. Conduit and cable support devices.

6. Support for conductors in vertical conduit.

7. Structural steel for fabricated supports and restraints.

8. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.

9. Fabricated metal equipment support assemblies.

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 7: Seismic Loads: Guide to the Seismic Load Provisions

B. ASTM International (ASTM):

1. A36: Standard Specification for Structural Steel

2. A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

3. D635: Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

4. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

5. F3125: Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions

C. American Welding Society (AWS):

1. D1.1: Structural Welding Code – Steel

2. D1.2: Structural Welding Code – Aluminum

D. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation

2. SP-69: Pipe Hangers and Supports – Selection and Application

E. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

2. 101: Standard for Installing Steel Conduits (Rigid, IMC, EMT)

3. 102: Standard for Installing Aluminum Rigid Metal Conduit

4. 105: Standard for Installing Metal Cable Tray Systems

5. 111: Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)

6. 568: Standard for Installing Commercial Building Telecommunications Cabling

F. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

G. The Society for Protective Coatings (SSPC):

1. PA 1: Shop, Field and Maintenance Coating of Metals

H. Telecommunications Industry Association (TIA):

1. 569-D: Telecommunications Pathways and Spaces

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories

b. Clamps

c. Hangers

d. Sockets

e. Eye nuts

f. Fasteners

g. Anchors

h. Saddles

i. Brackets

2. Include rated capacities and furnished specialties and accessories.

C. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.

2. Steel slotted-channel systems.

3. Aluminum slotted-channel systems.

4. Nonmetallic slotted-channel systems.

5. Equipment supports.

6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

D. Delegated-Design Submittal: For hangers and supports for communications systems.

1. Include design calculations and details of trapeze hangers.

2. Include design calculations for seismic restraints.

E. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which hangers and supports will be attached.

2. Size and location of initial access modules for acoustical tile.

3. Items penetrating finished ceiling, including the following:

a. Luminaires

b. Air outlets and inlets

c. Speakers

d. Sprinklers

e. Access panels

f. Projectors

F. Seismic Qualification Data: Certificates, for hangers and supports for communications equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Welding certificates.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1 and AWS D1.2.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1

2. AWS D1.2

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00, to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

2. Component Importance Factor: 1.5.

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.

2. Self-extinguishing according to ASTM D635.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Manufacturers:

a. Atkore International (allied Tube & Conduit)

b. Eaton (B-line)

c. Flex-strut Inc.

d. G-strut

e. nVent (CADDY)

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Material for Channel, Fittings, and Accessories: Galvanized steel, Plain steel, Stainless Steel, Type 304, Stainless Steel, Type 316.

4. Channel Width: 1-1/4 inches.

5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

9. Channel Dimensions: Selected for applicable load criteria.

B. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Manufacturers:

a. ABB (Electrification Products Division)

b. Cooper Industries, Inc.

c. Flex-Strut Inc.

d. Haydon Corporation

e. MKT Metal Manufacturing

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Channel Material: 6063-T6 aluminum alloy.

4. Fittings and Accessories Material: 5052-H32 aluminum alloy.

5. Channel Width: 1-1/4 inches.

6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

9. Channel Dimensions: Selected for applicable load criteria.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.

1. Manufacturers:

a. Atkore International (allied Tube & Conduit)

b. Eaton (B-line)

c. G-strut

d. Haydon Corporation

e. Seasafe, Inc.; AMICO, a Gibraltar Industries Company

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Channel Width: 1-1/4 inches.

4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.

5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.

6. Rated Strength: Selected to suit applicable load criteria.

7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices: Steel, Steel and malleable-iron, Stainless-steel, Glass-fiber-resin, clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A36 steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers:

(1) Hilti, Inc.

(2) ITW Ramset/Red Head; Illinois Tool Works, Inc

(3) MKT Fastening, LLC

(4) Simpson Strong-Tie Co., Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, stainless steel for use in hardened Portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers:

(1) Eaton (B-line)

(2) Empire Tool and Manufacturing Co., Inc.

(3) Hilti, Inc.

(4) ITW Ramset/Red Head; Illinois Tool Works, Inc

(5) MKT Fastening, LLC

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125,Grade A325.

6. Toggle Bolts: All-steel, Stainless-steel springhead type.

7. Hanger Rods: Threaded steel.

2.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES:

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 for steel shapes and plates.

PART 3 - EXECUTION

3.01 APPLICATION:

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1

2. NECA/BICSI 568

3. TIA-569-D

4. NECA 101

5. NECA 102

6. NECA 105

7. NECA 111

B. Comply with requirements for pathways specified in Section 27 05 28.

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps, single-bolt conduit clamps, single-bolt conduit clamps, using spring friction action for retention in support channel.

E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION:

A. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC and RMC may be supported by openings through structure members, according to NFPA 70.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 pounds.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Use expansion anchor fasteners.

5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Steel: Welded threaded studs complying with AWS D1.1, with lock washers and nuts, Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69, Spring-tension clamps.

7. To Light Steel: Sheet metal screws.

8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS:

A. Comply with installation requirements in Section 05 50 00 for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.

C. Stainless Steel Hangers and Supports are required when installed in corrosive / wet areas.

D. Aluminum Supports and Hangers may only be used in interior conditioned non-corrosive areas.

E. Field Welding: Comply with AWS D1.1.

3.04 FIELD PAINTING:

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 09 91 13, Section 09 91 23, and Section 09 96 00 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 27 05 36

CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide cable trays for communications systems as indicated and in compliance with Contract Documents.

1. Ladder cable tray

2. Wire-mesh cable tray

3. Cable tray accessories

4. Warning signs

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. H35.1: Alloy and Temper Designation Systems for Aluminum

B. American Society of Civil Engineers (ASCE):

1. 7: Seismic Loads: Guide to the Seismic Load Provisions

C. ASTM International (ASTM):

1. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A510: Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

3. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron AlloyCoated (Galvannealed) by the Hot-Dip Process

4. A1008: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

5. A1011: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

6. A1136: Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

7. B633: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

8. D769: Standard Specification for Black Synthetic Iron Oxide

9. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

10. F594: Standard Specification for Stainless Steel Nuts

D. National Electrical Manufacturers Association (NEMA):

1. FG 1: Fiberglass Cable Tray Systems

2. VE 2: Cable Tray Installation Guidelines

E. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

F. Underwriters' Laboratories, Inc. (UL):

1. 568: Standard for Safety Nonmetallic Cable Tray Systems

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

C. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.

b. Clearances for access above and to sides of cable trays.

c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

D. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.

2. Design Calculations: Calculate requirements for selecting seismic restraints.

3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

E. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.

2. Vertical and horizontal offsets and transitions.

3. Clearances for access above and to side of cable trays.

4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

F. Seismic Qualification Data: Certificates, for cable trays, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Field quality-control reports.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00, to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."

2. Component Importance Factor: 1.5, 1.0

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

2.02 GENERAL REQUIREMENTS FOR CABLE TRAYS:

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.

2. Concentrated Load: A load applied at midpoint of span and centerline of tray.

3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.03 LADDER CABLE TRAY:

A. Manufacturers:

1. Atkore International (Cope)

2. Eaton (B-line)

3. MonoSystems, Inc.

4. Niedex Inx.

B. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.

2. Width: 18 inches unless otherwise indicated on Drawings.

3. Minimum Usable Load Depth: 4 inches.

4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.

5. Rung Spacing: 9 inches o.c.

6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.

7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.

8. No portion of the rungs shall protrude below the bottom plane of side rails.

9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-pound concentrated load, when tested according to NEMA VE 1.

10. Fitting Minimum Radius: 24 inches.

11. Class Designation: Comply with NEMA VE 1, Class 8A.

12. Splicing Assemblies: Bolted type using serrated flange locknuts.

13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

14. Covers: Solid Louvered Ventilated-hat 2-in-3 pitch type made of same materials and with same finishes as cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A1011, SS, Grade 33 ASTM A1008, Grade 33, Type 2.

b. Steel Tray Splice Plates: ASTM A1011, HSLAS, Grade 50, Class 1.

c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510, Grade 1008.

d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123, Class B2.

(1) Galvanized, ASTM B633, Chromium-zinc plated ASTM F1136 or Stainless steel, Type 316

e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A653, G90.

(1) Hardware: Galvanized, ASTM B633 Chromium-zinc plated, ASTM F1136.

f. Finish: Electrogalvanized after fabrication, complying with ASTM B633.

(1) Hardware: Galvanized, ASTM B633.

g. Finish: Epoxy-resin Powder-coat enamel paint.

(1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.

(2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.

(3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

(4) Hardware: Chromium-zinc plated, ASTM F1136, Stainless steel, Type 316, ASTM F593 and ASTM F594.

h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F1136.

i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D769.

2. Aluminum:

a. Materials: Alloy 6063-T6 according to ANSI H35.1 for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1 for fabricated parts.

b. Hardware: Chromium-zinc-plated steel, ASTM F1136, Stainless steel, Type 316, ASTM F593 and ASTM F594.

c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

3. Stainless Steel:

a. Materials: Low-carbon, passivated stainless steel, Type 304L or Type 316L, ASTM F593 and ASTM F594.

b. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

2.04 WIRE-MESH CABLE TRAY:

A. Manufacturers:

1. Atkore International (Cope)

2. Cablofil; Legrand North America, LLC

3. Eaton (B-line)

4. MonoSystems, Inc.

5. Niedex Inx.

B. Description:

1. Configuration: Galvanized- steel wire mesh, complying with NEMA VE 1.

2. Width: 18 inches unless otherwise indicated on Drawings.

3. Minimum Usable Load Depth: 4 inches.

4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.

5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-pound concentrated load, when tested according to NEMA VE 1.

6. Class Designation: Comply with NEMA VE 1, Class 5A.

7. Splicing Assemblies: Bolted type using serrated flange locknuts.

8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A1011, SS, Grade 33, ASTM A1008, Grade 33, Type 2.

b. Steel Tray Splice Plates: ASTM A1011, HSLAS, Grade 50, Class 1.

c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510, Grade 1008.

d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123, Class B2.

(1) Hardware: Galvanized, ASTM B633, Chromium-zinc plated ASTM F1136 or Stainless steel, Type 316.

e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A653, G90.

(1) Hardware: Galvanized, ASTM B633, Chromium-zinc plated, ASTM F1136.

f. Finish: Electrogalvanized after fabrication, complying with ASTM B633.

(1) Hardware: Galvanized, ASTM B633.

g. Finish: Epoxy-resin, Powder-coat enamel paint.

(1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.

(2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.

(3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

(4) Hardware: Chromium-zinc plated, ASTM F1136, Stainless steel, Type 316, ASTM F593 and ASTM F594.

h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F1136.

i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D769.

2.05 NONMETALLIC CABLE TRAYS

A. Description: This product category covers nonmetallic, including fiberglass (fiberglass-reinforced plastic), cable trays and cable tray systems intended for field assembly and for use in accordance with Article 392 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria: UL CCN CYOV; including UL 568.

C. UL CYOV - Fiberglass Cable Tray:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Business.

b. Allied Tube & Conduit; Atkore International.

c. Cablofil; Legrand North America, LLC.

d. Cooper B-line; brand of Eaton, Electrical Sector.

e. Enduro Composites Inc.

f. MP Husky USA Cable Tray & Cable Bus.

g. MonoSystems, Inc.

2. Source Limitations: Obtain products from single manufacturer.

3. General Characteristics:

a. Configuration: Two longitudinal members with rounded edges and smooth surfaces, supporting a bearing surface, complying with NEMA FG 1.

b. Temperature Rating: Reduce the load rating of trays exposed to temperatures above 75 degrees F in accordance with Table 4-3, "Working Loads," in NEMA FG 1.

c. Splicing Assemblies: Minimum four nuts and bolts per plate. Splice plates must be furnished with straight sections and fittings.

d. Splicing Assembly Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

e. Fasteners: Fiberglass-encapsulated, ASTM F593 and ASTM F594 stainless steel, Type 316. Design fasteners so that no metal is visible when fully assembled and tightened. Fastener encapsulation must not be damaged when torqued to manufacturer's recommended value.

4. Options:

a. Materials: Straight section structural elements; side rails, rungs, and splice plates must be pultruded from glass-fiber-reinforced vinyl ester resin, complying with NEMA FG 1 and UL 568.

b. Width: 24 inch unless otherwise indicated on Drawings.

c. Minimum Usable Load Depth: 5 inch in accordance with NEMA FG 1.

d. Straight Section Lengths: 10 ft.

e. Class Designation: Comply with NEMA VE 1, Class 8C.

f. Fitting Minimum Radius: 12 inch.

g. Covers: Solid type made of same materials and with same finishes as cable tray.

2.06 CABLE TRAY ACCESSORIES:

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.07 WARNING SIGNS:

A. Comply with requirements for identification in Section 27 05 53.

B. Lettering: 1-1/2-inch-high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.08 SOURCE QUALITY CONTROL:

A. Testing: Test and inspect cable trays according to NEMA FG 1, NEMA VE 1.

PART 3 - EXECUTION

3.01 PREPARATION

A. Shop Drawings: Prepare and submit the following for each cable tray system:

1. Cable Tray Fabrication Drawings, Diagrams, and Supporting Documents:

a. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

b. Include load calculations to show that dead and live loads do not exceed manufacturer's rating for tray and its support elements.

c. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

(1) Vertical and horizontal offsets and transitions.

(2) Clearances for access above and to sides of cable trays.

(3) Vertical elevation of cable trays above the floor or bottom of ceiling structure.

3.02 CABLE TRAY INSTALLATION:

A. Install cable trays according to NEMA FG 1, NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure and install seismic restraints.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 pound. Comply with requirements in Section 26 05 48.16 and Section 27 05 29. Comply with seismic-restraint details according to Section 26 05 50 and Section 27 05 48.

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Locate and install supports according to NEMA FG 1, NEMA VE 2. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with center support hangers, trapeze hangers wall brackets.

N. Support center support hangers, trapeze hangers for wire-basket trays with 3/8-inch-diameter rods.

O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1 NEMA VE 2. Space connectors and set gaps according to applicable standard.

Q. Make changes in direction and elevation using manufacturer's recommended fittings.

R. Make cable tray connections using manufacturer's recommended fittings.

S. Seal penetrations through fire and smoke barriers.

T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

U. Install cable trays with enough workspace to permit access for installing cables.

V. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

W. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.03 CABLE TRAY GROUNDING:

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 27 05 26.

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.04 CABLE INSTALLATION:

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.05 CONNECTIONS:

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.06 INSTALLATION OF CABLE TRAY MARKINGS AND SIGNS

A. Trays Containing Cables Operating Over 600 V: Provide hazard markings in accordance with Section 392.18 of NFPA 70 and with NEMA Z535.4.

1. Legend: "DANGER - HIGH VOLTAGE - KEEP AWAY."

B. Ladder Cable Trays: Provide warning signs to prevent use as personnel ladder.

3.07 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.

2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.

4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.

5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

7. Check for improperly sized or installed bonding jumpers.

8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Field tests and inspections must be witnessed by authorities having jurisdiction.

C. Tests and Inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.

2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.

4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.

5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

7. Check for improperly sized or installed bonding jumpers.

8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 Ω.

D. Nonconforming Work:

1. Cable tray will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports

F. Manufacturer Services: Engage factory-authorized service representative to support field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.08 PROTECTION:

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

3.09 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 27 05 43

UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide underground pathways and structures for communications systems as indicated and in compliance with Contract Documents.

1. Metal conduit and fittings, including GRC and PVC-coated GRC.

2. Rigid nonmetallic duct.

3. Duct accessories, including rigid innerduct and fabric innerduct.

4. Precast concrete handholes.

5. Polymer concrete handholes and boxes with polymer concrete cover.

6. Fiberglass handholes and boxes with polymer concrete cover.

7. Fiberglass handholes and boxes.

8. High density plastic boxes.

9. Precast maintenance holes.

10. Cast-in-place maintenance holes.

11. Utility structure accessories.

1.02 REFERENCES:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. HB 17: Standard Specification for Highway Bridges

B. American National Standards Institute (ANSI):

1. C80.1: Electrical Rigid Steel Conduit

C. ASTM International (ASTM):

1. A48: Standard Specification for Gray Iron Castings

2. C270: Standard Specification for Mortar for Unit Masonry

3. C387: Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete

4. C858: Standard Specification for Underground Precast Concrete Utility Structures

5. C891: Standard Practice for Installation of Underground Precast Concrete Utility Structures

6. C990: Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

7. C1037: Standard Practice for Inspection of Underground Precast Concrete Utility Structures

8. E329: Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

9. F512: Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

D. National Electrical Manufacturers Association (NEMA):

1. RN 1: Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit

2. TC 2: Electrical Polyvinyl Chloride (PVC) Conduit

3. TC 3: Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

4. TC 6 & 8: Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations

5. TC 7: Smooth-Wall Coilable Electrical Polyethylene Conduit

6. TC 9: Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation

7. TCB 2: Guidelines for the Selection and Installation of Underground Nonmetallic Raceways

E. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

F. Society of Cable Telecommunication Engineers (SCTE):

1. 77: Specification for Underground Enclosure Integrity

G. Telecommunications Industry Association (TIA):

1. 569-C: Telecommunications Pathways and Spaces

2. 758-C: Customer-Owned Outside Plant Telecommunication Infrastructure Standard

H. Underwriters' Laboratories, Inc. (UL):

1. 6: Standard for Safety Electrical Rigid Metal Conduit – Steel

2. 651: Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

3. 651A: Standard for Safety Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit

1.03 DEFINITIONS:

A. Direct-Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.

2. Multiple duct banks.

D. GRC: Galvanized rigid conduit

E. IMC: Intermediate metal conduit

F. RNC: Rigid nonmetallic conduit

G. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.

2. Include duct and conduits and their accessories, including elbows, end bells, bends, fittings, duct spacers and solvent cement.

3. Include accessories for maintenance holes, handholes, and boxes, and other utility structures.

4. Include underground-line warning tape.

C. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:

a. Include plans, elevations, sections, details, attachments to other work, and accessories.

b. Include duct entry provisions, including location and duct size.

c. Include reinforcement details.

d. Include frame and cover design and maintenance hole chimneys.

e. Include ladder details.

f. Include grounding details.

g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.

b. Include duct entry provisions, including location and duct size.

c. Include cover design.

d. Include grounding details.

e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

2. Drawings shall be signed and sealed by a qualified professional engineer.

E. Product Certificates: For concrete and steel used in precast concrete maintenance holes and handholes, as required by ASTM C858.

F. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

G. Source quality-control reports.

H. Field quality-control reports.

I. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

J. Furnish cable-support stanchions, arms, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.09 PROJECT/SITE CONDITIONS:

A. Interruption of Existing Communications Service: Do not interrupt communications service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary communications service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of communications service.

2. Do not proceed with interruption of communications service without Owner's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS:

A. GRC: Comply with ANSI C80.1 and UL 6.

B. PVC-Coated Steel Conduit: PVC-coated GRC IMC.

1. Comply with NEMA RN 1.

2. Coating Thickness: 0.040 inch, minimum.

C. Manufacturers:

1. ABB (Electrification Products Division)

2. Champion Fiberglass, Inc.

3. FSR Inc.

4. NewBasis

5. Plasti-bond

D. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2. Comply with TIA-569-C and TIA-758-C.

2.02 RIGID NONMETALLIC DUCTS:

A. Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Manufacturers:

1. Beck Manufacturing

2. Cantex Inc.

3. ElecSys, Inc

4. IPEX USA LLC

5. National Pipe & Plastics

C. General Requirements for Nonmetallic Ducts and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2. Comply with TIA-569-C and TIA-758-C.

D. Solvents and Adhesives: As recommended by duct manufacturer.

1. Refer to Division 01 specifications for sustainable design requirements.

2.03 FLEXIBLE NONMETALLIC DUCTS:

A. HDPE Duct: Type EPEC 40-HDPE, Type EPEC 80-HDPE complying with NEMA TC 7 and UL 651A.

1. Manufacturers:

a. ARNCO Corp

b. Carlon; a brand of Thomas & Betts Corporation

c. National Pipe & Plastics

d. Opti-Com Manufacturing Network, Inc (OMNI)

e. Premier Conduit

2. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

3. Comply with TIA-569-C and TIA-758-C.

2.04 DUCT ACCESSORIES:

A. Rigid Innerduct: Smooth HDPE duct, orange in color, designed for installation within a duct or pathway.

1. Manufacturers:

a. ABB (Electrification Products Division)

b. Blue Diamond Industries

c. Carlon; a brand of Thomas & Betts Corporation

d. Dura-Line

e. Premier Conduit

B. Fabric Innerduct: Continuous, polyester, multi -pocket fabric innerduct, with internal pull tape and tracer wire.

1. Manufacturers:

a. Maxcell

C. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

1. Manufacturers:

a. Atkore International (Allied Tube & Conduit)

b. Cantex, Inc.

c. Carlon; a brand of Thomas & Betts Corporation

d. PenCell Plastics

e. Underground Devices, Inc

D. Underground-Line Warning Tape: Underground-line warning tape specified in Section 27 05 53.

2.05 PRECAST CONCRETE HANDHOLES AND BOXES:

A. Description: Monolithically poured, factory-fabricated, reinforced-concrete walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Manufacturers:

1. Christy Concrete Products

2. Elmhurst-Chicago Stone Co

3. Rinker Group, Ltd

4. Utility Concrete Products, LLC

5. Wausau Tile Inc.

C. Comply with ASTM C858 for design and manufacturing processes.

D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

E. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

F. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

1. Cover Hinges: Concealed, with hold-open ratchet assembly.

2. Cover Handle: Recessed.

G. Frame and Cover: Weatherproof aluminum frame, with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.

1. Cover Hinges: Concealed, with hold-open ratchet assembly.

2. Cover Handle: Recessed.

H. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

I. Cover Legend: Molded lettering, "COMMUNICATIONS"

J. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

K. Extensions and Slabs: Designed to mate with bottom of enclosure, and made of same material as enclosure.

1. Extension shall provide increased depth of 12 inches.

2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

L. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

M. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional 6 inches or 12 inches vertically and horizontally to accommodate alignment variations.

1. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.

2. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.

3. Knockout panel openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.

4. Knockout panels shall be 1-1/2 to 2 inches thick.

N. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct or conduit to be terminated.

2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

O. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.06 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER:

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Manufacturers:

1. Armorcast Products Company

2. MacLean Highline

3. NewBasis

4. Oldcastle Enclosure Solutions

5. Quazite; Hubbell Incorporated, Power Systems

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Green.

E. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, “COMMUNICATIONS”.

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.07 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER:

A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

B. Manufacturers:

1. Armorcast Products Company

2. Christy Concrete Products

3. NewBasis

4. Oldcastle Enclosure Solutions

5. Quazite; Hubbell Incorporated, Power Systems

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Green.

E. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, “COMMUNICATIONS”

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.08 FIBERGLASS HANDHOLES AND BOXES:

A. Description: Molded of fiberglass-reinforced polyester resin, with covers made of polymer concrete reinforced concrete cast iron hot-dip galvanized-steel diamond plate.

B. Manufacturers:

1. Christy Concrete Products

2. MacLean Highline

3. Nordic Fiberglass, Inc

4. Oldcastle Enclosure Solutions

5. Quazite; Hubbell Incorporated, Power Systems

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Green.

E. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, “COMMUNICATIONS”

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.09 HIGH-DENSITY PLASTIC BOXES:

A. Description: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be made of polymer concrete hot-dip galvanized-steel diamond plate plastic.

B. Manufacturers:

1. Nordic Fiberglass, Inc

2. Oldcastle Enclosure Solutions

3. PenCell Plastics

4. Quazite; Hubbell Incorporated, Power Systems

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Green.

E. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, “COMMUNICATIONS”

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.10 PRECAST MAINTENANCE HOLES:

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Manufacturers:

1. Carder Concrete Products

2. Christy Concrete Products

3. Oldcastle Precast, Inc.

4. Rinker Group, Ltd

5. Utility Vault Co.

C. Standard: Comply with ASTM C858.

D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

E. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional 6 inches vertically and horizontally to accommodate alignment variations.

1. Splayed Center window location.

2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of maintenance holes, but close enough to corners to facilitate racking of cables on walls.

3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.

4. Knockout panel openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.

5. Knockout panels shall be 1-1/2 to 2 inches thick.

F. Duct Entrances in Maintenance Hole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct or conduit to be terminated.

2. Fittings shall align with elevations of approaching duct and be located near interior corners of maintenance holes to facilitate racking of cable.

G. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in maintenance hole floors 2 inches from the wall adjacent to, but not underneath, the duct routed from the facility.

H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.11 CAST-IN-PLACE MAINTENANCE HOLES:

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C858 and with Section 03 30 00.

C. Structural Design Loading: As specified in "Underground Enclosure Application" Article.

2.12 UTILITY STRUCTURE ACCESSORIES:

A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.

B. Manufacturers:

1. BILCO Company (the)

2. Carder Concrete Products

3. EJ

4. New Basis

5. Oldcastle Precast Inc.

6. Quazite; Hubbell Incorporated, Power Systems

C. Maintenance Hole Frames, Covers, and Chimney Components: Comply with structural design loading specified for maintenance hole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A48, Class 30B cast aluminum, with milled cover-to-frame bearing surfaces; 26-inch or 29-inch diameter.

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.

3. Maintenance Hole Chimney Components: Precast concrete rings, with dimensions matched to those of roof opening.

a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities of less than 2.0 cubic feet, where packaged mix complying with ASTM C387, Type M, may be used.

b. Seal joints watertight using preformed plastic or rubber conforming to ASTM C990. Install sealing material according to the sealant manufacturers' printed instructions.

D. Maintenance Hole Sump Frame and Grate: ASTM A48, Class 30B, gray cast iron.

E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.

1. Working Load Embedded in 6-inch, 4000-psi Concrete: 13,000-lbf minimum tension.

F. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.

G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive

thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to a minimum of 1-1/4 inches at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

I. Ground Rod Sleeve: 3-inch, PVC duct sleeve in maintenance hole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.

J. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip, with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of nine holes for arm attachment.

2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-pound minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

L. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 degrees F. Capable of withstanding temperature of 300 degrees F without slump and adhering to clean surfaces of plastic duct, metallic duct, duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

M. Fixed Maintenance Hole Ladders: Arranged for attachment to roof or wall of maintenance hole. Ladder, mounting brackets, and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin hot-dip galvanized steel.

N. Portable Maintenance Hole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical maintenance holes. Minimum length equal to distance from deepest maintenance hole floor to grade plus 36 inches. One required.

O. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater Light duty, designed for lifts less than 60 lbf. Two required.

2.13 SOURCE QUALITY CONTROL:

A. Test and inspect precast concrete utility structures according to ASTM C1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of maintenance holes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.02 PREPARATION:

A. Coordinate layout and installation of duct, duct bank, maintenance holes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into maintenance holes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to maintenance holes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 31 10 00. Remove and stockpile topsoil for reapplication according to Section 31 10 00.

3.03 UNDERGROUND DUCT APPLICATION:

A. Duct for Communications: Type EPC-80-PVC or Type EPC-40-PVC RNC in concrete-encased duct bank unless otherwise indicated.

B. Duct for Communications: Type EPEC-40-HDPE Type EPEC-80-HDPE duct in direct-bored duct bank unless otherwise indicated.

C. Underground Duct Crossing Paved Paths Walks and Driveways Roadways and Railroads: Type EPC-40-PVC RNC, encased in reinforced concrete.

D. Stub-Ups for Communications: Concrete-encased RNC GRC PVC-coated GRC.

3.04 UNDERGROUND ENCLOSURE APPLICATION:

A. Handholes and Boxes for Communications:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 H-20 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 Polymer concrete, SCTE 77, Tier 15 Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15 Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 High-density plastic, SCTE 77, Tier 15 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-5 Precast concrete, AASHTO HB 17, H-10 Polymer concrete units, SCTE 77, Tier 8 Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 High-density plastic, SCTE 77, Tier 8 structural load rating.

4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin High-density plastic, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

5. Cover design load shall not exceed the design load of the handhole or box.

B. Maintenance Holes: Precast or cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.05 EARTHWORK:

A. Excavation and Backfill: Comply with Section 31 23 00, but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area immediately after backfilling is completed or after construction in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. .

E. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures according to Section 01 73 29.

3.06 DUCT AND DUCT-BANK INSTALLATION:

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct and duct bank according to NEMA TCB 2 and TIA-758-C.

C. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward maintenance holes and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two maintenance holes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct and duct banks shall have maximum of two 90-degree bends, or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings, and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank will not be subject to environmental temperatures above 40 degrees C. Where environmental temperatures are calculated to rise above 40 degrees C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End-Bell Entrances to Maintenance Holes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct slope and without forming a trap in the line.

2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to maintenance hole or handhole. Install an expansion fitting near the center of all straight-line direct-buried duct and duct banks, with calculated expansion of more than 3/4 inch.

3. Grout end bells into structure walls from both sides to provide watertight entrances.

H. Terminator Entrances to Maintenance Holes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to terminator spacing 10 feet from the terminator without reducing duct slope and without forming a trap in the line.

2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to maintenance hole or handhole. Install an expansion fitting near the center of all straight-line duct or duct bank, with calculated expansion of more than 3/4 inch.

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Use fittings manufactured for RNC duct-to-GRC conduit transition. Install GRC penetrations of building walls as specified in Section 27 05 44.

J. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

K. Innerduct: Install immediately after mandreling duct. Size and type as indicated on Drawings. Provide three innerducts per duct.

L. Pulling Cord: Install 200-lbf-test nylon cord in empty duct and innerduct.

M. Concrete-Encased Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct or duct bank. Prepare trench bottoms as specified in Section 31 23 00 for pipes less than 6 inches in nominal diameter.

2. Width: Excavate trench 12 inches wider than duct or duct bank on each side.

3. Width: Excavate trench 3 inches wider than duct or duct bank on each side.

4. Depth: Install top of duct and duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.

5. Support duct and duct bank on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

6. Minimum Space Between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.

7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.

8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout length of elbow.

9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    a. Couple GRC to duct with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

    b. Stub-Ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        (1) Stub-ups shall be flush with minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

    c. Stub-Ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        (1) Stub-ups shall be flush with minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of wall.

10. Reinforcement: Reinforce concrete-encased duct and duct bank where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

11. Forms: Use trench walls to form side walls of duct and duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

12. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between ducts, and 4 inches between power and communications duct.

13. Concreting Sequence: Pour each run of envelope between maintenance holes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.

    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 30 00. Place concrete carefully during pours to prevent voids under and between ducts and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto duct. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

N. Direct-Buried Duct and Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct and duct bank. Comply with requirements in Section 31 23 00 for preparation of trench bottoms for duct less than 6 inches in nominal diameter.

2. Install duct with a minimum of 3 inches between duct for like services and 6 inches between power and signal duct.

3. Width: Excavate trench 12 inches wider than duct or duct bank on each side.

4. Width: Excavate trench 3 inches wider than duct or duct bank on each side.

5. Depth: Install top of duct or duct bank at least 36 inches below finished grade unless otherwise indicated.

6. Set elevation of bottom of duct or duct bank below frost line.

7. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

8. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.

9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances through floor, and at changes of direction in duct unless otherwise indicated. Encase elbows for stub-ups throughout length of elbow. Extend encasement minimum of 36 inches beyond elbow joints.

10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

    a. Couple GRC to duct with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

    b. For equipment mounted on outdoor bases, extend GRC horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving duct at end of run free to move with expansion and contraction, as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around duct to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 31 23 00 for installation of backfill materials.

    a. Place minimum of 3 inches of sand as a bed for duct and duct bank. Place sand to a minimum of 6 inches above top level of duct and duct bank.

    b. Place minimum of 6 inches of engineered fill above concrete encasement of duct bank.

O. Underground-Line Warning Tape: Bury conducting underground-line warning tape specified in Section 27 05 53 no less than 12 inches above all concrete-encased duct and duct bank and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of ductbank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.07 INSTALLATION OF CONCRETE MAINTENANCE HOLES, HANDHOLES, AND BOXES:

A. Cast-in-Place Maintenance Hole Installation:

1. Finish interior surfaces with a smooth-troweled finish.

2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.

3. Comply with requirements in Section 03 30 00 for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Maintenance Hole Installation:

1. Comply with ASTM C891 unless otherwise indicated.

2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.

3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Maintenance Hole Roof: Install with rooftop at least 15 inches below finished grade.

2. Maintenance Hole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other maintenance hole frames 1 inch above finished grade.

3. Install handholes with bottom below frost line, below grade.

4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of maintenance holes where indicated. Coordinate with drainage provisions indicated.

E. Maintenance Hole Access: Circular opening in maintenance hole roof; sized to match cover size.

1. Maintenance holes with Fixed Ladders: Offset access opening from maintenance hole centerlines to align with ladder.

2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with maintenance hole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of maintenance holes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 07 21 00 and Section 07 92 00. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of maintenance hole chimneys after mortar has cured at least three days.

G. Dampproofing: Apply dampproofing to exterior surfaces of maintenance holes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 07 11 13. After duct has been connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of maintenance hole chimneys after mortar has cured at least three days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

I. Fixed Maintenance Hole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in maintenance holes.

J. Field-Installed Bolting Anchors in Maintenance Holes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for maintenance holes and 2 inches for handholes, for field-installed anchor bolts installed. Use a minimum of two anchors for each cable stanchion.

3.08 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE:

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct and duct bank, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring, encircling, and in contact with,

enclosure, and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Section 03 30 00, with a troweled finish.

2. Dimensions: 10 inches wide by 12 inches deep.

3.09 GROUNDING:

A. Ground underground duct, duct bank, and utility structures according to Section 27 05 26.

3.10 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.

2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.

3. Test maintenance hole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 27 05 26.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.11 CLEANING:

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris.

B. Clean internal surfaces of maintenance holes, including sump.

1. Sweep floor, removing dirt and debris.

2. Remove foreign material.

3.12 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 27 05 44

SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide sleeves and sleeve seals for communication pathways and cabling as indicated and in compliance with Contract Documents.

1. Round sleeves

2. Rectangular sleeves

3. Sleeve seal systems

4. Grout

5. Pourable sealants

6. Foam sealants

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

2. C1107: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

3. D1785: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

B. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 ROUND SLEEVES:

A. Wall Sleeves, Steel:

1. Manufacturers:

a. Advance Products & Systems, LLC

b. CCI Piping Systems

c. Flexicraft Industries

d. GPT; an EnPro Industries Company

2. Description: ASTM A53, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

2.02 RECTANGULAR SLEEVES:

A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:

1. Manufacturers:

a. Abesco Fire LLC

b. Specified Technologies, Inc.

c. Wiremold; Legrand North America, LLC

2. Description:

a. Material: Galvanized sheet steel.

b. Minimum Metal Thickness:

(1) For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness must be 0.052 inch.

(2) For sleeve cross-section rectangle perimeter not less than 50 inches or with one or more sides larger than 16 inches, thickness must be 0.138 inch.

2.03 SLEEVE SEAL SYSTEMS:

A. Manufacturers:

1. Advance Products & Systems, Inc.

2. BWM Company

3. CALPICO, Inc

4. Flexicraft Industries

5. Metraflex Company (The)

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable.

1. Sealing Elements: EPDM Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Carbon steel Fiber-reinforced plastic Stainless steel.

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.04 GROUT:

A. Manufacturers:

1. W. R. Meadows, Inc.

B. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.05 POURABLE SEALANTS:

A. Manufacturers:

1. Carlisle SynTec Incorporated

2. GAF

3. Johns Manville; a Berkshire Hathaway Company

B. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.06 FOAM SEALANTS:

A. Manufacturers:

1. Dow Chemical Company (The)

2. Innovative Chemical Products (Building Solutions Group)

B. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.01 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS:

A. Comply with NECA 1.

B. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.

b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for wall assemblies.

D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel cast-iron pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Underground, Exterior-Wall and Floor Penetrations:

1. Install steel pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.02 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS:

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.03 INSTALLATION OF SLEEVE SEAL SYSTEMS:

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 27 05 48

VIBRATION AND SEISMIC CONTROLS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide vibration and seismic controls for communications systems as indicated and in compliance with Contract Documents.

1. Elastomeric isolation pads

2. Restraints – rigid type

3. Restraints – cable type

4. Restraint accessories

5. Post-installed concrete anchors

6. Concrete inserts

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 355.2: Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary

B. American Society of Civil Engineers (ASCE):

1. 7: Seismic Loads: Guide to the Seismic Load Provisions

2. 7-10: Minimum Design Loads for Buildings and Other Structures

3. 7-16: Minimum Design Loads and Associated Criteria for Buildings and Other Structures

C. ASTM International (ASTM):

1. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

2. A492: Standard Specification for Stainless Steel Rope Wire

3. A603: Standard Specification for Metallic-Coated Steel Structural Wire Rope

4. A1023: Standard Specification for Carbon Steel Wire Ropes for General Purposes

5. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

6. E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

D. American Welding Society (AWS):

1. D1.1: Structural Welding Code – Steel

E. International Code Council (ICC):

1. ES AC156: Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components

F. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation

G. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

H. Underwriters' Laboratories, Inc. (UL):

1. 723: Standard for Safety Test for Surface Burning Characteristics of Building Materials

1.03 DEFINITIONS:

A. Designated Seismic System: A communications system component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Delegated Design Submittals: Product Data: For each type of product.

1. Include rated load capacity for each seismic- and wind-load-restraint device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic- and wind-load-restraint component used.

3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by ICC-ES product listing UL product listing FM Approvals an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction.

4. Annotate to indicate application of each product submitted and compliance with requirements.

C. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

D. Delegated Design Submittal for Each Seismic-Restraint Device:

1. For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems and anchorage for equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

2. For each seismic-restraint device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.

b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.

c. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.

d. Qualified Professional Engineer: All designated design submittals for seismic calculations are to be signed and sealed by the qualified professional engineer responsible for their preparation.

E. Delegated Design Submittal for Each Wind-Load Protection Device:

1. For each wind-load protection device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

   a. Wind-Load Restraint: Select wind-load restraints complying with performance requirements, design criteria, and analysis data.

   b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind-loads. Include certification that device is approved by an NRTL for reinforcement use.

   c. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.

   d. Qualified Professional Engineer: All designated design submittals for wind-load restraint calculations are to be signed and sealed by the qualified professional engineer responsible for their preparation.

2. Seismic- and Wind-Load-Restraint Detail Drawings:

   a. Design Analysis: To support selection and arrangement of seismic and wind-load restraints. Include calculations of combined tensile and shear loads.

   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

   c. Coordinate seismic-restraint details with wind-load details required for equipment mounted outdoors.

3. Product Listing, Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES UL FM Approvals OSHPD an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

4. All delegated design submittals for seismic and wind-load-restraint detail drawings are to be signed and sealed by the qualified professional engineer responsible for their preparation.

F. Coordination Drawings: Show coordination of seismic and wind-load bracing for communications components with other systems and equipment in the vicinity, including other supports and seismic restraints.

G. Qualification Data: For professional engineer and testing agency.

H. Welding certificates.

I. Field quality-control reports.

J. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active communications seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or experience data as permitted by ASCE/SEI 7-05, ASCE/SEI 7-10, and ASCE/SEI 7-16.

2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-05, ASCE/SEI 7-10, and ASCE/SEI 7-16.

3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed Professional Engineer.

4. The following communications systems and components are Designated Seismic Systems and require written special certification of seismic qualification by manufacturer:

K. Wind-Load Performance Certification: Provide special certification for communications components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-load performance certification.

1. Provide equipment manufacturer's written certification for each designated communications device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.

2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction

3. The following communications systems and components require special certification for high wind performance. Written special certification of resistance to effects of high wind load and impact damage must be provided by manufacturer.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Testing Agency Qualifications: Independent agency must have experience and capability to conduct testing indicated, be and NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.

C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1, "Structural Welding Code – Steel."

D. Seismic- and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing UL product listing FM Approvals an evaluation service member of ICC-ES an agency acceptable to authorities having jurisdiction.

E. Comply with NFPA 70.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00, to design seismic and wind-load control system.

1. Seismic and Wind-Load Performance: Equipment shall withstand the effects of earthquake motions and high wind events determined in accordance with ASCE/SEI 7-05, ASCE/SEI 7-10, and ASCE/SEI 7-16.

B. Seismic Design Calculations:

1. Perform calculations to obtain force information necessary to properly select seismic restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05 and ASCE/SEI 7-10 including Supplement No. 1, ASCE/SEI 7-16. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the section text.

   a. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.

   b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors.

   c. Building Occupancy Category: III

   d. Building Risk Category: III

   e. Building Site Classification: D

2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 – Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.

   a. Horizontal Seismic Design Force F_p: Value is to be calculated by Delegated Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation.

      (1) S_{DS} = Spectral Acceleration: Value applies to all components on Project.

      (2) a_p = Component Amplification Factor: See Drawing Schedule for each component.

      (3) I_p = Component Importance Factor: See Drawing Schedule for each component.

      (4) W_p = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from each component submittal.

      (5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.

      (6) z = Height in Structure of Point of Attachment of Component with Respect to Base: Determine from Project Drawings for each

component by Delegated Design Contractor. For items at or below the base, "z" shall be taken as zero.

(7) h = Average Roof Height of Structure with Respect to Base: Determine from Project Drawings by Delegated Design Contractor.

b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.

c. Seismic Relative Displacement D_{pl}: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:

(1) D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.

(2) I_e = Structure Importance Factor: Value applies to all components on Project.

(3) 8_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.

(4) 8_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.

(5) 8_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.

(6) h_x = Height of Level x to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.

(7) h_y = Height of Level y to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.

(8) A_{aA} = Allowable Story Drift for Structure A: See Drawing Schedules for each component.

(9) A_{aB} = Allowable Story Drift for Structure B: See Drawing Schedules for each component.

(10) h_{sx} = Story Height Used in the Definition of the Allowable Drift A_a: See Drawings Schedules for each component.

d. Component Fundamental Period T_p: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:

(1) W_p = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.

(2) g = Gravitational Acceleration: 32.17 fps^2 K_p = Combined Stiffness of the Component, Supports, and Attachments: Determined by delegated design seismic engineer.

3. Calculation Factors, ASCE/SEI 7-10, Ch. 13 – Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.

a. Horizontal Seismic Design Force F_p: Calculated by Delegated Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:

(1) S_{DS} = Spectral Acceleration: Value applies to all components on Project.

(2) a_p = Component Amplification Factor: See Drawing Schedule for each component.

(3) I_p = Component Importance Factor: See Drawing Schedule for each component.

(4) W_p = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from equipment submittal.

(5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.

(6) z = Height in Structure of Point of Attachment of Component with Respect to Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" shall be taken as zero.

(7) h = Average Roof Height of Structure with Respect to Base: Determine from Project Drawings by Delegated Design Contractor.

b. Vertical Seismic Design Force: Calculate by Delegated Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.

c. Seismic Relative Displacement D_{pI}: Calculate by Delegated Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:

(1) D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.

(2) I_e = Structure Importance Factor: Value applies to all components on Project.

(3) 8_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.

(4) 8_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.

(5) 8_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.

(6) h_x = Height of Level x to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.

(7) h_y = Height of Level y to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.

(8) A_{aA} = Allowable Story Drift for Structure A: See Drawing Schedule for each component.

(9) A_{aB} = Allowable Story Drift for Structure B: See Drawing Schedule for each component.

(10) h_{sx} = Story Height Used in the Definition of the Allowable Drift A_a: See Schedule for each component.

4. Calculation Factors, ASCE/SEI 7-05, Ch. 13 – Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise noted.

a. Horizontal Seismic Design Force F_p: Calculated by Delegated Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation:

(1) S_{DS} = Spectral Acceleration: Value applies to all components on Project.

(2) a_p = Component Amplification Factor: See Drawing Schedule for each component.

(3) I_p = Component Importance Factor: See Drawing Schedule for each component.

(4) W_p = Component Operating Weight: Obtain by Delegated Design Contractor for each component from component submittal.

(5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.

(6) z = Height in Structure of Point of Attachment of Component with Respect to Base: Determine by Delegated Design Contractor for each component from Project Drawings. For items at or below the base, "z" shall be taken as zero.

(7) h = Average Roof Height of Structure with Respect to Base: Determine by Delegated Design Contractor from Project Drawings.

b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.

c. Seismic Relative Displacement D_p: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:

(1) 8_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.

(2) 8_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.

(3) 8_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.

(4) h_x = Height of Level x to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.

(5) h_y = Height of Level y to Which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.

(6) A_{aA} = Allowable Story Drift for Structure A: See Drawing Schedule for each component.

(7) A_{aB} = Allowable Story Drift for Structure B: See Drawing Schedule for each component.

(8) h_{sx} = Story Height Used in the Definition of Allowable Drift A_a: See Drawing Schedule for each component.

C. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05, ASCE/SEI 7-10, and ASCE/SEI 7-16. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.

a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.

b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section.

2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations according to one of the following, as appropriate:

a. PART 1: Low-Rise Buildings

b. PART 2: Low-Rise Buildings (Simplified)

c. PART 3: Buildings with "h" less than 60 feet

d. PART 4: Buildings with "h" greater than 60 feet and less than 160 feet

e. PART 5: Open Buildings

D. Consequential Damage: Provide additional seismic and wind-load restraints for suspended communications components or anchorage of floor-, roof-, or wall-mounted communications components as indicated in ASCE/SEI 7-05, ASCE/SEI 7-10, and ASCE/SEI 7-16 so that failure of a non-essential or essential communications component will not cause failure of any other essential architectural, mechanical, or communications building component.

E. Fire/Smoke Resistance: Seismic- and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-

developed index of 450 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

F. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-05 Section 13.6, ASCE/SEI 7-10 Section 13.6, and ASCE/SEI 7-16 Section 13.6.

2.02 ELASTOMERIC ISOLATION PADS:

A. Manufacturers:

1. Ace Mounting Co., Inc.

2. California Dynamics Corporation

3. Isolation Technology, Inc.

4. Korfund

5. nVent (CADDY)

B. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.

C. Size: Factory or field cut to match requirements of supported equipment.

D. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.

E. Surface Pattern: Smooth, ribbed, or waffle pattern.

F. Infused nonwoven cotton or synthetic fibers.

G. Load-bearing metal plates adhered to pads.

H. Sandwich-Core Material: Resilient and elastomeric.

1. Surface Pattern: Smooth, ribbed, or waffle pattern.

2. Infused nonwoven cotton or synthetic fibers.

2.03 RESTRAINTS – RIGID TYPE:

A. Manufacturers:

1. Atkore International (Unistrut)

2. Eaton (B-line)

3. Hilti, Inc.

4. Isolation Technology, Inc.

5. nVent (CADDY)

B. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53 steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.04 RESTRAINTS – CABLE TYPE:

A. Manufacturers:

1. Atkore International (Unistrut)

2. Eaton (B-line)

3. Hilti, Inc.

4. Mason Industries, Inc.

5. nVent (CADDY)

B. Seismic- and Wind-Load-Restraint Cables: ASTM A1023 galvanized or ASTM A603 galvanized-steel ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.05 RESTRAINT ACCESSORIES:

A. Manufacturers:

1. Atkore International (Unistrut)

2. Eaton (B-line)

3. Hilti, Inc.

4. Mason Industries, Inc.

5. nVent (CADDY)

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.06 POST-INSTALLED CONCRETE ANCHORS:

A. Mechanical Anchor Bolts:

1. Manufacturers:

a. Atkore International (Unistrut)

b. Eaton (B-line)

c. Hilti, Inc.

d. Mason Industries, Inc.

e. Powers Fasteners

2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488.

B. Adhesive Anchor Bolts:

1. Manufacturers:

a. Atkore International (Unistrut)

b. Eaton (B-line)

c. Hilti, Inc.

d. Mason Industries, Inc.

e. Powers Fasteners

2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

C. Provide post-installed concrete anchors which have been prequalified for use in seismic applications. Post-installed concrete anchors must conform to all requirements of ASCE/SEI 7-05 Ch. 13, ASCE/SEI 7-10 Ch. 13, and ASCE/SEI 7-16, Ch. 13.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.

2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.07 CONCRETE INSERTS:

A. Manufacturers:

1. Atkore International (Unistrut)

2. Eaton (B-line)

3. Hilti, Inc

4. Mason Industries, Inc.

5. Power Fasteners

B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

C. Comply with MSS SP-58.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and equipment to receive seismic and wind-load control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS:

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static, wind-load, and seismic loads within specified loading limits.

3.03 INSTALLATION OF SEISMIC RESTRAINT AND WIND-LOAD CONTROL DEVICES:

A. Provide seismic restraint and wind-load control]devices for systems and equipment where indicated in Equipment Schedules or Communications Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

1. Install all equipment and devices to withstand the effects of earthquake motions and high wind events determined in accordance with ASCE/SEI 7-05 ASCE/SEI 7-10 ASCE/SEI 7-16.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00.

C. Installation of seismic and wind-load restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.

D. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

2. Install seismic-restraint and wind-load-restrain devices using methods approved by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

2. Install seismic-restraint and wind-load-restraint devices using methods approved by an evaluation service member of ICC-ES OSHPD or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

3. Comply with requirements in NFPA 70 and ASCE/SEI 7-16.

F. Equipment and Hanger Restraints:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction providing required submittals for component.

G. Install cables so they do not bend across edges of adjacent equipment or building structure.

H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

J. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION:

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.05 FIELD QUALITY CONTROL:

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Perform tests and inspections with the assistance of a factory-authorized service representative.

2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.

4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

5. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.

6. Test to 90 percent of rated proof load of device.

C. Remove and replace malfunctioning units and retest as specified above.

D. Seismic controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 27 05 53

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide identification for communications systems as indicated and in compliance with Contract Documents.

1. Underground-line warning tape

2. Signs

3. Bands and tubes

4. Cable ties

5. Miscellaneous identification products

6. Labels

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. Z535.1: Safety Colors

2. Z535.2: Environmental and Facility Safety Signs

3. Z535.3: Criteria for Safety Symbols

4. Z535.4: Product Safety Signs and Labels

B. ASTM International (ASTM):

1. D638: Standard Test Method for Tensile Properties of Plastics

2. D882: Standard Test Method for Tensile Properties of Thin Plastic Sheeting

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

D. Telecommunications Industry Association (TIA):

1. 606: Administration Standard for Telecommunications Infrastructure

E. Underwriters' Laboratories, Inc. (UL):

1. 94: Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

2. 969: Standard for Safety Marking and Labeling Systems

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.

C. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

D. Identification Schedule:

1. Outlets: Scaled drawings indicating location and proposed designation.

2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.

3. Racks: Scaled drawings indicating location and proposed designation.

4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Comply with NFPA 70 and TIA 606-B.

B. Comply with ANSI Z535.4 for safety signs and labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS:

A. Equipment Identification Labels:

1. Black letters on a white field.

2.03 LABELS:

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers:

a. Brady Corporation

b. Champion America

c. Emedco

d. HellermannTyton

e. Panduit Corp

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

1. Manufacturers:

a. Brady Corporation

b. HellermanTyton

c. Marking Services, Inc.

d. Panduit Corp.

e. Seton Identification Products; a Brady Corporation company

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester flexible labels with acrylic pressure-sensitive adhesive.

1. Manufacturers:

a. Brady Corporation

b. Emedco

c. Grafoplast Wire Markers

d. Ideal Industries, Inc.

e. Panduit Corp

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.

3. Marker for Labels:

a. Permanent, waterproof black ink marker recommended by tag manufacturer.

b. Machine-printed recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Manufacturers:

a. Brady Corporation

b. Emedco

c. HellermannTyton

d. Ideal Industries, Inc.

e. Panduit Corp

2. Minimum Nominal Size:

a. 1-1/2 by 6 inches for raceway and conductors.

b. 3-1/2 by 5 inches for equipment.

c. As required by authorities having jurisdiction.

2.04 BANDS AND TUBES:

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

1. Manufacturers:

a. Brady Corporation

b. HellermannTyton

c. Marking Services, Inc.

d. Panduit Corp

2.05 UNDERGROUND-LINE WARNING TAPE:

A. Manufacturers:

1. Brady Corporation

2. Brimar Industries, Inc.

3. Ideal Industries, Inc

4. LEM Products Inc.

5. Marking Services, Inc.

B. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

C. Color and Printing:

1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.

2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL-FIBER CABLE".

D. Tag, Nonconducting Polyolefin: Type I:

1. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

2. Width: 3 inches

3. Thickness: 4 mils

4. Weight: 18.5 lb/1000 sq. ft.

5. Tensile according to ASTM D882: 30 lbf and 2500 psi

E. Tag, Nonconducting Multilayer Laminate: Type II:

1. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

2. Width: 3 inches

3. Thickness: 12 mils

4. Weight: 36.1 lb/1000 sq. ft.

5. Tensile according to ASTM D882: 400 lbf and 11,500 psi

F. Tag, Detectable:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

2. Width: 3 inches

3. Overall Thickness: 5 mils

4. Foil Core Thickness: 0.35 mil

5. Weight: 28 lb/1000 sq. ft.

6. Tensile according to ASTM D882: 70 lbf and 4600 psi

G. Tag, Detectable, Reinforced:

1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

2. Width: 3 inches

3. Overall Thickness: 8 mils

4. Foil Core Thickness: 0.35 mil

5. Weight: 34 lb/1000 sq. ft.

6. Tensile according to ASTM D882: 300 lbf and 12,500 psi

2.06 SIGNS:

A. Baked-Enamel Signs:

1. Manufacturers:

a. Carlton Industries, LP

b. Champion America

c. Emedco

d. Marking Services, Inc

2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.

3. 1/4-inch grommets in corners for mounting.

4. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:

1. Manufacturers:

a. Brady Corporation

b. Champion America

c. Emedco

d. Marking Services, Inc

2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.

3. 1/4-inch grommets in corners for mounting.

4. Nominal Size: 10 by 14 inches.

C. Laminated-Acrylic or Melamine-Plastic Signs:

1. Manufacturers:

a. Brady Corporation

b. Carlton Industries, LP

c. Emedco

d. Marking Services, Inc

2. Engraved legend.

3. Thickness:

a. For signs up to 20 square inches., minimum 1/16 inch thick.

b. For signs larger than 20 square inches, 1/8 inch thick.

c. Engraved legend with black letters on white face white letters on a dark gray background.

d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting Self-adhesive.

e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.07 CABLE TIES:

A. Manufacturers:

1. HellermannTyton

2. Ideal Industries, Inc.

3. Marking Service, Inc.

4. Panduit Corp.

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 degrees F according to ASTM D638: 12,000 psi.

3. Temperature Range: -40 to +185 degrees F.

4. Color: Black, except where used for color-coding.

C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 degrees F according to ASTM D638: 12,000 psi.

3. Temperature Range: -40 to +185 degrees F.

4. Color: Black.

D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 degrees F according to ASTM D638: 7000 psi.

3. UL 94 Flame Rating: 94V-0.

4. Temperature Range: -50 to + 284 degrees F.

5. Color: Black.

2.08 MISCELLANEOUS IDENTIFICATION PRODUCTS:

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.02 INSTALLATION:

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.

G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

H. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

3. Provide label 6 inches from cable end.

I. Snap-Around Labels:

1. Secure tight to surface at a location with high visibility and accessibility.

2. Provide label 6 inches from cable end.

J. Self-Adhesive Wraparound Labels:

1. Secure tight to surface at a location with high visibility and accessibility.

2. Provide label 6 inches from cable end.

K. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

L. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

M. Underground-Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

2. Limit use of underground-line warning tape to direct-buried cables.

3. Install underground-line warning tape for direct-buried cables and cables in raceways.

N. Cable Ties: General purpose, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

3.03 IDENTIFICATION SCHEDULE:

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.

1. System legends shall be telecommunications.

D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:

1. Wiring closet designation.

2. Colon.

3. Faceplate number.

E. Equipment Room Labeling:

1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.

2. Patch Panels: Label individual rows in each rack, starting at top and working down, with self-adhesive labels. Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.

3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:

a. Room number being served

b. Colon

c. Faceplate number

F. Backbone Cables: Label each cable with a vinyl-wraparound label snap-around label self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

G. Horizontal Cables: Label each cable with a vinyl-wraparound label snap-around label self-adhesive wraparound label indicating the following, in the order listed:

1. Room number

2. Colon

3. Faceplate number

H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.

I. Instructional Signs: Self-adhesive labels.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels Baked-enamel warning signs Metal-backed, butyrate warning signs.

1. Apply to exterior of door, cover, or other access.

K. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label Baked-enamel signs Metal-backed butyrate signs Laminated-acrylic or melamine-plastic sign.

2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.

3. Equipment to be Labeled:

a. Communications cabinets.

b. Uninterruptible power supplies.

c. Computer room air conditioners.

d. Fire-alarm and suppression equipment.

e. Egress points.

f. Power distribution components.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide communications equipment room fittings as indicated and in compliance with Contract Documents.

1. Backboards.

2. Boxes, enclosures, and cabinets.

3. Power strips.

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 7: Seismic Loads: Guide to the Seismic Load Provisions

B. Building Industry Consulting Service International (BICSI):

1. ITSIMM: Information Technology Systems Installation Methods Manual

2. TDMM: Telecommunications Distribution Methods Manual

C. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

D. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

2. FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

3. OS 1: Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

4. OS 2: Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports

5. WD 6: Wiring Devices – Dimensional Specifications

E. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

F. Telecommunications Industry Association (TIA):

1. 569-D: Telecommunications Pathways and Spaces

G. Underwriters' Laboratories, Inc. (UL):

1. 50: Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations

2. 514A: Standard for Safety Metallic Outlet Boxes

3. 514C: Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

4. 1363: Standard for Safety Relocatable Power Taps

5. 1449: Standard for Safety Surge Protective Devices

6. 1773: Standard for Safety Termination Boxes

1.03 DEFINITIONS:

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. RCDD: Registered communications distribution designer.

D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

E. TGB: Telecommunications grounding bus bar.

F. TMGB: Telecommunications main grounding bus bar.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.

3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

D. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

E. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.

2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this section is performed at Project site.

3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 Telcordia GR-63-CORE requirements for Zone 4 Seismic Earthquake Environments.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.02 BACKBOARDS:

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

B. Backboard Paint: Pre-painted light-colored fire-retardant paint, light-colored interior latex paint.

2.03 BOXES, ENCLOSURES, AND CABINETS:

A. Manufacturers:

1. Adalet

2. Eaton (Crouse-Hinds)

3. FSR Inc

4. nVent (Hoffman)

5. Plasti-Bond

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, ferrous alloy or aluminum, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum galvanized cast iron with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 Type 3R Type 4 Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Nonmetallic Enclosures: Plastic Fiberglass.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:

1. NEMA 250, Type 1 Type 3R Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.04 POWER STRIPS:

A. Comply with requirements in Section 27 11 16.

B. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Rack mounting, with detachable integral flanges.

3. Height: 1 RU.

4. Housing: Metal.

5. Six, 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.

6. Front Rear-facing receptacles.

7. LED indicator lights for power and protection status.

8. LED indicator lights for reverse polarity and open outlet ground.

9. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.

10. Close-coupled, direct plug-in Cord connected with 15-foot line cord.

11. Rocker-type on-off switch, illuminated when in on position.

12. Surge Protection: UL 1449, Type 3.

    a. Maximum Surge Current, Line to Neutral: 27 kA 72 kA.

    b. Protection modes shall be line to neutral, line to ground, and neutral to ground.

    c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be 600 V and 500 V for neutral to ground.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES:

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 27 05 28 for materials and installation requirements for underground buried aerial pathways.

3.02 INSTALLATION:

A. Comply with NECA 1.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.

1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.

2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.

4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Backboards:

1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.

2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.

3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.03 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS:

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 44.

3.04 FIRESTOPPING:

A. Comply with requirements in Section 07 84 00.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices".

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 27 11 16

COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide communications racks, frames and enclosures as indicated and in compliance with Contract Documents.

1. 19-inch freestanding and wall-mounted equipment cabinets

2. Power strips

3. Grounding

4. Labeling

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE):

1. 7: Seismic Loads: Guide to the Seismic Load Provisions

B. ASTM International (ASTM):

1. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process

C. Building Industry Consulting Service International (BICSI):

1. ITSIMM: Information Technology Systems Installation Methods Manual

2. TDMM: Telecommunications Distribution Methods Manual

D. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

2. 607: Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

E. National Electrical Manufacturers Association (NEMA):

1. WD 6: Wiring Devices – Dimensional Specifications

F. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

G. Telecommunications Industry Association (TIA):

1. 606-B: Administration Standard for Telecommunications Infrastructure

H. Underwriters' Laboratories, Inc. (UL):

1. 467: Standard for Safety Grounding and Bonding Equipment

2. 969: Standard for Safety Marking and Labeling Systems

3. 1363: Standard for Safety Relocatable Power Traps

4. 1449: Standard for Safety Surge Protective Devices

1.03 DEFINITIONS:

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. TGB: Telecommunications grounding bus bar.

G. TMGB: Telecommunications main grounding bus bar.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.

2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

C. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.

3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

D. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

E. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 Telcordia GR-63-CORE requirements for Zone 4 Seismic Earthquake Environments.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. UL listed.

C. RoHS compliant.

D. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.02 BACKBOARDS:

A. Backboards: Plywood, fire-retardant treated, 3/4 inch by 48 inches by 96 inches.

2.03 19-INCH EQUIPMENT CABINETS:

A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.

B. Manufacturers:

1. CommScope, Inc.

2. Great Lakes Data Racks & Cabinets

3. Hammond Manufacturing

4. Leviton Manufacturing Co., Inc.

C. General Cabinet Requirements:

1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

2. Material: Extruded steel Extruded aluminum Sheet steel Sheet aluminum.

3. Finish: Manufacturer's standard, baked-polyester powder coat.

4. Color: Black

D. Modular Freestanding Cabinets:

1. Overall Height: 84 inches

2. Overall Depth: 23 inches

3. Load Rating: 3300 pounds

4. Number of Rack Units: 48

a. Numbering: Every rack unit, on interior of rack.

5. Threads: 12-24

6. Removable and lockable side and top panels.

7. Hinged and lockable front and rear doors.

8. Adjustable feet for leveling.

9. Screened ventilation openings in roof and rear door.

10. Cable access provisions in roof and base.

11. TGB.

12. Rack mounted, 550-cfm fan with filter.

13. Power strip.

14. All cabinets keyed alike.

E. Cable Management:

1. Metal, with integral wire retaining fingers.

2. Baked-polyester powder coat finish.

3. Vertical cable management panels shall have front and rear channels, with covers.

4. Provide horizontal crossover cable manager at top of each relay rack, with a minimum height of two rack units each.

2.04 POWER STRIPS:

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Rack mounting.

3. Six 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.

4. LED indicator lights for power and protection status.

5. LED indicator lights for reverse polarity and open outlet ground.

6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and supply of power is lost, circuit can be manually reset when fault is cleared.

7. .

8. Close-coupled, direct plug-in Cord connected with 15-foot line cord.

9. Rocker-type ON-OFF switch, illuminated when in ON position.

10. Peak Single-Impulse Surge Current Rating: 13 kA per phase.

11. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.05 GROUNDING:

A. Comply with requirements in Section 27 05 26 for grounding conductors and connectors.

B. Manufacturers:

1. Chatsworth Products, Inc.

2. Harger Lightning & Grounding

3. Panduit Corp

C. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.

2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

3. Rack-Mounted Vertical TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

2.06 LABELING:

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.

1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.

2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.

4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.02 GROUNDING:

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Chapter.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.03 IDENTIFICATION:

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 27 05 53.

B. Comply with requirements in Section 09 90 00 for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 3 level of administration, including optional identification requirements of this standard.

D. Labels shall be machine printed. Type shall be 3/16 inch in height.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 27 13 23

OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide fiber optic cables as indicated and as specified.

B. Fiber optic cables shall be provided for use with plant-wide systems, including the following: distributed control system; the fire detection and alarm system; the security access and surveillance system; and the telephone and paging system.

C. Provide fiber optic patch panels, splice closures, terminal connectors and ancillary equipment.

D. Provide fiber optic pull boxes based on fiber optic cable with a maximum allowable pulling tension of 600 pounds. Provide calculations for pulling with innerduct shop drawing submittal.

E. Provide innerduct, distribution pedestals, terminal connectors and ancillary equipment needed for a complete installation.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. TIA-568C: Generic Telecommunications Cabling for Customer Premises

2. TIA/EIA 598-C: Optical Fiber Cable Color Coding.

3. TIA/EIA 606-A: Administration Standard for Commercial Telecommunications Infrastructure

B. Insulated Cable Engineers Association, Inc. (ICEA):

1. S-104-696: Standard for Indoor-Outdoor Optical Fiber Cable.

C. International Electrical Testing Association (NETA):

1. ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

E. Underwriters Laboratories, Inc. (UL):

1. 94: Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

2. 1666: Standard for Safety Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.

1.03 DEFINITIONS:

A. OFNR: Nonconductive optical fiber riser cable

B. OFCR: Conductive optical fiber riser cable

C. FOTP: Fiber Optic Test Procedure

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Installer Qualifications - Include resumes of staff and previous project experience with references. Proposed Products List.

2. Outline drawings of termination cabinets showing dimensions, cables, jumpers and associated hardware for termination.

3. Provide written confirmation that product is to be submitted as acceptable to control systems supplier.

4. For each component and material submit shop drawing which shall include:

a. Manufacturer

b. Model number

c. General data and description

d. Engineering specifications and data sheets

e. Catalog cuts

f. For information purposes only, submit manufacturer’s printed installation instructions.

B. Submit a drawing showing the routing for the fiber optic network. Include the following information:

1. Routing, length, and attenuation based on TIA-568-C.

2. Cable and conduit identification.

3. Locations of maintenance holes, pull boxes, pedestals and patch panels.

C. Test Documentation:

1. Document results of tests (shop test, field test, acceptance test) and submit copies of documents to Engineer as tests are completed.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Fiber optic cables and related equipment shall be the products of approved manufacturers. Fabrication of the fiber optic cables and related equipment shall utilize the most advanced commercial materials and manufacturing processes. Manufacturer shall be ISO 9001 and TL-9000 certified.

C. Fiber optic cable installation shall be performed by experienced fiber optic cable installers who shall have been regularly engaged in the installation of fiber optic cables for the last five years at the minimum. The installer shall be MDIS certified with current qualifications provided by the fiber optic cable manufacture.

D. Fiber optic cable splicing and terminations shall be performed by experienced cable splicers who shall have been regularly engaged in splicing and termination of fiber optic cables for the last five years at the minimum.

E. Provide the services of the fiber optic cable manufacturer's technical representative to certify that the fiber optic cable installation is in accordance with the manufacturer's installation requirements.

F. Provide the services of an independent testing firm who shall perform acceptance testing of the fiber optic cable installation. The testing firm shall have experience in the inspection and testing of cables of the specified type and shall be a member company of NETA.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with APWA Section 01 66 00 and as specified.

1.07 EQUIPMENT IDENTIFICATION:

A. Each fiber shall be labeled at each termination point and all splice location. Conductor or circuit identification shall be applied at specified points with circuit numbers or other identification stamped on terminal boards when provided, or on the cable itself in such a manner that the identification is visible around the cable's circumference.

B. Each fiber shall be identified in junction boxes, pull boxes, maintenance holes, handholes, terminal boxes, and cabinets. Where no termination is made, use a plastic-coated, self-adhesive, wire marker. Where termination is made, use a plastic, pre-printed sleeve wire marker. Paper self-adhesive wire markers are not acceptable.

1.08 WARRANTY:

A. The Contractor shall be a manufacturers' certified installer and shall provide a five-year extended warranty program; and shall also provide written warranty certification and evidence of current program membership.

B. The Contractor shall warrant that all materials and equipment furnished under the contract are in good working order, free from defects, and in conformance with system specifications. All installed equipment shall conform to the manufacturer's official published specifications. The warranty shall begin at the system acceptance date and remain in effect for a period of five years from that date. The Contractor shall agree to repair, adjust, and/or replace (as determined by the Engineer to be in its best interest) any defective equipment, materials, or other parts of the system at the Contractor's sole cost. The Owner will incur no costs for service or replacement of parts during the warranty period of five years. All third party warranties shall be passed through from the Contractor to the Owner.

C. The Contractor shall warrant and supply evidence that the installation of materials and hardware will be made in strict compliance with all applicable provisions of the National Electrical Code (NEC), the rules and regulations of the Federal Communications Commission, and state and/or local codes or ordinances that may apply.

D. The Contractor shall warrant that the system will function in accordance with the manufacturer's published technical description guide.

E. The Contractor shall warrant that the system shall accommodate traffic at the levels specified in the Specification.

1.09 SPARE PARTS:

A. Furnish two spare connectors for each type used.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Corning Cable Systems

B. Belden

C. Draka

D. OFS Fiber

2.02 FIBER OPTIC CABLE:

A. Single Mode Fiber Optic Cable:

1. Provide indoor/outdoor tight-bound tight-buffered fiber optic cable. Provide gel-free and powder-free tight-buffered water-block cable. Provide cable fiber count as indicated on the drawings. Provide cable that shall pass the TIA-455-83B water-block test for 48 hours.

2. Provide Singlemode fiber optic cable as specified and as shown on the contract drawings.

3. Provide optical fiber proof tested by the fiber manufacturer at a minimum of 100 kpsi.

4. Provide fiber that meets the following minimum specifications in 12 fiber subgroups as:

Feature Performance	Specification Requirement
Fiber Type	Singlemode
Core Diameter	8.3µm
Cladding Diameter	125 µm
Secondary Buffer Diameter	900 µm
Wavelength	1310 nm
Gigabit Ethernet Distance	5 km
Max Attenuation	0.5 dB/km
Cable Diameter	~15 mm (30 fiber count)
Installation:	
Max Tensile Load	~5600 N
Min Bend Radius	~23 cm
Operating:	
Max Tensile Load	~2400 N
Min Bend Radius	~23 cm
Operating Temperature	-40 degrees C to +85 degrees C
Installation Temperature	-10 degrees C to + 60 degrees C
Flame Retardancy	UL Listed Type OFNR

B. Fiber Optic Non-Breakout Cable:

1. Heavy duty, tight buffer construction with additional strength members, and a oil, water, and chemical resistant, UV stabilized, flame retardant, PVC outer jacket, UL listed OFNR. Fiber cladding shall be 125 micron and fiber buffer shall be 900 micron.

2. Cable Specifications:

   a. Fiber Count: 12 or as indicated on the drawings

   b. Minimum Installation Load: 100 pounds

   c. Minimum Long Term Application Load: 14 pounds

   d. Minimum Crush Resistance: 80 pounds per /inch

   e. Operating Temperature: 14 to 122 degrees F

C. Code Compliance:

1. The cable must meet the requirements of the National Electrical Code (NEC) Section 770.

2. Non-Plenum Applications: Applicable Flame Tests: UL 1666. All-dielectric cables shall be listed OFNR. Armored cables and Interlocking armored cables shall be listed OFCR.

3. Finished cables shall conform to the applicable performance requirements of the Insulated Cable Engineers Association, Inc. (ICEA) Standard for Indoor-Outdoor Optical Fiber Cable (ICEA S-104-696).

D. Fiber Specifications:

1. General Fiber Specifications:

   a. All fibers in the cable must be usable and meet required specifications.

   b. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

   c. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi.

   d. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

E. Cable Construction:

1. Tight Buffer Fiber Optic Cable: Cladded Optic fiber strands shall be coated with a 900 microns protective coating and arranged in a PVC subcable containing 12 coated fiber strands surrounded by yarn strength members. Subcables are contained within a PVC outer jacket. The number of strands specified on the drawings will determine the number of Subcables.

2. Fiber Optic Cable Core: A central, nonmetallic core member shall be included to serve as a cable core foundation to reduce strain on the fibers, but not to serve as a pulling strength member. Fillers shall be used to ensure cable has a circular shape. Fiber optic cable and subcables shall have a rip cord.

3. Each buffer tube shall contain up to 12 fibers.

4. The fibers shall not adhere to the inside of the buffer tube.

5. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-C, “Optical Fiber Cable Color Coding."

6. The fibers shall be colored with ultraviolet (UV) curable inks. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature ranges, and not subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

7. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-C, “Optical Fiber Cable Color Coding.” Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 0.04 inch. For dual layer buffer tube construction cables, standard colors are used for tubes 1 through 12 and standard colors with stripes are used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only, and shall begin with the first tube. The tube color sequence shall start from the inside layer and progress outward.

8. The buffer tubes shall be resistant to kinking.

9. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

10. The tensile strength shall be provided by the central member, and additional dielectric yarns. The dielectric yarns shall be helically stranded evenly around the cable core.

11. A flame-retardant tape may be applied to provide additional resistance to flame propagation for higher fiber count cables.

12. Cables shall be sheathed with flame-retardant polyvinyl chloride (PVC). The nominal jacket thickness shall be 0.08 inch. Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The PVC shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

13. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable.

14. Cable jackets shall be marked with the manufacturer's name or file number, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code (NESCÒ), fiber count, and fiber type, flame rating and listing marking. The actual length of the cable shall be within plus or minus 1 percent of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 0.1 inch.

15. If the initial marking fails to meet the specified requirements (i.e., improper text statement, color, legibility, or print interval), the cable may be remarked using a contrasting alternate color. The numbering sequence will differ from the previous numbering sequence, and a tag will be attached to both the outside end of the cable and to the reel to indicate the sequence of remarking. The preferred remarking color will be yellow, the secondary choice will be blue.

16. The maximum pulling tension shall be 600 pounds during installation (short term) and 135 pounds long-term installed.

17. The cable specified herein shall be available in three sheath designs. Un-armored, all-dielectric cables shall be listed OFNR and shall be as described previously in this section.

18. Armored cables shall be as described previously in this section, but shall also include a corrugated steel tape armor applied longitudinally underneath the cable jacket. The armor shall be plastic-coated on both sides for corrosion resistance and shall have an overlapping seam with the corrugations in register. Because of the metallic armor, this cable shall be listed OFCR and shall provide improved resistance to rodent damage. The corrugated armor option will be specified on the purchase order.

19. Interlocking armored cables shall be as described previously in this section but shall also include an interlocking steel or aluminum armor applied helically around the outside of the cable jacket. The interlocking armor may be left un-jacketed or may have a PVC outer jacket. The color of the armor jacket (if specified), shall match the jacket color of the optical fiber cable located inside of the armor. The armor for these cables shall be comparable to liquid tight flexible metal conduit if jacketed, or flexible metal conduit if not jacketed. Because of the interlocking metallic armor, this cable shall be listed OFCR and shall provide improved resistance to crush damage. The interlocking armor and outer jacket options will be specified on the purchase order.

F. Packing and Shipping:

1. The completed cable shall be packaged for shipment on non-returnable wooden reels. Required cable lengths shall be stated in the purchase order.

2. Top and bottom ends of the cable shall be available for testing.

3. Both ends of the cable shall be sealed to prevent the ingress of moisture.

4. Each reel shall have a weather resistant reel tag attached identifying the reel and cable.

5. Each cable shall be accompanied by a cable data sheet.

2.03 INNERDUCT:

A. Manufacturers:

1. Carlon

2. Endot

3. A-D Technologies

B. Features:

1. Innder duct shall be used for fiber optic installations in conduit 2 inches and lager.

2. Inner duct shall be minimum 1 inch and shall be sized properly for the fiber optic cable.

3. Inner duct shall be orange, ribbed, riser rated and UL listed.

4. System shall include:

a. Innerduct

b. Gasketing that allows watertight assembly and disassembly of outer and innerducts for direct buried and encased installations.

c. Couplings, access hole terminators, innerduct seals for both empty and cabled ducts, and fixed and flexible bends.

2.04 TERMINAL CONNECTORS:

A. Manufacturers:

1. Corning Cable Systems

2. AFL Telecommunications

3. 3M Telecom Systems Group

B. Field installable SC type fiber optic connectors, with ceramic ferrule material and a maximum insertion loss of 0.5 dB. If Pre-Connectorized cable assemblies or pigtails are used, the connectors shall terminate on a 10-foot length single-fiber cable. The fiber-cable shall contain a buffered optical fiber of the same type and specification as that used in the multi-fiber cable. Connectors and pre-connectorized cable assemblies or pigtails shall be in accordance with EIA ANSI/TIA/EIA-568-B.3.

2.05 OPTICAL HARDWARE:

A. Manufacturers:

1. Corning Cable Systems

2. 3M Telecom Systems

3. AFL Telecommunications AMP

4. OCC

B. Optical Splicing and Distribution Enclosure:

1. Provide pedestal type enclosure.

2. Provide NEMA 3 fiber enclosure.

3. Provide pedestal mounted on precast concrete base with bollard type traffic protection.

4. Provide splicing and distribution enclosure to support up to 240 single mode fibers.

5. Provide distribution hub within pedestal. Provide hub with grommet seal. Provide cable strain relief system.

C. Connector Panels: Rack and wall mountable connector housings shall accept an interchangeable connector panel. A connector panel is defined as a modular removable plate containing optical fiber connector adapters or copper jacks. The connector panel shall have the following characteristics:

1. The connector panel shall utilize a single mounting footprint and shall be available with three, four, six, eight or twelve connector adapters in each panel. Copper jack panels shall accept up to four copper jacks. The connector panel shall be interchangeable between the rack and wall mountable hardware being proposed. The panel shall be attached with two push-pull latches to allow quick installation and removal.

2. The connector panel shall be available with industry standard single fiber and small form factor multi-fiber adapters, including the SC duplex, ST compatible, SC-DC and MT-RJ. It shall also be available with industry standard copper jacks.

3. The connector panel shall include removable icons that identify the circuits. As a minimum, these icons shall be available with the following symbols: blank, telephone, computer, CATV, video camera, satellite dish, or CAT5. The icons shall also be available in a variety of colors, including blue, yellow, red, white, electric ivory, ash, green, purple, gray, black, brown and orange.

4. Blank connector panels shall be available to fill unused space within the housings. The blank connector panel shall be attached with at least two push-pull latches to allow quick installation and removal. Housings shall be supplied with blank connector panels for all available positions unless the housing is ordered with optical fiber adapters or copper jacks pre-installed. The blank panels shall be manufactured from injection molded polycarbonate and shall be finished with a wrinkled black texture to match the housing.

5. Panels shall be manufactured from 16 gage cold rolled steel or injection molded polycarbonate for structural integrity.

6. Panels shall be finished with a wrinkled black texture to match other hardware.

D. Connector Modules: Rack mountable connector housings shall accept an interchangeable connector module. A connector module is defined as a modular removable case containing optical fiber connector adapters and provisions for strain-relief, slack storage, and the furcation of fiber optic cables. The connector module shall have the following characteristics:

1. The connector module shall consist of a panel incorporated into a protective case with a removable cover for access to the interior connectors and fibers. Modules shall contain a fiber-retaining spool for managing fiber slack.

2. The connector module shall utilize a single mounting footprint and shall be available with three, four, six, eight or twelve connector adapters in each module. The module shall be attached with two push-pull latches to allow quick installation and removal.

3. The connector module shall be available with industry standard single fiber and small form factor multi-fiber adapters, including the SC duplex, ST compatible, and MT-RJ.

4. The connector module shall include removable icons that identify the circuits. As a minimum, these icons shall be available with the following symbols: blank, telephone, computer, CATV, video camera, satellite dish, or CAT5. The icons shall also be available in a variety of colors, including blue, yellow, red, white, electric ivory, ash, green, purple, gray, black, brown and orange.

5. Modules shall be manufactured from 16 gage cold rolled steel or injection molded polycarbonate (or thermoplastic resin) for structural integrity.

6. Modules shall be finished with a wrinkled black texture to match other hardware.

7. Modules shall be available in the following configurations: adapter modules, pigtailed modules, and pre-terminated system modules.

E. Rack Mountable Connector Housings: Rack mountable connector housings shall be available for cross-connecting or inter-connecting purposes. The units shall provide for direct connectorization and pigtail splicing.

1. The unit shall meet the design requirements of ANSI/TIA/EIA-568 and the plastics flammability requirements of UL 94 V-0.

2. Housings shall be manufactured using 16 gage aluminum or equivalent for structural integrity and shall be finished with a wrinkled black powder coat for durability. Installation fasteners shall be included and shall be black in color.

3. The unit shall have routing guides that allow a transition and segregation point for jumpers exiting the sides of the housing.

4. The unit shall include a clamshell-type cable clamping mechanism to provide cable strain relief. The cable clamp shall accept one cable from 0.37 to 1.13 inch in diameter. The cable clamp mechanism shall also handle multiple smaller fiber count cables when used with the multiple cable insert. The total cable capacity per clamp shall be five cables less than 0.4 inch OD when used with the multiple cable insert.

5. The connector housings shall have a labeling scheme that complies with ANSI/TIA/EIA 606.

6. Provisions for mounting fiber fan-out devices shall be incorporated into the housing.

7. The housings shall be available with factory installed connectorized cable stubs in multiple cable and connector types.

F. Wall Mountable Combination Connector/Splice Housings: Wall mountable combination connector and splice housings shall be available for splicing inside the same housing as the connectorized fiber. These combination units shall be the units described in the previous section for wall mountable connector housings; additionally they shall contain provisions for mounting splice trays and routing the associated fibers.

1. Splice tray mounting shall allow individual splice tray access without disturbing adjacent splice trays or fibers.

2. Splice tray shall be retained in the splice tray holder by a hook and loop strap.

3. Access to splice trays shall be accomplished by rotating the splice tray holder horizontally from the housing.

4. Wall mountable connector housings shall be convertible to combination connector/splice housings with the installation of a splice tray conversion kit.

G. Wall Mountable Splice Housings: Wall mountable splice housings shall be available for splicing multiple optical fiber cables. These units shall contain provisions for mounting splice trays and routing the associated fibers.

1. Splice tray mounting shall allow individual splice tray access without disturbing adjacent splice trays or fibers.

2. Splice trays shall be retained in the splice tray holder by a hook and loop strap.

3. Cable ports in the splice housing shall line up with the cable and jumper ports in the appropriate wall mountable connector housing so as to allow direct routing of cables and jumpers from one housing into the other.

4. Wall-mountable splice housing shall accept splice trays for industry standard splice types and store routing slack for these trays.

5. The unit shall be mountable on standard plywood walls.

6. The housing shall not exceed the following dimensions:

   a. 13.5 inch high x 22.5 inch wide x 5.1 inch deep.

7. The unit shall meet the design requirements of ANSI/TIA/IEA-568 and the plastics flammability requirements of UL 94 V-0.

8. Housing shall be manufactured using 16 gage aluminum or equivalent for structural integrity and shall be finished with a wrinkled black powder coat for durability. Assembly hardware and equipment attaching machine screws shall be included and shall be black in color.

9. The unit shall have fiber cable routing guides that allow a transition and segregation point for fibers existing the top and bottom of the housing. Cable entries shall be grommeted to minimize dust/water intrusion.

10. The unit shall accept a clamshell type cable clamping mechanism to provide cable strain relief. This clamp shall be included with the housing and also shall be available with an external mounting bracket as an optional accessory. The cable clamp shall accept one cable from 0.37 to 1.13 inch in diameter. The cable clamp mechanism shall also handle multiple smaller fiber count cables when used with the multiple cable insert. The total cable capacity per clamp shall be five cables less than 0.4 inch OD when used with the multiple cable insert. Housing cable clamp capacity shall e at least four clamps.

11. The splice housing shall have a metal door. This door shall be lockable when used with an optional key lock kit.

12. The splice housings shall have a labeling scheme that complies with ANSI/TIA/EIA 606.

13. Brackets shall be available that allow rack mounting of the wall-mount housings.

14. An optional offset bracket kit shall be available that allows mounting the housing away from the wall to give space for cable routing behind the unit. The offset brackets shall be stackable to allow incremental increase in the amount of offset from the wall.

H. Wall Mount Jumper Management: Wall mountable housings shall have an optional external means available to transition between the housing and nearby cable trough or tray. This means shall provide 1.5 inch minimum bend radius protection for cables.

2.06 SPLICE CLOSURES:

A. Manufacturers:

1. Corning Cable Systems

2. 3M Telecom Systems

3. AFL Telecommunications

B. Splice Closures: Constructed of thermoplastic, suitable for “butt” or “through” cable entry, moisture tight sealing arrangement, removable splice tray organizer, splice trays for mechanical splices, suitable for multimode system operation at 850 and 1,300 nm, grounding lugs or equivalent for grounding cable armor.

1. The optical fiber splice closure shall meet all requirements stated in this specification.

2. The splice closure housing shall be non-metallic. It shall be resistant to solvents, stress cracking, and creep. The housing materials shall also be compatible with chemicals and other materials to which they might be exposed in normal applications.

3. The optical fiber closure shall be capable of accepting any optical fiber cable used in interoffice, outside plant, and building entrance facilities.

4. As an option, the ability to double the cable capacity of an installed canister splice closure by use of a kit shall be available. Such a conversion shall not disturb existing cables or splices.

5. Encapsulation shall not be required to resist water penetration.

6. The splice closure shall be re-enterable. The closure end cap shall be capable of accepting additional cables without removal of the sheath retention or strength member clamping hardware on previously installed cables or disturbing existing splices. The optical fiber splice closure shall provide a clamping mechanism to prevent pistoning of the central member or strength members and to prevent cable sheath slip or pullout.

7. The splice closure shall have appropriate hardware and installation procedures to facilitate the bonding and grounding of metal components in the closure and the armored cable sheath. The cable bonding hardware shall be able to accommodate a copper conductor equal to or larger than a 6 AWG.

8. Aerial splice closures shall have available the necessary hardware to attach and secure the closure to an aerial strand.

9. The closure shall accommodate splice trays suitable for single fiber, single fiber heat shrink, mechanical, or ribbon heat shrink splices.

10. The small splice closure shall accommodate up to 72 single fiber splices or 144 ribbon fiber splices using 12-fiber ribbons. The medium sized closure shall accommodate up to 288 single fiber splices or 432 ribbon fiber splices. The large closure shall accommodate up to 480 single fiber splices or 864 ribbon fiber splices.

11. Spliced fibers shall not be subjected to a bend radius smaller than 1.2 inch. Buffer tubes shall not be subjected to a bend radius smaller than 1.5 inch.

12. The installation of the splice closure shall not require specialized tools or equipment, other than those normally carried by installation crews.

2.07 SHOP TESTS:

A. Fiber optic cables shall be shop tested at the manufacturer's plant in accordance with the manufacturer's standard testing procedures. Shop tests shall be performed prior to shipment of the fiber optic cables.

B. Provide test plan defining all tests required to ensure that the system meets specified requirements. The test plan shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plan shall identify the capabilities and functions to be tested.

C. Provide test reports in booklets form showing all field tests performed shall be submitted no later than 7 days after completion and testing of the installed system.

D. Measurements shall be tabulated on a strand-by-strand basis.

E. Factory test results showing routine tests performed by the manufacturer shall be submitted prior to installation.

F. Optical fibers in cables shall be 100 percent attenuation tested. The attenuation shall be measured at 850 nm and 1300 nm for multimode fibers. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode fibers. The manufacturer shall store these values for a minimum of five years. These values shall be available upon request.

G. The Contractor shall submit manufacturer's shop test reports.

PART 3 - EXECUTION

3.01 GENERAL:

A. Provide all material, equipment, and labor to install the fiber optic cables as indicated and as specified.

B. Installation shall be in accordance with the National Electrical Code and all local codes.

3.02 INSTALLATION:

A. Install cables in accordance with manufacturer's printed instructions.

B. Install cable directly from shipping reels. Ensure that cable is not:

1. Dented, nicked, or kinked.

2. Subjected to pull stress greater, or bend radius less, than manufacturer's specification.

3. Subjected to treatment which may damage fiber strands during installation.

C. Conduit: Install fiber optic cable directly in conduit/innerduct.

D. Identification: Identify each cable on both ends and in all maintenance holes and pull points it goes through.

E. Sequencing: Provide cables in accordance with sequencing requirements.

F. Sealing: Seal cables into innerducts to stop ingress of water and grit with expansion plugs or ductseal.

G. Maintenance Holes:

1. Provide supports for cables at maximum 12 inch centers along sides of maintenance holes.

2. Provide a minimum 4 foot coil of spare fiber in each maintenance hole throughout the cable length.

H. Install fiber optic cables in underground ducts. Rod and swab out ducts prior to installing cables.

I. Install fiber optic cables in the conduit systems provided inside buildings and structures.

J. Lubricate cables with lubricants specially formulated for fiber cabling jackets during installation. Do not exceed cable manufacturer's specifications for tensile strength and bending radius. All pulleys used to aid in the installation of the fiber optic cable must be sized according to the minimum bending radius.

K. Provide breakout kits, splice closures, patch panels, pigtails, and jumpers and as indicated to install a complete data highway communications network as indicated. Patch panels shall be wall mounted plumb and level. Splice closures shall be installed in pullboxes.

L. Splices: Splices shall be made only where indicated. Provide adequate put-up lengths on cable reels to make termination-to-termination runs without splices. Where splices are indicated provide mechanical splices with attenuation losses of 0.3 dB or less. Make splices watertight and provide mechanical protection equal to the cable jacket, or better.

M. Support cables in riser conduits at intervals as required by the National Electrical Code.

N. Installation tools and materials shall be provided by the cable manufacturer.

O. The polishing process of terminal connectors shall be a multi-stage dry and wet process using multiple lapping films for initial and final polishing polish.

3.03 CABLE TERMINATIONS:

A. Terminate cables in accordance with ANSI/TIA 568.

B. Fan out fibers to allow flexibility and ease of installations for future expansion at connection points. Provide a metal or high density plastic fan-out collar to relieve the stress on the individual fibers. To protect the individual fibers, provide sleeves from the fan-out collar to the terminal point. Terminate all fibers in each cable with a suitable connector as specified below.

C. Fiber connectors shall be bayonet-type with "twist-lock" mounting for quick and secure installation. Connectors shall be pull-proof with a durable ceramic tip to protect the fibers from damage during installation and frequent rearrangements. "Push-pull" couplings are unacceptable. Provide a sample of the connector to the Engineer for inspection and acceptance prior to installation.

D. Provide all equipment, mounting kits and consumable materials required for a proper installation as defined by the manufacturer.

E. Each individual cable shall be clearly and uniquely identified. At a terminal cabinet or backboard provide a type written directory listing the cable, identification code and type of signal. The directory shall be mounted within the termination cabinet or on the backboard and protected by a clear plastic cover.

F. Provide a minimum of 20 feet of neatly coiled, slack fiber optic cable at each terminal cabinet or backboard for flexibility.

3.04 MAINTEINANCE HOLES, INTERMEDIATE PULL BOXES AND DISTRIBUTION PEDESTALS:

A. Provide pull boxes and maintenance holes so the fiber pulling requirement is at least 5 percent below the manufacturers pulling strength recommendations. Provide pulling procedures as part of the fiber installation submittal requirements:

B. Provide plans showing proposed pull boxes, maintenance holes and distribution pedestals.

C. Provide distribution pedestal at the beginning and end point of the contract installation.

D. Provide fiber testing from the contract endpoint distribution pedestals.

3.05 PHYSICAL CHECKOUT:

A. General Procedures:

1. Conduct physical checkout of the fiber optic data highway network.

2. Physical checkout shall be performed prior to functional testing.

B. Check Procedures:

1. Verify that fiber optic cables reels have been off-loaded from truck carefully and not damaged.

2. Verify that the optical fibers of the cable assembly are the type and quantity as specified or as recommended by the Instrument and Controls supplier.

3. Verify that cable construction is the type specified.

4. Verify that fiber optic patch panels have been installed plumb and level at locations indicated.

5. Verify that fiber optic splice closures have been installed at locations indicated.

6. Verify that optical fiber connections or terminations within patch panels and splice closures are in accordance with cable manufacturer's printed recommendations.

3.06 FIELD TESTING:

A. Conduct the following field tests after cable installation:

1. Visually, inspect terminal connectors for out-of-round condition and surface defects such as micro-chips and cracks using a 100X (minimum) inspection microscope.

B. Cable Testing:

1. Provide equipment, instrumentation, and supplies necessary to perform testing. Engineer and Owner shall have the option to witness and participate actively in on-site tests.

a. Notify Engineer and Owner at least 3 days prior to testing.

2. Perform all tests and inspections as required by NETA ATS, paragraph 7.25.

3. Post-Installation Testing: Demonstrate that all fibers in each cable meet requirements of TIA-568 as modified here:

a. Maximum attenuation as specified.

b. Measure attenuation in both directions, not in one direction only.

4. Replace all cables or mated connector pairs that do not meet attenuation standards and redo tests until cable meets requirements and at no additional cost to the Owner.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 27 13 43

COMMUNICATIONS SERVICES CABLING

PART 1 - GENERAL

1.01 SUMMARY:

A. Section Includes: Premises wiring for telephone distribution, including installations for service by local telephone exchange carrier.

1.02 REFERENCES:

A. Insulated Cables Engineers Association, Inc. (ICEA):

1. S-80-576: Standard for Category 1 & 2 Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for Use in Communications Wiring Systems Technical Requirements

B. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

C. Occupational Safety & Health Act (OSHA).

1. Regulation 1910.7

D. Telecommunications Industry Association (TIA)/Electronic Industries Association (EIA):

1. TIA-570: Residential Telecommunications Infrastructure Standard.

E. Underwriters' Laboratories, Inc., (UL):

1. 486A: UL Standard for Safety Wire Connectors and Soldering Lugs for Use with Copper Conductors

2. 486B: UL Standard for Safety Wire Connectors for Use with Aluminum Conductors

1.03 DEFINITIONS:

A. Local Exchange Carrier: Telephone utility or other entity that provides access line from local exchange into premises.

B. Exchange Access Line: Circuit carrying telephone service into premises.

C. Distribution Circuit: Circuit from network interface device to distribution device, such as terminal block or junction box.

D. Station Circuit: Circuit from distribution device to telecommunications outlet.

E. Telecommunications Outlet: Telephone jack for connecting equipment to communication circuits.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data:

1. For each type of product specified.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term “NRTL” shall be as defined in OSHA Regulation 1910.7.

2. Terms “listed” and “labeled” shall be as defined in National Electrical Code, Article 100.

C. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

D. Comply with TIA-570.

1.06 PROJECT CONDITIONS:

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under following conditions and then only after arranging temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Engineer written permission.

1.07 COORDINATION:

A. Coordinate premises wiring with requirements of telephone equipment supplier.

PART 2 - PRODUCTS

2.01 COMPONENTS:

A. Comply with TIA-570.

B. Telecommunications and Auxiliary Disconnect Outlets: Four-position modular, latching, plug-type, jack-in, flush-mounting wall plate, unless otherwise indicated.

C. Wall Plates: Design for telephone service. Match those indicated for power receptacle outlets in same spaces for materials and finish. For wall telephone units, include provision for support of unit.

D. Distribution and Station Cable: Four-pair, No. 24 AWG, solid-copper, unshielded, twisted-pair construction in PVC sheath.

1. Comply with ICEA S-80-576.

2. Cable used in plenums shall be UL listed for plenum use.

E. Cabinets: Comply with Section 26 27 17. Furnish cabinets with backboard.

F. Backboard: 3/4-inch interior grade plywood. Where installed in wire closet, height and width shall cover entire wall up to 96 inch above floor, unless otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Telephone Service: Comply with local telephone exchange carrier's requirements for details of telephone service.

B. Existing Telephone Outlets and Wiring: Maintain fully operational until new system has been tested and is operational. As new outlets are installed, label them "Not in Service" with temporary labels.

C. Install outlet boxes and telecommunications outlets.

D. Install cable without damaging conductors and jacket.

1. Do not bend cable to smaller radius than minimum recommended by manufacturer.

E. Install premises wiring in raceways, unless otherwise indicated.

1. Install cables in walls unless walls are solid or filled with insulation. In solid walls, install in raceway and terminate raceway with bushing in ceiling space above outlet.

2. Install cables without raceway where concealed in accessible ceiling space, unless otherwise indicated.

3. Use pulling methods that will not damage cable or raceway, including fish tape, cable, rope, and wire-cable grips. Do not exceed manufacturer's recommended pulling tensions.

4. Pull cables simultaneously where more than one is being installed in same raceway or at same location.

5. Conceal raceway, except in unfinished spaces and as indicated.

F. Install exposed cable parallel or perpendicular to surfaces or exposed structural members and follow surface contours where possible.

1. Secure cable to independent supports at intervals as required to prevent sagging between supports.

3.02 CONNECTIONS:

A. Install ground terminal at local exchange carrier service location and connect according to Section 26 05 26.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A-486B.

3.03 IDENTIFICATION:

A. Identify components and circuits according to Section 26 05 53.

B. Identify telephone system backboards and cabinets with legend "Telephone".

C. Identify terminals at terminal strips, telecommunications outlets, and pull-and-junction boxes with approved designations.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 27 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide communications copper horizontal cabling as indicated and in compliance with Contract Documents.

1. Category 6 twisted pair cable.

2. Twisted pair cable hardware, including plugs and jacks.

3. Cabling identification products.

4. Grounding provisions for twisted pair cable.

5. Source quality control requirements for twisted pair cable.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

B. Building Industry Consulting Service International (BICSI):

1. ITSIMM: Information Technology Systems Installation Methods Manual

2. TDMM: Telecommunications Distribution Methods Manual

C. Insulated Cable Engineers Association (ICEA):

1. 90-661: Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and LAN Communication Wiring Systems Technical Requirements

2. 103-701: Riser Cables Technical Requirements

3. S-116-732: Standard for Category 6 and 6A, 100 Ohm, Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in LAN Communication Wiring Systems

D. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

2. 568: Standard for Installing Commercial Building Telecommunications Cabling

3. 607: Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

E. National Electrical Manufacturers Association (NEMA):

1. WC 63.1: Performance Standard for Twisted Pair Premise Voice and Data Communications Cable

2. WC 66: Standard for Category 6 and 6A, 100 Ohm, Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in LAN Communication Wiring Systems

F. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

G. Telecommunications Industry Association (TIA):

1. 568: Generic Telecommunications Cabling for Customer Premises

2. 569-D: Telecommunications Pathways and Spaces

3. 606: Administration Standard for Telecommunications Infrastructure

4. 607: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

H. Underwriters' Laboratories, Inc. (UL):

1. 50: Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations

2. 969: Standard for Safety Marking and Labeling Systems

3. 1666: Standard for Safety Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

4. 1685: Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

5. 1863: Standard for Safety Communications-Circuit Accessories

6. 2043: Standard for Safety Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces

1.03 DEFINITIONS:

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.04 COPPER HORIZONTAL CABLING DESCRIPTION:

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.

2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.

3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 square feet, and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

C. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

3. Cabling administration Drawings and printouts.

4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

a. Telecommunications rooms plans and elevations.

b. Telecommunications pathways.

c. Telecommunications system access points.

d. Telecommunications grounding system.

e. Telecommunications conductor drop locations.

f. Typical telecommunications details.

g. Mechanical, electrical, and plumbing systems.

D. Twisted pair cable testing plan.

E. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration and faceplates for color selection and evaluation of technical features.

F. Qualification Data: For RCDD installation supervisor, and field inspector.

G. Product Certificates: For each type of product.

H. Source quality-control reports.

I. Field quality-control reports.

J. Maintenance Data: For splices and connectors to include in maintenance manuals.

K. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On USB media or compact disk, complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

L. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: One of each type.

2. Faceplates: One of each type.

3. Jacks: Ten of each type.

4. Multiuser Telecommunications Outlet Assemblies: One of each type.

5. Patch-Panel Units: One of each type.

6. Plugs: Ten of each type.

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings, cabling administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.09 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT/SITE CONDITIONS:

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION:

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.12 SOFTWARE SERVICE AGREEMENT:

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.02 GENERAL CABLE CHARACTERISTICS:

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway or Type CMP in listed cable routing assembly.

2. Communications, Non-plenum: Type CMR complying with UL 1666 and ICEA S-103-701.

3. Communications, Non-plenum: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less

2. Smoke-Developed Index: 450 or less

C. RoHS compliant.

2.03 CATEGORY 6 TWISTED PAIR CABLE:

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Manufacturers:

1. 3M

2. Belden CDT Networking Division/NORDX

3. CommScope, Inc.

4. Hitachi Cable America Inc.

5. Superior Essex Inc.

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP) Shielded twisted pairs (FTP) Screened twisted pairs (F/UTP) Screened and shielded twisted pairs (F/FTP).

F. Cable Rating: Plenum.

G. Jacket: White Gray Blue Yellow thermoplastic.

2.04 TWISTED PAIR CABLE HARDWARE:

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers:

1. 3M

2. Belden CDT Networking Division/NORDX

3. Dynacom Corporation

4. KRONE Incorporated

5. Panduit Corp

C. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.

2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.

3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer. Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

E. Connecting Blocks:

1. 110-style IDC for Category 6.

2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels

b. Labeling areas adjacent to conductors

c. Replaceable connectors

d. 24 or 48 ports

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.

3. Number of Jacks per Field: One for each four-pair cable indicated conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

H. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.

2. Patch cords shall have color-coded boots for circuit identification.

I. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.

2. Standard: Comply with TIA-568-C.2.

3. Marked to indicate transmission performance.

J. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.

2. Designed to snap-in to a patch panel or faceplate.

3. Standard: Comply with TIA-568-C.2.

4. Marked to indicate transmission performance.

K. Faceplate:

1. Four port, vertical single gang faceplates designed to mount to single gang wall boxes.

2. Eight port, vertical double gang faceplates designed to mount to double gang wall boxes.

3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26.

4. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26.

5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

L. Legend:

1. Machine printed, in the field, using adhesive-tape label.

2. Snap-in, clear-label covers and machine-printed paper inserts.

2.05 IDENTIFICATION PRODUCTS:

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.06 GROUNDING:

A. Comply with requirements in Section 27 05 26 for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.07 SOURCE QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 WIRING METHODS:

A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Section 27 05 28.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.02 INSTALLATION OF PATHWAYS:

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 27 11 00.

B. Comply with Section 27 05 28.

C. Comply with Section 27 05 29.

D. Comply with Section 27 05 36.

E. Drawings indicate general arrangement of pathways and fittings.

3.03 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES:

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.

2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.

3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.

5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

6. MUTOA shall not be used as a cross-connect point.

7. Consolidation points may be used only for making a direct connection to equipment outlets:

a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.

b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.

8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.

10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual , Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.

11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.

12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

13. In the communications equipment room, install a 10-foot-long service loop on each end of cable.

14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.04 FIRESTOPPING:

A. Comply with requirements in Section 07 84 00.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.05 GROUNDING:

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.06 IDENTIFICATION:

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53.

1. Administration Class: Class 3.

2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 3 level of administration, including optional identification requirements of this standard.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.

4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

   a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.

   b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.07 FIELD QUALITY CONTROL:

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

   a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 27 15 23

COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide communications optical fiber horizontal cabling as indicated and in compliance with Contract Documents.

1. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).

2. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS2).

3. Optical fiber cable connecting hardware, patch panels, and cross-connects.

4. Grounding.

5. Cabling identification products.

1.02 REFERENCES:

A. Building Industry Consulting Service International (BICSI):

1. ITSIMM: Information Technology Systems Installation Methods Manual

2. TDMM: Telecommunications Distribution Methods Manual

B. Insulated Cable Engineers Association (ICEA):

1. S-83-596: Indoor Optical Fiber Cable.

2. S-104-696: Indoor-Outdoor Optical Fiber Cable

C. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

2. 301: Standard for Installing and Testing Fiber Optics

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

2. 262: Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

E. Telecommunications Industry Association (TIA):

1. 492AAAA: Detail Specification for 62.5-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers

2. 492AAAB: Detail Specification for 50-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers

3. 492AAAC: Detail Specification for 850-nm Laser- Optimized, 50-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers

4. 492AAAD: Detail Specification for 850-nm Laser- Optimized, 50-µm Core Diameter/125-µm Cladding Diameter Class la Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber

5. 492CAAA: Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers

6. 492CAAB: Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak

7. 526-14-B: Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant

8. 568: Generic Telecommunications Cabling for Customer Premises

9. 569-D: Telecommunications Pathways and Spaces

10. 598-D: Optical Fiber Cable Color Coding

11. 604: Fiber Optic Connector Intermateability Standard

12. 604-10-B: FOCIS 10B Fiber Optic Connector Intermateability Standard- Type LC

13. 606: Administration Standard for Telecommunications Infrastructure

14. 607: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

F. Underwriters' Laboratories, Inc. (UL):

1. 444: Standard for Safety Communications Cables

2. 969: Standard for Safety Marking and Labeling Systems

3. 1651: Standard for Safety Optical Fiber Cable

1.03 DEFINITIONS:

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.04 OPTICAL FIBER HORIZONTAL CABLING DESCRIPTION:

A. Optical fiber horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.

2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the equipment outlet.

3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 square feet, and includes the components that extend from the equipment outlets to the equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

C. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

3. Cabling administration Drawings and printouts.

4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

   a. Telecommunications rooms plans and elevations.

   b. Telecommunications pathways.

   c. Telecommunications system access points.

   d. Telecommunications grounding system.

   e. Telecommunications conductor drop locations.

   f. Typical telecommunications details.

   g. Mechanical, electrical, and plumbing systems.

D. Fiber optic cable testing plan.

E. Sustainable Design Submittals:

1. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration and faceplates for color selection and evaluation of technical features.

F. Qualification Data: For RCDD, installation supervisor, and field inspector.

G. Product Certificates: For each type of product.

H. Source quality-control reports.

I. Field quality-control reports.

J. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On USB media or compact disk, complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

K. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

L. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: One of each type

2. Jacks: Ten of each type

3. Patch-Panel Units: One of each type

4. Plugs: Ten of each type

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Technician**,** who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD.

C. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.09 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.

2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.10 PROJECT/SITE CONDITIONS:

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION:

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications equipment and service suppliers.

1.12 SOFTWARE SERVICE AGREEMENT:

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.02 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM4):

A. Description: Multimode, 50/125-micrometer, fiber-strand count as indicated on drawings, nonconductive conductive, tight buffer, optical fiber cable.

B. Manufacturers:

1. Belden CDT Networking Division/NORDX

2. Corning Cable Systems

3. Hitachi Cable America Inc.

4. Superior Essex Inc.

5. TE Connectivity Ltd.

C. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.

2. Comply with TIA-568-C.3 for performance specifications.

3. Comply with TIA-492AAAD for detailed specifications.

D. Conductive cable shall be aluminum armored type.

E. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 3500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Minimum Effective Modal Bandwidth-length Product: 4700 MHz-km at 850 nm.

H. Jacket:

1. Jacket Color: Aqua.

2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.

3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

2.03 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2):

A. Description: Single mode, 9/125-micrometer, 1 - 2 fibers, tight buffered, nonconductive conductive optical fiber cable.

B. Manufacturers:

1. 3M

2. Belden CDT Networking Division/NORDX

3. CommScope, Inc

4. Hitachi Cable America Inc.

5. Superior Essex Inc

C. Conductive cable shall be aluminum armored type.

D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

E. Jacket:

1. Jacket Color: Yellow.

2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.

3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

F. Standards:

1. Comply with TIA-492CAAB for detailed specifications.

2. Comply with TIA-568-C.3 for performance specifications.

3. Comply with ICEA S-104-696 for mechanical properties.

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

2.04 OPTICAL FIBER CABLE HARDWARE:

A. Manufacturers:

1. ADC

2. Belden CDT Networking Division/NORDX

B. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.

2. Comply with TIA-568-C.3.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: Factory-made, single-fiber cables in 36-inch lengths.

E. Connector Type: Type LC complying with TIA-604-10-B connectors.

F. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.

2. Insertion loss not more than 0.25 0.75 dB.

3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.

2. Insertion loss not more than 0.25 0.75 dB.

3. Marked to indicate transmission performance.

4. Designed to snap-in to a patch panel or faceplate.

H. Faceplate:

1. Two Four -port, vertical single-gang faceplates designed to mount to single-gang wall boxes.

2. Eight -port, vertical double-gang faceplates designed to mount to double-gang wall boxes.

3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26.

4. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26.

5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

2.05 GROUNDING:

A. Comply with requirements in Section 27 05 26 for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.06 IDENTIFICATION PRODUCTS:

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.07 SOURCE QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

C. Factory test preterminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 WIRING METHODS:

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for pathways specified in Section 27 05 28.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.02 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES:

A. Comply with NECA 1, NECA 301 and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568-C.1 and TIA-568-C.3.

2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."

3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.

7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

9. In the communications equipment room, provide a 10-foot-long service loop on each end of cable.

10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.03 FIRESTOPPING:

A. Comply with TIA-569-D, Annex A, "Firestopping."

B. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.04 GROUNDING:

A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.05 IDENTIFICATION:

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53.

1. Administration Class: Class 3.

2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 3 level of administration including optional identification requirements of this standard.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, horizontal pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.

4. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.06 FIELD QUALITY CONTROL:

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

b. Link End-to-End Attenuation Tests:

(1) Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.

(2) Attenuation test results for horizontal links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 27 15 33

COMMUNICATIONS COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide communications coaxial horizontal cabling as indicated and in compliance with Contract Documents.

1. Communications coaxial cable.

2. CATV coaxial cable.

3. Coaxial cable hardware.

4. Grounding.

5. Identification products.

1.02 REFERENCES:

A. Building Industry Consulting Service International (BICSI):

1. ITSIMM: Information Technology Systems Installation Methods Manual

2. TDMM: Telecommunications Distribution Methods Manual

B. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

2. 568: Standard for Installing Commercial Building Telecommunications Cabling

3. 607: Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

C. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

E. Telecommunications Industry Association (TIA):

1. 568: Generic Telecommunications Cabling for Customer Premises

2. 569-D: Telecommunications Pathways and Spaces

3. 606-B: Administration Standard for Telecommunications Infrastructure

4. 607-B: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

F. Underwriters' Laboratories, Inc. (UL):

1. 13: Standard for Safety Power-Limited Circuit Cables

2. 444: Standard for Safety Communications Cables

3. 969: Standard for Safety Marking and Labeling Systems

4. 1655: Standard for Safety Community-Antenna Television Cables

5. 1685: Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

1.03 DEFINITIONS:

A. BICSI: Building Industry Consulting Service International

B. EMI: Electromagnetic interference

C. IDC: Insulation displacement connector

D. LAN: Local area network

E. RCDD: Registered Communications Distribution Designer

1.04 COAXIAL HORIZONTAL CABLING DESCRIPTION:

A. Coaxial horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Nominal OD.

2. Minimum bending radius.

3. Maximum pulling tension.

C. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

2. Cabling administration drawings and printouts.

3. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration and faceplates for color selection and evaluation of technical features.

D. Qualification Data: For RCDD, installation supervisor, and field inspector.

E. Source quality-control reports.

F. Field quality-control reports.

G. Maintenance Data: For splices and connectors to include in maintenance manuals.

H. Maintenance Data: For coaxial cable, splices, and connectors to include in maintenance manuals.

I. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: One each type

2. Jacks: Ten of each type

3. Patch-Panel Units: One of each type

4. Plugs: Ten of each type

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Technician who shall be present at all times when Work of this Section is performed at Project site.

C. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.09 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Test cables upon receipt at Project site.

1. Test each coaxial cable on the reel for continuity.

1.10 PROJECT/SITE CONDITIONS:

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION:

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.02 GENERAL CABLE CHARACTERISTICS:

A. Communications Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway or Type CMP in listed cable routing assembly.

2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. CATV Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. CATV Plenum Rated: Type CATVP installed in riser raceways or cable routing assemblies, complying with NFPA 262.

2. CATV Cable: Type CATV, or CATVP or CATVR installed in general purpose, riser, or plenum communications raceways or cable routing assemblies in fireproof riser shafts with firestops at each penetration.

2.03 COMMUNICATIONS COAXIAL CABLE:

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for broadband data transmission.

B. Manufacturers:

1. Alpha Wire

2. Belden CDT Networking Division/NORDX

3. Coleman Cable, Inc

4. CommScope, Inc

5. Prysmian Group North America

C. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 13, and with NFPA 70, "Class 1, Class 2, and

Class 3 Remote-Control, Signaling, and Power-Limited Circuits" and "Communications Circuits" articles. Types are as follows:

1. RG-6/U: UL Type CMP and CL2P.
    a. No. 18 AWG, solid, copper-covered steel conductor.
    b. Plenum rated.
    c. Gas-injected, foam-PE insulation.
    d. Shielded with 100 percent aluminum tape and 40 percent aluminum braid.
    e. Jacketed with white PVC or PE.
    f. Suitable for indoor installations.
2. RG-11/U: UL Type CMP and CL2P.
    a. No. 14 AWG, solid, copper-covered steel conductor.
    b. Plenum rated. Suitable for outdoor installations in ambient temperatures ranging from -40 to +85 degrees F.
    c. Gas-injected, foam-PE insulation.
    a. Shielded with 100 percent aluminum tape and 40 percent aluminum braid.
    b. Jacketed with sunlight-resistant, white PVC or PE.
3. RG-59/U: UL Type CMP and CL2P.
    a. No. 20 AWG, solid copper conductor.
    b. Plenum rated.
    c. Gas-injected, foam-PE insulation.
    d. Single shielded with 100 percent aluminum shield and 40 percent aluminum braid.
    e. PVC jacket.

2.04 CATV COAXIAL CABLE:

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.

B. Manufacturers:

1. Alpha Wire

2. Belden CDT Networking Division/NORDX

3. Coleman Cable, Inc

4. CommScope, Inc

5. Prysmian Group North America

C. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution Systems" Article. Types are as follows:

1. RG-6/U: UL Type CATVP.

a. No. 18 AWG, solid, copper-covered steel conductor.

b. Plenum rated.

c. Gas-injected, foam-PE insulation.

d. Shielded with 100 percent aluminum tape and 60 percent aluminum braid.

e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.

f. Jacketed with white PVC or PE.

g. Suitable for indoor installations.

2.05 COAXIAL CABLE HARDWARE:

A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.

B. Manufacturers:

1. Emerson Network Power Connectivity Solutions

2. Leviton Manufacturing Co., Inc.

3. Siemon Co. (The)

C. Coaxial-Cable Connectors: Type BNC, 75 ohms.

D. Jacks and Jack Assemblies: Modular, color-coded, with female Type BNC connectors.

E. Patch Cords: Factory-made cables in minimum of 36-inch lengths; terminated with a male Type BNC connector at each end.

F. Faceplates:

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26.

2. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26.

3. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.

a. Flush-mounted jacks, positioning the cord at a 90-degree angle from faceplate surface.

4. Legend:

a. Factory labeled by silk-screening or engraving for stainless steel faceplates.

b. Machine printed, in the field, using adhesive-tape label.

c. Snap-in, clear-label covers and machine-printed paper inserts.

2.06 GROUNDING:

A. Comply with requirements in Section 27 05 26 for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.07 IDENTIFICATION PRODUCTS:

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.08 SOURCE QUALITY CONTROL:

A. Cable will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES:

A. Coordinate horizontal cabling with the protectors and demarcation point provided by communications service provider.

3.02 WIRING METHODS:

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Section 27 05 28.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.03 INSTALLATION OF PATHWAYS:

A. Comply with Section 27 11 00. Comply with requirements in Section 27 05 28 for installation of conduits and wireways.

B. Comply with Section 27 05 28.

C. Drawings indicate general arrangement of pathways and fittings.

D. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.

2. Install cable trays to route cables if conduits cannot be located in these positions.

3. Secure conduits to backboard when entering room from overhead.

4. Extend conduits 3 inches above finished floor.

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.04 INSTALLATION OF COAXIAL HORIZONTAL CABLES:

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.

2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.

3. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

8. In the communications equipment room, install a 10-foot-long service loop on each end of cable.

9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend coaxial cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.

2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 12 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 3 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.05 FIRESTOPPING:

A. Comply with TIA-569-D, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.06 GROUNDING:

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.07 IDENTIFICATION:

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 26 05 53.

1. Administration Class: Class 3.

2. Color-code fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications

closets, horizontal pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.

4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.

b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communications cabling, use a different color for jacks and plugs of each service.

E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.08 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Visually inspect coaxial jacket materials for NRTL certification markings.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test coaxial horizontal copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.09 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

DIVISION 28

ELECTRONIC SAFETY AND SECURITY

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SECTION 28 05 13

CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide conductors and cables for electronic security as indicated and in compliance with Contract Documents.

1. UTP cabling

2. 50/125-micrometer, multimode optical-fiber cabling

3. Coaxial cabling

4. RS-232 cabling

5. RS-485 cabling

6. Control-voltage cabling

7. Control-circuit conductors

8. Identification products

1.02 REFERENCES:

A. Building Industry Consulting Service International (BICSI):

1. ITSIMM: Information Technology Systems Installation Methods Manual

B. Insulated Cable Engineers Association (ICEA):

1. S-83-596: Indoor Optical Fiber Cable.

2. S-90-661: Category 3, 5 and 5e Individually Unshielded Twisted Pair Indoor Cables (with or without an Overall Shield) for Use in General Purpose and LAN Communication Wiring Systems Technical Requirements

C. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

D. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

E. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

F. Telecommunications Industry Association (TIA):

1. 492AAAB: Detail Specification for 50-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers

2. 492-B: Specifications for Optical Waveguide Fibers

3. 568: Generic Telecommunications Cabling for Customer Premises

4. 569: Telecommunications Pathways and Spaces

5. 526-14-B: Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant

6. 598-C: Optical Fiber Cable Color Coding

7. 604: Fiber Optic Connector Intermateability Standard

8. 604-12: FOCIS 12 Fiber Optic Connector Standard Type MT-RJ

9. 606: Administration Standard for Telecommunications Infrastructure

G. Underwriters' Laboratories, Inc. (UL):

1. 44: Standard for Safety Thermoset-Insulated Wires and Cables

2. 83: Standard for Safety Thermoplastic-Insulated Wires and Cables

3. 444: Standard for Safety Communications Cables

4. 969: Standard for Safety Marking and Labeling Systems

5. 1581: Standard for Safety Reference Standard for Electrical Wires, Cables and Flexible Cords

6. 1651: Standard for Safety Optical Fiber Cable

1.03 DEFINITIONS:

A. EMI: Electromagnetic interference.

B. IDC: Insulation displacement connector.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

E. RCDD: Registered Communications Distribution Designer.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1. Installation data for UTP and optical-fiber cables as specified in TIA 568-C-1.

C. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

3. Cabling administration drawings and printouts.

4. Wiring diagrams to show typical wiring schematics, including the following:

a. Cross-connects

b. Patch panels

c. Patch cords

5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

D. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

E. Source quality-control reports.

F. Field quality-control reports.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Test cables upon receipt at Project site.

1. Test optical-fiber cable to determine the continuity of the strand, end to end. Use optical loss test set.

2. Test optical-fiber cable on reels. Use an optical time domain reflectometer to verify the cable length, and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.

3. Test each pair of UTP cable for open and short circuits.

C. Refer and comply to Section 27 15 00 for all network cabling.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.

2. Smoke-Developed Index: 50 or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Refer and comply to Section 27 15 00 for all network cabling.

2.02 UTP CABLE:

A. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.

2. Comply with TIA-568-C.1 for performance specifications.

3. Comply with TIA-568-C.2, Category 6A.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP complying with NFPA 262.

b. Multipurpose, Plenum rated: Type MPP, complying with NFPA 262.

2.03 UTP CABLE HARDWARE:

A. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

B. Connecting Blocks: 110-style for Category 6A. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

2.04 OM4 OPTICAL-FIBER CABLE:

A. Description: Multimode, 50/125-micrometer, 24-fiber, nonconductive**,** tight buffer, optical-fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.

2. Comply with TIA-568-C.3 for performance specifications.

3. Comply with TIA-492AAAB, TIA-492-B for detailed specifications.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

B. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.

2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.

3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.05 OPTICAL-FIBER CABLE HARDWARE:

A. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

B. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

C. Cable Connecting Hardware: Comply with the Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA-604-12. Comply with TIA-568-C.3.

1. Quick-connect, simplex and duplex, Type LC, connectors. Insertion loss not more than 0.75 db.

2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.06 RS-232 CABLE:

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Nine No. 22 AWG, stranded (7x30) tinned copper conductors.

2. PE insulation.

3. Aluminum foil-polyester tape shield with 100 percent shield coverage.

4. Fluorinated ethylene propylene jacket.

5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

6. Flame Resistance: Comply with NFPA 262.

2.07 RS-485 CABLE:

A. Standard Cable: NFPA 70, Type CM

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.

2. PVC insulation.

3. Unshielded.

4. PVC jacket.

5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.

2. Fluorinated ethylene propylene insulation.

3. Unshielded.

4. Fluorinated ethylene propylene jacket.

5. Flame Resistance: NFPA 262, Flame Test.

2.08 CONTROL-VOLTAGE CABLE:

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30**)** tinned copper conductors.

2. PVC insulation.

3. Unshielded.

4. PVC jacket.

5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.

2. PVC insulation.

3. Unshielded.

4. PVC jacket.

5. Flame Resistance: Comply with NFPA 262.

2.09 CONTROL-CIRCUIT CONDUCTORS:

A. Class 1 Control Circuits: Stranded copper. Type THHN-THWN, complying with UL 83, in pathway Type XHHN, complying with UL 44, in pathway, XLP/PVC tray cable, complying with UL 83, in cable tray.

B. Class 2 Control Circuits: Stranded copper. Type THHN-THWN, complying with UL 83, in pathway, power-limited cable, complying with UL 83, concealed in building finishes, power-limited tray cable, complying with UL 83, in cable tray, Type XHHN, complying with UL 44, in pathway.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF in pathway, Power-limited tray cable, complying with UL 83, in cable tray, complying with UL 83.

2.10 IDENTIFICATION PRODUCTS:

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.11 CABLE MANAGEMENT SYSTEM:

A. Description: Computer-based cable management system, with integrated database capabilities.

B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

C. Information shall be presented in database view.

2.12 SOURCE QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical-fiber cables on reels according to TIA-568-C.1.

C. Factory test UTP cables according to TIA-568-C.2.

D. Factory test multimode optical fiber cables according to TIA-526.14-B and TIA-568-C.3.

E. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results. Structural Return Loss shall be less than 20 db.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 INSTALLATION OF HANGERS AND SUPPORTS:

A. Comply with requirements in Section 26 05 29 for installation of supports for cables.

3.02 WIRING METHOD:

A. Install wiring in metal pathways and wireways.

1. Minimum conduit size shall be 3/4 inch. Control and data-transmission wiring shall not share conduits with other building wiring systems.

2. Comply with requirements in Section 28 05 00.

3. Comply with requirements in Section 27 05 36.

B. Install cable, concealed in accessible ceilings, walls, and floors when possible.

C. Wiring on Racks and within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM's "Cabling Termination Practices" chapter. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered.

2. Install lacing bars and distribution spools.

3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.

4. Install conductors parallel with or at right angles to sides and back of enclosure.

5. Connect conductors associated with intrusion system that are terminated, spliced, or interrupted in any enclosure onto terminal blocks.

6. Mark each terminal according to system's wiring diagrams.

7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.03 INSTALLATION OF CONDUCTORS AND CABLES:

A. Comply with NECA 1 and NFPA 70.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

D. Install UTP, optical-fiber, and coaxial cables and connecting materials after spaces are complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

E. General Requirements for Cabling:

1. Comply with TIA-568-C.1.

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels. Leave a minimum of 6 inches of slack at outlet terminations and coil loosely into box after termination on outlet fitting.

4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

5. Maintain minimum cable bending radius during installation and termination of cables.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions. Do not exceed manufacturer's rated cable-pulling tension.

9. Riser Cable: Riser cable support intervals shall be in accordance with manufacturer's recommendations.

10. Comply with Section 27 05 00.

F. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6A rating of components and that ensure Category 6A performance of completed and linked signal paths, end to end.

1. Comply with TIA-568-C.2.

2. Install 110-style IDC termination hardware unless otherwise indicated.

3. Do not untwist UTP cables more than 1/2 inch from point of termination to maintain cable geometry.

G. Optical-Fiber Cable Installation:

1. Comply with TIA-568-C.3.

2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

H. Coaxial-Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.

2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

3. Install indoor cables in pathway.

I. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart. Cable supports shall be fastened to structural members or floor slabs in accordance with Section 26 05 29.

3. Cable shall not be run in contact with pipes, ducts, or other potentially damaging items. Cables shall not be run through structural members or use structural members, pipes, ducts, or equipment as a support.

J. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.

3. Cable 72 inches long shall be neatly coiled not less than 12 inches in diameter below each feed point.

K. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-C recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communication cables or cables in nonmetallic pathways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communication cables in grounded metallic pathways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between cables in grounded metallic pathways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or hp and Larger: A minimum of 48 inches.

6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.04 POWER AND CONTROL-CIRCUIT CONDUCTORS:

A. 120-V Power Wiring: Install according to Section 26 05 19 unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.

2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.

3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.05 CONNECTIONS:

A. Comply with requirements in Section 28 15 00 for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Section 28 20 00 for connecting, terminating, and identifying wires and cables.

3.06 FIRESTOPPING:

A. Comply with requirements in Section 07 84 13.

B. Comply with TIA-569-C, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.07 GROUNDING:

A. For communication wiring, comply with J-STD-607-A and with BICSI TDMM's "Grounding, Bonding, and Electrical Protection" chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 28 05 26.

3.08 IDENTIFICATION:

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 26 05 53.

3.09 FIELD QUALITY CONTROL:

A. Refer and comply with Division 27 requirements.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections:

1. Visually inspect UTP and optical-fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color coding for pin assignments and inspect cabling connections to confirm compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.

    a. Test instruments shall comply with or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical-Fiber Cable Tests:

    a. Test instruments shall comply with or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

    b. Link End-to-End Attenuation Tests:

        (1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.

        (2) Attenuation test results for links shall be less than 2.0 db. Attenuation test results shall be less than that calculated according to equation in TIA-568-C.1.

    c. Signal-to-Noise-Ratio Test: Use a field-strength meter to make a sequence of measurements at the output of the last distribution amplifier or of another agreed-on location in system. With system operating at normal levels, tune meter to the picture carrier frequency of each of the designated channels in turn and record the level. With signal removed and input to corresponding headend amplifier terminated at 75 ohms, measure the level of noise at same tuning settings. With meter correction factor added to last readings, differences from first set shall not be less than 45 db.

d. Qualitative and Quantitative Performance Tests: Demonstrate reception quality of color-television program transmissions at each user interface from each designated channel and source. Quality shall be equal or superior to that obtained with performance checks specified below, using a standard, commercial, cable-ready, color-television receiver. Level and quality of signal at each outlet and from each service and source shall comply with the following Specifications when tested according to 47 604-12 76:

(1) RF video-carrier level.

(2) Relative video-carrier level.

(3) Carrier-level stability, during 60-minute and 24-hour periods.

(4) Broadband frequency response.

(5) Channel frequency response.

(6) Carrier-to-noise ratio.

(7) RF visual signal-to-noise ratio.

(8) Antenna combiner insertion loss.

(9) Signal power splitter loss.

(10) Cable connector attenuation.

E. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 28 05 26

GROUNDING AND BONDING FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide grounding and bonding for electronic security as indicated and in compliance with Contract Documents.

1. Grounding conductors

2. Grounding busbars

1.02 REFERENCES:

A. ASTM International (ASTM):

1. B3: Standard Specification for Soft or Annealed Copper Wire

2. B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

3. B33: Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes

B. Institute of Electrical and Electronics Engineers (IEEE):

1. 1100: Recommended Practice for Power and Grounding Electronic Equipment

C. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

E. Telecommunications Industry Association (TIA):

1. 568: Generic Telecommunications Cabling for Customer Premises

F. Underwriters' Laboratories, Inc. (UL):

1. 83: Standard for Safety Thermoplastic-Insulated Wires and Cables

2. 467: Standard for Safety Grounding and Bonding Equipment

3. 486A-486B: Standard for Safety Wire Connectors

1.03 DEFINITIONS:

A. Signal Ground: The ground reference point designated by manufacturer of the system that is considered to have zero voltage.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 CONDUCTORS:

A. Comply with UL 486A-486B.

B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

C. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3

2. Stranded Conductors: ASTM B 8

3. Tinned Conductors: ASTM B 33

4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor

5. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick

2.02 CONNECTORS:

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

C. Busbar Connectors: Cast silicon bronze, solderless exothermic-type mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.03 GROUNDING BUSBARS:

A. Grounding Busbars: See telecom drawings for size and location in IDF rooms.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

2. Bond shields and drain conductors to ground at only one point in each circuit.

B. Signal Ground:

1. For each system, establish the signal ground and label that location as such.

2. Bond the signal ground to the alternating-current (ac) power system service by connecting to one of the following listed locations, using insulated No. 6 AWG**,** stranded, Type THHN wire:

   a. Grounding bar in an electrical power panelboard if located in the same room or space as the signal ground.

   b. Telecommunications grounding busbar.

C. Comply with NECA 1.

3.02 APPLICATION:

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.

2. Install without splices.

3. Support at not more than 36-inch intervals.

3.03 CONNECTIONS:

A. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

B. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.

2. Pretwist the conductor.

3. Apply an antioxidant compound to all bolted and compression connections.

C. Shielded Cable: Bond the shield of shielded cable to the signal ground. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

D. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.04 FIELD QUALITY CONTROL:

A. Refer and comply also to Section 27 05 26 requirements.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 28 13 00

ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide access control software and database management as indicated and in compliance with Contract Documents.

B. The Security Management System (SMS), The Access Control Software server is existing in the existing operations building.. Contractor to provide programming for new buildings.

C. Provide field devices such as card readers, alarm inputs, control points, etc. The devices shall be connected to fully distributed intelligent field controllers All connections of the field devices shall be by the contractor.

1.02 EXISTING CONDITIONS:

A. The existing access control system is manufactured by Genetec Access Control.

B. The existing system will be expanded to connect the new card readers/keypads

C. Monitoring of the access control system is provided at the operations building and is to remain operational until the new operations building is complete and functioning, control and monitoring shall then be transferred to the new operations building.

1.03 REFERENCES:

A. Institute of Electrical and Electronics Engineers (IEEE):

1. 1100: Recommended Practice for Power and Grounding Electronic Equipment

B. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

D. Security Industry Association (SIA):

1. CP-01: Security System Standard

2. DC-01: DCS Computer Interface (CIS-1) Technical Report

3. DC-03: DCS SIA Format Standard

4. DC-07: DCS Computer Interface (CIS-2) Standard

E. Telecommunications Industry Association (TIA):

1. EIA 568-C-1: Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements.

2. EIA 606-B: Administration Standard for Commercial Telecommunications Infrastructure.

F. Underwriters' Laboratories, Inc. (UL):

1. 1610: Central-Station Burglar-Alarm Units

1.04 DEFINITIONS:

A. CCTV: Closed-circuit television

B. CPU: Central processing unit

C. SMS: Security Management System

D. Credential: Data assigned to an entity and used to identify that entity.

E. GFI: Ground fault interrupter

F. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

G. I/O: Input/Output

H. LAN: Local area network

I. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

J. PC: Personal computer. Applies to the central station, workstations, and file servers.

K. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.

L. RAS: Remote access services

M. RF: Radio frequency

N. ROM: Read-only memory. ROM data are maintained through losses of power.

O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

P. UPS: Uninterruptible power supply

Q. USB: Universal serial bus

R. WAN: Wide area network

S. WAV: The digital audio format used in Microsoft Windows

T. WMP: Windows media player

U. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card

V. Windows: Operating system by Microsoft Corporation

W. Workstation: A PC with software that is configured for specific, limited security-system functions.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Diagrams for cable management system

2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.

3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:

   a. Workstation outlets, jacks, and jack assemblies

   b. Patch cords

   c. Patch panels

4. Cable Administration Drawings: As specified in "Identification" Article.

5. Battery and charger calculations for central station, workstations, and controllers.

D. Product Schedules

E. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

F. Field quality-control reports.

G. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23, include the following:

1. Microsoft Windows software documentation.

2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.

3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

4. System installation and setup guides with data forms to plan and record options and setup decisions.

5. Hard copies of all installed software programs as programmed into the system and PDF files on CD-ROM of the hard-copy submittal.

H. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Laser Printers: Three toner cassettes and one replacement drum unit.

2. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.

3. Fuses of all kinds, power and electronic, equal to 25 percent of amount installed for each size used, but no fewer than three units.

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

C. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70, "National Electrical Code."

F. Comply with SIA DC-01, SIA DC-03 and SIA DC-07.

G. Comply with UL 294.

1.09 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Central Station, Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 degrees F, and not more than 80 percent relative humidity, noncondensing.

2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

3. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.10 PROJECT/SITE CONDITIONS:

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 degrees F dry bulb and 20 to 90 percent relative humidity, noncondensing.

2. Indoor, Uncontrolled Environment: NEMA 250, Type 3R enclosures. System components installed in non-temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122 degrees F dry bulb and 20 to 90 percent relative humidity, noncondensing.

3. Outdoor Environment: NEMA 250, NEMA 250, Type 4 enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 degrees F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick.

4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

5. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 6P enclosures.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. The SMS shall be an integrated system that utilizes a single, industry-standard relational database management system for the storage and manipulation of related data. The SMS shall include a server with operating system and applications software, operator and administrator terminals with appropriate software, hard copy printers and fixed magnetic storage media. The security devices shall communicate with the field panels via a

dedicated cable network. The field panels shall communicate to the server via a Fast Ethernet 10/1000, TCP/IP network or a serial (RS-232, RS-485) connection.

B. The SMS shall allow for growth and scalability from a low-end or entry level system to a high end or enterprise system by increasing CPU power, memory and database. The SMS shall be modular in nature, allowing system capacities to be easily expanded without requiring major changes to system operation. All defined system data as well as historical information shall be maintained. Customizable user interfaces shall allow management of system information and activity for administrators and operators. The SMS shall include an intuitive .NET based badging solution with a WYSIWYG badge layout editor and GUI for badge design.

C. Upon any alarm generated by the access control stations, the system shall automatically display the image of the camera(s) closest to the alarm point on spot monitor next to ACS workstation.

2.02 SMS FUNCTIONALITY:

A. Partitioning: The SMS shall allow system administrators to separate the creation and viewing of objects into partitions. SMS operators shall be associated with partitions and this shall determine which objects operators have the ability to create and or view. The SMS shall support an unlimited number of partitions.

1. The SMS partitions shall include but not be limited to the following objects:

a. Personnel

b. Clearances

c. Doors

d. Controllers with all associated hardware (readers, inputs, outputs, etc.)

e. Video servers with all associated objects (cameras, tours, views, etc.)

f. Application layouts

g. Events

h. Dynamic views

i. Maps

j. Reports, forms, results

k. Holidays

l. Badge layouts

m. Queries

n. Images

2. Through the use of privileges, the SMS System Administrator shall be able to determine which objects are associated with a particular partition. These objects shall then be assigned to System Operators with the appropriate privilege.

3. The SMS shall support a super-user assigned the 'System All' privilege who shall have full access to all objects in all partitions.

4. Any operator shall have the ability to be assigned access rights to any partition. Individual Access rights shall be created and have the ability to be assigned to any users of the SMS.

5. The SMS shall allow objects to be created in any partition. The SMS shall have the ability to grant or remove permission from any object in any partition.

6. The SMS shall provide the ability to move objects from one partition to another partition without the requirement of deleting and recreating.

7. The SMS shall provide the ability to import/export any configured object.

8. The SMS shall support the display of all associated objects contained within a partition.

B. Enterprise Architecture:

1. The SMS shall provide an Enterprise Architecture, licensable option that allows you to configure multiple Satellite Application Servers (SAS) to communicate with a Master Application Server (MAS). The Master Application Server shall provide a platform for global management of the personnel, video, and access control security objects on two or more Satellite Application Servers (SAS) in an enterprise.

2. The Enterprise Architecture shall work by synchronizing each SAS system's database with the MAS database. The MAS shall contain the global data that is used across every server, such as global personnel records, global clearances, and global schedules. The global data shall be synchronized to each SAS to provide enterprise-wide security. The MAS shall be used to remotely monitor and manage controllers and video servers attached to SAS's in the enterprise, however it shall not support any directly connected controllers or video servers.

3. The MAS shall provide the capability for Central Monitoring of the entire enterprise, using the Monitoring Station application. From a Central Monitoring Station connected to the MAS, the system shall be capable of viewing events, activities, and status of every SAS in the enterprise. Alternatively, you can connect

to an individual SAS to monitor that system and its connected hardware. In addition, the MAS shall provide the ability to integrate with external sources via LDAP, XML, CSV or ODBC imports both manually or automatically through scheduled processes.

4. Each SAS shall contain database records for all connected video and access control devices, as well as local personnel, clearances, privileges, and other related data. Each SAS shall synchronize with the MAS so that SAS local data is replicated to the MAS for central management and monitoring. In addition, the MAS shall provide central reporting capability for replicated SAS objects including journal and audit transactional data.

5. All local data shall be synchronized immediately to the MAS or queued if a server is offline. All queued data shall be replicated automatically upon restoral of communication. Global data that is created or changed at the SAS/MAS shall be replicated to all locations. Journal and Audit data shall be synchronized either manually or on a configurable schedule, providing the ability to manage bandwidth usage and load balancing.

6. Operators in the enterprise architecture shall be configured as local or global. Global operators shall be subject to the user privileges as defined on each SAS.

7. The Enterprise Architecture shall support a Standalone to SAS Migration Utility that shall be used to merge a standalone SMS server into an existing SMS Enterprise site.

8. The Enterprise Architecture option shall include:

    a. Support for up to 20 SAS Systems

    b. Global Administration of Personnel and Clearances, Images, Card formats, CHUID Formats, Holidays, Personnel groups, and Operators and Privileges

    c. Centralized Reporting

    d. Central Monitoring of Events and Activities across the Enterprise

    e. Central Management of Access Card Enrollment

    f. Central Badging and Image processing

    g. Global Management of Badge Layouts

    h. Single Card Access across the Entire Enterprise

    i. Increased Scalability of Security Hardware and Video

    j. End-to-End Encryption

k. Automated Synchronization of Enterprise Security Databases

l. Central Management of Video and Hardware Resources

m. Remote Editing of Global and Local Data

C. Graphical User Interface (GUI):

1. The SMS shall employ a standard Windows graphical user interface (GUI). A mouse and keyboard shall be the primary operator interface with the system. Operator screens shall utilize all standard Windows-style functions such as drop-down menus, context menus, radio buttons, and lists, as appropriate. The interface shall utilize a 'tree structure' similar to Windows Explorer.

D. Administration Operator Interface:

1. The SMS shall employ an Administration Operator Interface to control the following:

a. Hardware (readers, inputs, outputs, video systems, door controls, CCTV, and other systems).

b. Configuration of personnel records, operators and operator privileges.

c. Graphical Maps.

d. Application Layouts.

e. Dynamic Views.

f. Queries.

g. Import/Export of objects, including images.

h. System Variables.

i. Reports (either periodic or one-time).

j. System functions (event command and control, actions, schedules).

k. Display of a list of objects in a grid that can have their values modified and respond to real-time status changes.

l. Scheduling of backups.

m. Monitoring of system settings and performance.

n. Designing of and printing of badges.

2. The GUI shall be configurable by the system administrator to control the views and access of each Monitoring Station operator.

E. Monitoring Operator Interface/Activity Monitoring:

1. The SMS shall contain a monitoring component that is capable of, among other things, displaying the current state of any object in the system. Additionally the monitoring station shall be capable of displaying a log of all activity that occurs in the system, from object state changes, to access control information. All text for events (alarms) in the system shall be configurable to be displayed in color based on the user-specified priority of the event.

2. The Monitoring Station shall be capable of showing all changes occurring to an object without requiring the associated activity messages for that object to be routed to that monitoring station. The SMS shall require the operator to have appropriate permissions to view and/or control any object.

3. The monitoring station interface shall be user-customizable. The SMS shall support the ability of the end user to create a customized application layout for the monitoring station. The monitoring station shall support multiple application layouts that can be assigned to the operators. Each application layout can have multiple panes in the same window. The panes can have multiple tabs so that different objects such as cameras and tours can be displayed in the same pane. The panes shall have the ability to include: General activity; Event (Alarm) activity; Dynamic card swipe information; Video cameras and tours; Maps; Dynamic Views; Reports; and links to external applications. Each pane shall have the ability to be moved to a specific screen.

4. The SMS monitoring station shall support a Swipe and Show Viewer. The Swipe and Show Viewer shall monitor a configurable list of Doors and shall display a portrait or multiple portraits of personnel who present an access credential at a Reader on an included Door or Elevator. The SMS shall allow multiple Swipe and Show Viewers to be added to an Application Layout. The Swipe and Show Viewer shall provide configurable image border colors that shall correspond to access transaction states (Admit, Reject etc.). The Swipe and Show Viewer shall display the date and time of the transaction, the location, area, Cardholders name and the status of the transaction. The Swipe and Show Viewer shall allow an Operator with the appropriate Privileges to perform the following functions from the Viewer:

a. View/Edit the Cardholder record

b. Perform a momentary unlock of the associated door

c. Grace the Cardholder (allow the cardholder into an APB area)

d. Perform an Area Lockout Grace of the cardholder

e. Perform an APB reset on the cardholder

5. The SMS shall support the ability to configure an Operator's Application Layouts to open in separate instances of the Monitoring Station to enhance the performance of multiple displays. Each Application Layout shall support the assignment of a monitor number. The Operator opening the Monitoring Application shall automatically open a separate instance of the Monitoring Application on each assigned Monitor. The SMS shall support up to Ten (10) assigned monitors for Application Layouts.

6. The SMS shall provide the Monitoring Operator with following functional capabilities:

   a. Shall provide a scrolling list of lines or tiles showing current activity on the system.

   b. Shall display activity in real-time as data is being transmitted by field hardware.

   c. Shall include icons that indicate the type of activity and textual description of the activity.

   d. The color of the frames of the tiles, icons, and/or text shall indicate the type or importance of the information contained therein.

   e. A series of menus, driven by drop-down or trees, shall allow the Monitoring Station operator to perform manual actions, such as “momentary door unlock” for a given door.

   f. As part of the manual action capability, the system shall provide screens or boxes that query the operator on specifics, such as start and end time, and offer guidance on performing the manual actions.

   g. Ability to view a sortable list of active alarms or events and recently active alarms or activity.

   h. A GUI that minimizes the number of operator mouse clicks or keyboard strokes.

   i. Mouse controls include “right-click” pop-ups and highlighted default selections.

   j. Objects shall be displayed to the operator based on his/her assigned operator privilege. The operator shall only be able to monitor/command those objects for which he or she has been assigned privilege.

k. When an operator logs out of a workstation and a new operator logs on, the objects displayed on the workstation screen shall by dynamically updated to display only those objects for which the new operator has privilege.

l. Allow the customization of columns as defined by the operator privilege, including:

(1) Adjusting width (on the fly or pre-programmed).

(2) Not displaying Columns (on the fly or pre-programmed)

(3) Sorting on selected columns (to follow standard Windows conventions)

m. Allow for a "freeze" function. This includes a configurable "freeze time-out" that permits an activity to be selected and temporarily prevents the display of subsequent activities which push the selected activity off the screen. A break-through event disables the freeze function. The freeze function shall provide a graphic bar where the remaining time available in the freeze timeout shall be displayed. Selecting the freeze timeout icon before the time elapses shall extend the freeze timeout to the maximum.

n. Provide Acknowledge All, Acknowledge and Clear All and Silence All buttons for events.

o. Support multiple panes for the display of events, activities, video, personnel images, and maps.

p. Display the number of active causes of an event.

q. Support the ability to attach a log message to an event, even after the event has been acknowledged.

r. Provide the ability to attach Predefined Log Messages to an event upon acknowledgement.

s. Shall allow a Monitoring Operator to select on-screen transactions (both events and system activity) and Email the transactions with a single mouse click.

7. Pre-defined Alarm Acknowledgement Messages:

a. The SMS shall provide the ability to create Predefined Log Messages. Each log message shall have a Name, Description, Label and Message Text. These messages shall be assigned to any event providing the ability to select the appropriate response that resolved the event. The SMS shall provide the ability to group multiple log messages and then assign the group to an event. Each group shall contain up to one hundred messages and each event shall

support up to one hundred messages. The SMS shall allow only users with specified operator privileges to add, modify, or delete messages or message groups. Predefined messages shall be editable by an operator with the proper privilege and may be appended as required by the operator.

b. Messages shall have the following characteristics:

(1) Message Name shall be configured with up to 500 characters

(2) Message Description shall be configured with up to 500 characters

(3) Message Label shall be configured with up to 100 characters

(4) Message Text shall be configured with up to 3000 characters

8. The SMS shall support audible alarm annunciation at operator workstations (operator configurable audio files associated with alarms).

9. The activity monitoring screen shall be capable of displaying the following features:

a. System clock

b. Date/time when the activity actually occurred and the date/time when the activity was received by the server shall be displayed (when they are different).

c. Real time event counters

d. Count of the active events

e. Count of the events requiring operator acknowledgment

f. Name of operator logged on at the workstation

g. Real-time display of the current activity on the system in chronological order

h. Acknowledge All and Silence All buttons for events

i. Manual Action command buttons

j. Pre-defined and configurable acknowledgement messages

k. Log message

l. Clear event

m. Clear group of events

n. Event action message (automatically display selected message for event)

o. Dynamic views

F. Web Client:

1. The SMS shall support a Thin Client to provide remote access to the SMS Server via a web browser. The Thin Client shall support Microsoft® Internet Explorer latest vested version and Mozilla Firefox® 3.0 or greater. The Thin Client shall support 128-bit AES encryption to the SMS Server.

2. The Thin Client shall support Single Sign-on utilizing Windows Authentication. The privileges of the SMS operator shall be propagated to the Thin Client User allowing only access to Security Objects for which the SMS Operator is authorized. The Thin Client shall provide support for Partitioning of the system and utilize the Partitions assigned to the Operator.

3. All changes made to the SMS database via the Thin Client shall be recorded in the Audit Trail Database.

4. The Thin Client shall provide Personnel Management including:

a. Shall allow the operator to create and modify personnel data (includes adding/removing clearances, schedules, and expiration dates).

b. Operator shall have the ability to enable and disable cards.

c. Operator shall have the ability to search for, edit, add, and delete Personnel records from the SMS database.

d. Search function shall allow wildcards and shall include First name, Last name, card number, and user defined text.

e. Shall support for the Auto-increment Card Number feature for Credentials created using the Web Client.

f. Shall support a Change CHUID Format button on the Credentials tab that allows you to change the CHUID format of a Credential.

g. Shall support an Auto Generate button that allows you to randomly generate a PIN for PIN-only Credentials.

h. SMS thin client shall provide a personnel image tab that includes image display, Image capture from a file or a local USB camera, and the capability to crop the Image and save it to the SMS personnel record.

5. The Thin Client shall support an Activity Monitor to provide a scrolling display of system activity. Activity shall be restricted based upon the Operator's Privilege

and Partition assignments. Display controls shall include page up, page down, and a freeze function.

6. The Thin Client shall support acknowledgement of an Event from the Event Dynamic View.

7. The Thin Client shall support for logging an Event Message from the Event Dynamic View

8. The Thin Client shall support Manual Actions to include the Locking/unlocking of doors, and the Activation/deactivation of events.

9. The Thin Client shall support the display of Dynamic Views as defined by the SMS. Dynamic Views shall provide a real time view of SMS data including Journal and Audit Trail history. Viewing of Multiple Dynamic Views shall be supported.

10. The Thin Client shall support creating, configuring, loading and saving of reports. Reports shall consist of personnel history activity or audit data. The report data shall allow sorting within the thin Client view page by any displayed field in ascending or descending order. The Thin Client shall allow reports to be saved in the following formats: XLS, CSV, XML, TXT or PDF. The operator shall have the option to save the report to a file or send it via email.

11. The Thin Client shall support Manual Action Challenges. The Manual Action Challenge shall require an operator to enter their login credentials (User name and password) when executing a manual action, such as a door unlock, from within the Thin client.

12. The Thin Client shall support the ability to query on a specific cardholder or a group of cardholders for the purpose of assigning clearances to multiple cardholders at once. Once the query is complete, the operator shall have the ability to assign a single access clearance or a group of clearances to all cardholders.

13. The Thin Client shall support the ability to display a door activity report from the web client cardholder record configuration view. In addition, it shall provide the ability to display the Activation / Expiration Date and Time for each credential assigned to a cardholder. The thin client shall display all user-defined personnel fields and the details of each assigned access clearance in a separate window.

14. The Thin Client shall support Auto-Logoff based upon inactivity. The Thin Client shall monitor user activity and shall automatically log a user out of the workstation after a user defined timeout period.

15. The Thin Client shall support the ability to assign or remove clearances to multiple cardholders simultaneously.

G. Graphic Maps:

1. The SMS shall support unlimited graphic maps and icons to be displayed on the operator workstation monitor.

2. The system shall support an operator-programmable, color graphic map display that:

   a. Shall be capable of showing the floor plan, the location of alarm devices, and alarm instructions for a facility.

   b. Shall be centralized in the system configuration and displayed on the operators' workstations.

   c. Shall allow various maps to be associated with different areas to create a hierarchy of maps.

   d. Shall support graphic maps having a resolution of 1024x768 Pixels or greater.

3. Operators shall be able to use drag-and-drop mouse technique to place dynamic system level object icons of all objects such as: cameras, video servers, inputs/outputs, events, maps, reports, dynamic views, and door/elevator icons. These dynamic object icons shall allow a system operator to perform tasks and issue commands related to the object by double-clicking on the icon.

4. The SMS shall allow the addition of new layers to the drawing (such that if the drawing must ever be reloaded due to an update of the drawing, the layer(s) created within the SMS will be added back automatically without additional reconfiguration).

5. The SMS shall be able to directly import the following file formats for the map:

   a. AutoCAD (.DWG)

   b. DXF

   c. JPEG (.JPG)

   d. PNG

6. The Maps feature shall include two operational modes: an administrative mode to allow configuring of the facility floor plans or site plans that show exterior features and a runtime mode to allow monitoring and interacting with the configured facility layouts or site plans.

H. Information Storage, Backup and Transfer:

1. All programmed information, as well as transactional history, shall be automatically stored in the database for later retrieval and backup. The SMS shall support configurations where the SMS database(s) may be installed on a hard drive on the SMS server, on an independent database server, or in an existing corporate database server.

2. The SMS shall be capable of backing up and restoring all system data and transactional history. The server shall be capable of transferring all programmed data and transactional history to CD-ROM, DVD, or Hard Drive (including networked drives).

3. The SMS shall allow activity history to be written to a database. The system shall have the capacity to store a minimum of 50 million transactions. There shall be a method of backing up the activity history on external media and then restoring and replaying it.

4. The SMS shall support AES 256-bit encrypted communications between server and user client.

5. The SMS shall support AES 256-bit encrypted communications between server and controller. The encryption shall support both local and third-party digital certificates.

I. Communication Ports:

1. The SMS shall be able to support multiple serial devices. In addition to COM1 and COM2, up to 32, additional ports may be configured through the use of a port expander or its equivalent. These serial ports may be used for connection to CCTV matrix switchers, or apC panels.

2. The SMS shall support the use of Ethernet networks as the communications path between the host computer and field devices. This communications path shall be the same network used for communications between the host server and the operator workstations. The communications between the host computer and the field devices shall be encapsulated in a TCP/IP network/transport layer.

J. Printers:

1. The SMS shall support report printing. The report printer(s) may be connected directly to the client PC or shared over a network. The SMS shall support as report printer(s) any printer for which a printer driver exists within the Windows 7, Windows 8.1 and Windows Server 2008 operating systems.

K. Software Configuration:

1. The SMS configuration tools shall utilize intelligent configuration controls. The system shall be structured so an operator is unable to perform configuration functions that are invalid based on the configuration used. The system shall support the ability to search within browser lists using filtering operators such as “begins with”, “ends with”, “contains”, etc. The system shall also allow an operator to do searches using filtering operators on any class of object in the system, both in the Administration application and the Monitoring Station application.

2. The SMS shall allow text description of all configured objects. The SMS shall allow the renaming of an existing title description without removing the sub-components of that configuration object. The SMS shall automatically remove from the system all configuration references to an object being deleted. The SMS shall automatically provide default names for all inputs, outputs, readers, and extension boards. The SMS shall clearly display which hardware objects (inputs, outputs, readers) on a controller are configured, and which are not.

3. The SMS shall provide for the configuration of templates. Templates of supported objects shall be operator-configurable to provide default values for data fields within an object class’s configuration.

4. The SMS shall support an unlimited number of groups for any object type. The SMS shall support unlimited object group definitions. In general, a group shall be usable wherever an individual object is referenced in the SMS. For example, a group may be used instead of an object when configuring a schedule/object pair in a clearance, and a group may be used instead of an object when performing a manual action to unlock a door.

5. The SMS shall generally allow any object in the system to be grouped including personnel, doors, inputs, outputs and clearances.

6. The SMS shall restrict the viewing and controlling of objects in the administration and monitoring stations via operator privileges. The SMS shall support the configuration of operator restrictions on an object class basis, and on an object-by-object basis. The SMS shall maintain a distinction between objects that are being monitored and objects that are being controlled, preventing operators from issuing object manual actions to objects for which the operator does not have manual action privileges. There shall be different levels of controls within the system for administration privileges versus monitoring privileges.

7. The SMS shall support unlimited operator accounts with unlimited definable privilege levels.

8. The SMS shall allow configuration of controllers using hierarchical tree-based navigation and context menus.

9. The SMS shall support the ability to download firmware updates to the controllers.

10. The SMS shall support the following methods for Operator authentication and authorization:

    a. Windows Single Sign-On (SSO)

    b. Basic User Authentication with locally defined user names and passwords with strong password rule enforcement.

11. The SMS shall provide an automatic client update process for quick distribution of application updates.

12. The SMS shall have context sensitive online help (at the screen level) available at any point requiring operator input.

L. Personnel Records:

1. The SMS shall provide Personnel Templates that shall eliminate repetitive data entry by pre-configuring Personnel Records with data common to all Personnel.

2. The SMS Personnel records shall provide multiple tabbed pages of personnel data containing default system and user-defined fields. The SMS shall support an unlimited number of tabs allowing an unlimited number of user-defined fields. Labels for user-defined field tabs shall be customizable by the System Administrator with the appropriate privileges. Each user-defined field shall allow a name, description and label. A default language shall be selectable by the System Administrator for the user-defined field labels.

3. User-defined fields shall be definable as Mandatory or Unique and shall support the following field types:

    a. Character

    b. Integer

    c. Logical

    d. Date/Time

    e. Date

    f. Time

    g. Enumerated List

    h. Multi Line

i. Decimal

j. Identity

4. User-defined fields shall support masking to provide consistency of data entry across all system operators. Custom masks, as well as the following predefined masks, shall be available:

a. Alphabetic

b. Alphanumeric

c. Numeric

d. Phone Number – USA

e. Zip Code

f. Zip Code +4

g. Alpha – All Caps

h. Alpha – All Lower case

M. Credentials:

1. The SMS shall support a minimum of five (5) credentials (cards) per Personnel record and shall only count Active and/or Expired Cards towards the maximum assignable Cards per Person. Cards designated as Lost, Stolen and Disabled shall not count towards the maximum assignable Cards per Person.

2. The SMS shall support the ability to define the default period of time (in Days, Hours or Years) from a Credential's Activation Date until its Expiration. The SMS shall support an override of the default Expiration time period for individual Personnel Types.

3. The SMS shall support Temporary Credentials. Temporary Credentials shall be available for general re-use without being associated to specific Personnel records. Temporary Credentials shall be assignable to visitors and can also serve as temporary replacement cards for Personnel who misplaced or forgot their regular Credentials. The SMS shall support the configuration of a default number of days for Temporary Credentials to remain active after they are created.

4. The SMS shall provide the ability to define background colors for the Active/Expired Credential Status fields in the Personnel Record.

5. The SMS shall support a system-wide setting to automatically disable Personnel Credentials that have not been used for a specified period of time. The Disable by Inactivity process shall support a user configurable daily scan time.

N. Personnel Views:

1. The SMS shall support user-defined Personnel Views. Personnel Views shall provide the ability to customize the Personnel record by adding and/or removing certain objects from the operator's view. Personnel Views shall be assignable to SMS operators via the operator's assigned privilege and shall be definable for use in the creation and/or editing of the Personnel record. All Personnel Views enabled for an operator shall be selectable from the current view to allow an operator to switch views in real time. Personnel Views shall support the following:

   a. Adding/Removing Fields (including all user-defined fields)

   b. Custom Field Labels

   c. Adding Boxes to group together common fields

   d. Adding/Removing tabs to organize fields

   e. Custom Tab Labels

   f. Customization of Tab display order

   g. Background/Foreground color control of fields and labels

O. Inputs:

1. The SMS shall monitor both supervised and unsupervised hardware inputs as well as virtual inputs such as predefined system messages. These inputs include door / elevator inputs and monitor points. The SMS shall also monitor controller inputs such as tamper, AC fail, and low battery.

2. The SMS shall have the ability to name and allow for user-defined descriptions for individual inputs, outputs, and readers as well as input and output modules.

3. There shall be three separate and distinct states for inputs, which can be defined on the input configuration screen: Disabled, Enabled / Disarmed and Enabled / Armed.

4. The SMS shall allow configuration to link the state of an input to an output. The system shall allow multiple inputs to activate a single output or group of outputs.

P. Outputs:

1. The SMS shall have outputs, also known as Control points, that associate an input or event action with a relay output. These output uses include doors / elevators, alarms and industrial control.

2. There shall be three types of outputs available: dry contact / Form C relays, wet or voltage sourced relays and Open Collectors. Outputs shall be configured such that they can be activated, deactivated or pulsed by system actions.

Q. Card and Reader Support:

1. The SMS shall be designed to support multiple card formats and card reader types.

2. The SMS shall support the following features for directly connected readers:

a. User defined card formats up to 256 bits.

b. Unlimited number of SMS card formats.

c. The ability to assign up to 10 card formats per reader.

d. The ability to show reader status on RM LCD.

e. Support Wiegand and 3x4 matrix keypads.

f. The enrollment of biometric templates to smartcards.

g. Custom CHUID FIPS201-compliant supporting full 256-bit data.

h. The SMS shall support readers that provide Wiegand signaling and magnetic signaling to include:

(1) HID card readers

R. Advanced Door Monitoring:

1. The SMS shall support Advanced Door Monitoring allowing additional monitoring inputs and lock sensing equipment at all doors. Advanced Door Monitoring shall allow integration with third-party lock release inputs, such as fire and crash bar devices, that control emergency egress.

2. Advanced Door Monitoring shall include:

a. Multiple inputs – Advanced Doors shall support up to 16 inputs.

b. Single and double-leaf doors with multiple DSM or Request To Exit (RTE) inputs.

c. Shall support Lock sensing devices – to monitor locking on magnetic bonds, bolts, and cams.

d. Integrated lock releases – to integrate door unlocking with fire, crash bar, power fail, and key switch inputs.

e. Special events and actions – to create keypad commands that lock, unlock, and secure doors for a specific time period.

f. Alarm Suppression and RTE control on a per door basis.

g. Enhanced Shunt control.

h. Grace and change timing options – to fine tune the SMS timing to avoid the effects of 'door bounce'.

i. Journal reports and Monitor Station activities – to manage the system and monitor door activity.

j. Additional Event Actions related to Advanced Doors

S. Door Configurations / Elevator Control:

1. The SMS shall allow doors to be configured to operate in any of the following access control modes:

a. Unlocked

b. No Access (Secure mode)

c. Any combination of the following, as defined by schedule, event, card only, Card entry and biometrics.

2. The SMS shall allow a door to be configured to operate using the following functions:

a. Readers shall read cards while the door is in the open position.

b. Door lock relay shall automatically lock upon the door being opened.

c. Allow for a user-defined delay relock time period.

d. Allow for a user-defined door unlock time and door held open time.

e. A separate (alternate) shunt timer for ADA flagged cardholders

f. The operator shall be able to specify a shunt expiration output to be triggered for a configurable time (in hh:mm:ss) before the expiration of the door open or alternate shunt. Can be enabled for ADA only, or all the time.

g. Allow for a user-defined door unlock and door held time, in seconds.

h. PIN-only access (keypad).

i. PIN-entry on the reader keypad shall be required during a specified schedule after a card access (unless a manual action or event has disabled PIN).

j. Card entry through keypad.

3. The SMS shall allow each door to be configured to cause a variety of events such as alarms to occur based on activity at that door.

4. The SMS shall support configuration of unlimited elevators.

5. The SMS shall support an extended unlock function initiated via two valid card presentations to a single reader or a 'double swipe'. The double swipe feature provides the ability to designate doors at which cardholders with double swipe privileges may perform an extended lock or unlock of the door. The double swipe feature shall support the following:

a. Modified reader beeper pattern to reflect the extended unlock mode.

b. Individual card access privileges to perform double swipe action.

c. Unique parameters assignable to any door.

d. Reset of a double swipe unlock (relock) via scheduled event.

e. Event activation to reflect double swipe state (Lock, Unlock).

T. Maintenance Mode:

1. The SMS shall support a Maintenance Mode to facilitate the installation, testing and maintenance of selected SMS objects. Maintenance Mode shall be used to limit information about an object displayed on the SMS Monitoring Station. An SMS System Operator, with the appropriate Privileges, shall be able to place SMS objects into Maintenance Mode. Placing an object into Maintenance Mode shall not prevent SMS actions associated with that object from occurring. Maintenance Mode shall only affect the Monitoring Application and shall allow the System Operator to:

a. Only view those objects in Maintenance Mode

b. Exclude those objects in Maintenance Mode from an Operator's view

c. View information about all System objects, including those in Maintenance Mode

2. Operator Privilege and Application Layout Filtering assignments shall determine whether or not an object in Maintenance Mode is viewable as being in Maintenance Mode on the Monitoring Station. Only Monitoring Station operators with the correct privilege and Application Layout Filtering shall be able to view objects in Maintenance Mode. Maintenance Mode shall only be reported in Journal messages when an object is placed in Maintenance Mode.

3. The following objects shall be supported in Maintenance Mode (at a minimum):

a. Controllers

b. Doors

c. Readers

d. Input/Output Modules

e. Inputs

f. Outputs

g. Elevators

h. Events

i. Areas

j. Intrusion Zones

k. Keypad Commands

U. Area Control and Antipassback:

1. The SMS shall support the ability to define Area configurations. Areas are defined as physical regions bounded by doors. An area shall consist of a room, a specific location(s) within a building, or an entire building

2. All configured areas shall have in/out access doors providing the ability to run reports showing all present cardholders in each area. There shall be no way to leave an area without presenting a credential to a reader/door.

3. The SMS shall support Global Antipassback and shall allow an area to be configured to cross multiple clusters (groups of controllers) to enforce Global Antipassback decisions.

4. The SMS shall provide the ability to run a Roll Call report. The host shall maintain a current area for each personnel record, and the time at which the area was entered (AreaAccessTime).The current area shall represent the last area entered by the cardholder based on a valid admit.

5. The SMS shall support Area control to provide the ability for tracking personnel. With this function, an operator shall obtain the current location of cardholders. Dynamic views and or reports can be generated to show specific cardholders who are present in each defined area.

6. Each cardholder's record shall provide easy access to view and maintain their current area location. This card record property will be updated as a person moves from one area to another using a valid credential.

7. The local controller shall provide the ability to manage and control the Area configuration in the event that it loses communication with the SMS system server.

8. The SMS Area configuration shall have three modes of operations: None, Antipassback, and Timed Antipassback.

9. Antipassback shall control access based on the cardholder's location. The SMS shall deny access to cardholders who are in violation of antipassback rules. In the event that a cardholder leaves an area without presenting their credential to the Out access reader/door and then tries to enter back into the area by swiping the In access reader/door, a denial of access will occur. The SMS shall provide the ability to grace individual cardholders who have violated antipassback rules. The Grace option shall also provide the ability to grace all cardholders.

10. Antipassback shall continue to be enforced during communications failure. SMS controllers shall have the ability to be clustered in a group. The master controller in the group and all other controllers within that group shall have full access to the existing antipassback information. The cluster can be configured for 'No Access' Communications Failure mode or for 'Local' Communications Failure mode.

11. Clustered controllers configured in 'Local' mode that are disconnected from the master controller shall grace all cardholders from antipassback violations. The disconnected controller shall then follow antipassback rules specific to the areas defined on that controller. If the controller does not know if a cardholder is in antipassback violation based on areas that are configured between controllers, access will be granted.

12. Clustered controllers configured in 'No Access' mode that are disconnected from the master controller mode shall not grace all cardholders from antipassback violations. All cardholders will receive a denial of access until communications is restored.

13. The SMS shall support Timed Antipassback. Areas configured for Timed Antipassback shall require a cardholder use an exit reader to exit an area. Cardholders who do not exit properly shall be required to wait for a predetermined period of time before re-entering the area.

14. The SMS shall support Pass-through Areas. Area Pass-through shall serve to restrict the length of time that Personnel can remain in an Area before being required to exit or pass through to another area. The SMS shall support a user-defined time period for the Pass-through area. Personnel Groups shall be configurable with Pass-through Restrictions and each Personnel Group shall support a separate, user-defined time period that may be different than the Area-wide time interval. Personnel Groups shall be configurable to be exempt from Pass-through Restrictions.

15. The SMS shall provide occupancy restrictions for areas. Restrictions shall be applied to individual cardholders (personnel) or user defined groups of cardholders. Areas shall be configurable to provide limits for the maximum and minimum number of personnel who can access an area at one time. It shall be possible to trigger an event based upon a violation of either of these rules. Events shall be configurable based upon the following criteria:

    a. Maximum occupancy status

    b. Minimum occupancy status

    c. Group Maximum occupancy status

    d. Group Minimum occupancy status

    e. Personnel Count (user-defined)

    f. Violation status (Antipassback entry/exit violation etc.)

16. The SMS shall support Soft occupancy restrictions for both maximum and minimum occupancy to allow reporting of violations while still allowing access to the area.

17. The SMS shall support Area Lockout. Area Lockout shall restrict or lockout certain cardholders from an area once they have accessed another area. The cardholder shall be locked out of the designated target Area or Group of Areas for a specified period of time. The maximum time period for lockout shall be five (5) days. The target locked-out Area shall be any of the following:

    a. Same Area

    b. Another Area

    c. Area group

18. The SMS shall allow a System Operator with the appropriate privileges to cancel the lockout time (lockout grace) for all or individual cardholders, thereby canceling the area lockout.

V. Intrusion Zones:

1. The SMS shall support the configuration of Intrusion Zones. An Intrusion Zone is a user-defined group of Doors and Inputs on the same local Controller that delineates a physical area. This area shall be monitored and produce an alarm during any violation of the objects associated with the Zone.

2. The local controller shall provide the ability to manage and control the Intrusion Zone in the event that it loses communication with the SMS system server.

3. The Intrusion Zone shall have 2 modes of operations: Armed or Disarmed. When an Intrusion Zone is in an armed mode, the state of the Intrusion Zone shall either be Violated or Not Violated based on the state of the inputs and doors associated with the Zone. If the Zone is violated the SMS shall provide the ability to execute any defined event(s) within the SMS.

4. The SMS shall provide the ability to display the "Ready to Arm State" of any configured Zone. The "Ready to Arm State" shall be able to be displayed from any SMS monitoring application or from a local reader with an LCD display. All off-normal points/doors shall be able to be displayed from both locations. If any point or door associated with a Zone is not in a normal state, the Zone shall show a "Not Ready to Arm State".

5. When a door is placed in a Zone, the operation of the door shall be configured based on the state of the Zone (unlocked, locked, secure). Specific doors assigned to the Intrusion Zone shall be configured as entrance or exit points for the Zone. When the Zone is being armed or disarmed, a user-definable time shall be set for exit or disarm operations. Specific readers/doors shall have the ability to be defined as arm/disarming stations.

6. The Intrusion Zone shall be configured such that when an input configured in a Zone is active, the Zone cannot be armed without executing a force arm. When a Zone is force armed, the input(s) that were in an active state shall not function as part of the Zone until they are placed back in a normal state and the Zone is disarmed and rearmed.

7. Inputs configured in a Zone shall have the ability to be configured as Controlled Inputs or Monitored Inputs. A Controlled Input shall follow the state of the Zone. If the Zone is disarmed, the Controlled Input shall be disarmed as well. A Monitored Input shall have the ability to cause a Zone violation even if the Zone is in a disarmed state.

W. Schedules:

1. The SMS shall support unlimited operator configurable schedules. Each schedule shall allow unlimited individual time intervals.

2. Each system controller shall support a minimum of 128 schedules and a minimum of 18 time intervals per schedule.

3. Each schedule shall consist of operator-defined time segments. Each time segment shall be day(s) of the week and include holidays and starting and ending times. The system shall provide grouping of days.

4. Recurring schedules shall be supported and provide hourly, daily, weekly, bi-weekly, monthly, quarterly, annual and semi-annual intervals. Recurring schedules shall support a start date and shall be configurable to end by a certain date or after a pre-defined number of occurrences.

5. Recurrence patterns shall be supported to allow:

   a. Schedule recurs every X year(s)

   b. Schedule activates on the last day of each month

   c. Schedule activates on the specified day of each month

   d. Schedule activates on the first, second, third etc. weekday of each month

X. Holidays:

1. The SMS shall support unlimited holidays.

2. The SMS shall support holiday type designations as Recurring Day of Month, Recurring Relative Monthly, Non-Recurring or Day of Week. The SMS shall allow assignment of duration to each holiday.

3. Holiday groups can be assigned to a Schedule.

Y. Time Zones:

1. The SMS shall maintain time zones to be used when configuring certain system objects. A time zone shall adhere to standard international Time Zone behavior, and the system shall support all time zones supported by the Windows OS.

2. The SMS shall allow time zones to be assigned to IP devices, controllers, CCTV matrix switchers, DVRs, and scheduled Manual Actions.

Z. Clearances:

1. The SMS shall support configuration of unlimited Clearances.

2. The controllers shall support up to 150 clearances per person.

3. The SMS shall support clearance activation and expiration date and time.

4. The SMS shall support the ability to select multiple personnel from a Dynamic View and assign clearance(s) to the selected personnel.

5. The SMS shall support the ability to select multiple personnel from a Dynamic View and remove clearance(s) from the selected personnel.

AA. Custom Clearances:

1. The SMS shall support the configuration of up to 20 Custom Clearances per Personnel record and up to 100,000 system-wide. Custom clearance shall give unique individualized access to Doors/Door Groups and Elevators/Elevator Groups during an assigned schedule. The SMS Custom Clearances shall also support the assignment of activation and expiration dates.

2. The SMS shall support a process to remove expired custom clearances from personnel records. The process shall be configured as a system-wide event action with the option to activate by schedule.

BB. Clearance Filters:

1. The SMS shall support Clearance Filters. Clearance Filters shall provide the ability to dynamically change the access rights of personnel (cardholders) or groups of personnel. Personnel with a lower Clearance Filter level than that assigned to a card reader shall be denied access to that card reader (door). Clearance Filter levels shall be assignable to card readers either manually or automatically via event logic or a time schedule.

CC. Events:

1. The SMS shall support unlimited operator configurable events, including the scheduling of events, and action-based trigger of events.

2. The system shall provide 8 configurable event priority levels with a total of 200 numbered event priorities. The system shall allow the operator to define custom colors and labels per individual priority level.

3. The system shall allow an event to be configured to:

a. Be sortable by event name, date/time, priority, state, and any other displayable information.

b. Be routed to operators by operator privileges, including support for the routing by time of day feature.

c. Require or not require operator acknowledgment.

d. Require or not require operator clearing.

e. Require or not require a log message to be entered by the system operator acknowledging the event.

f. Require or not require a log message to be entered by the system operator clearing the event.

g. Display or not display the event activation.

h. Require the object(s) causing the event activation to reset before the operator may acknowledge the event.

i. Display an operator-defined text message upon event activation.

j. Display an operator-defined text message when the event is deactivated.

k. Be associated with a map so the map opens automatically on the monitoring station when the event activates.

l. Activate a second event when the first event activates and is unacknowledged for a specified period of time.

m. Activate a second event when the first event activates, is acknowledged and is not cleared for a specified period of time.

n. Allow the operator to associate an audio wave file with the event.

o. Allow for minimum activation time and delayed activation time for events.

p. Download events to the iSTAR controllers.

q. Run imports and exports.

r. Run reports and remove report results.

4. Event Instructions:

a. Each event shall support event instructions to be displayed in the Event Details Screen. Event instructions shall support a maximum of five hundred characters and shall support website addresses, UNC addresses and local file paths.

5. Latch, Unlatch, Toggle, and Pulse for Event:

    a. The SMS shall support Event Actions and Manual Action buttons that can be used to Latch, Unlatch, Toggle, and Pulse other Events.

        (1) The SMS shall support a “Latch” Event Action which shall cause it to activate and remain activated.

        (2) The SMS shall support an “Unlatch” Event Action which shall cause it to deactivate and remain inactive.

        (3) The SMS shall support a “Toggle” Event Action which shall reverse an Event’s Latch-Unlatch state: switching a Latched Event to an Unlatched Event and vice versa.

        (4) The SMS shall support a “Pulse” Event Action which shall cause an event to activate momentarily.

6. The SMS shall allow an operator to create a copy of an existing event from within the event editor.

7. Event Assessment:

    a. The SMS shall provide an Event Assessment Feature which allows an operator to quickly view all objects associated with an event in a user defined Event Assess Application Layout.

    b. The SMS shall not require the operator to navigate away from the event assessment window to review objects associated with the event.

    c. The SMS shall provide an Event Editor “Assess Configuration” to allow an operator to configure the objects available during the assessment of an event in the Monitoring Station.

    d. The Assess Event Application Layout shall have the following capabilities:

        (1) View any documents associated with the Event.

        (2) View live video associated with the Event.

        (3) View recorded video associated with the Event.

        (4) View Event details.

        (5) View a Map associated with the Event.

        (6) View a Journal Replay of the event, based on a query associated with the Event.

(7) Use an Event Details Viewer with additional quick action buttons to process the Event.

e. Each event shall provide the ability to show the entire Event Assessment with a single mouse click via an icon.

f. The event assessment layout shall only be available for viewing by operators with appropriate privilege.

DD. Manual Action Challenge:

1. The SMS shall support Manual Action Challenges. The Manual Action Challenge shall require a SMS operator to enter their login credentials (User name and password) when executing a manual action from within the SMS.

2. The Manual Action Challenge shall be available from both the Administration and Monitoring Applications.

3. The Manual Action Challenge shall be assigned to a Privilege and the Privilege shall be assigned to the SMS operator.

EE. Document Editor:

1. The SMS shall support the ability to import multiple types of document objects to include:

a. PDF, TXT, XML, DOC, XLS, JPG, GIF, PNG, TIF

2. The SMS shall have the ability to attach these object types to the following areas:

a. Personnel records to provide additional information.

b. Events as part of the Events Assessment Feature.

c. A Guard Tour

FF. Import / Export:

1. The SMS shall provide a means for manually importing and exporting selected data in XML format. This mechanism shall support the import and export of any and all classes or types of data in the system. Specific data validation and logging requirements shall be met.

2. The system shall also support importing from CSV files.

3. The SMS shall provide an automated import mechanism (preferably XML-based). This mechanism shall support the import of most classes or types of data into the system. Specific data validation and logging requirements shall be met.

4. The SMS shall have the capability to perform automated imports from an Open Database Connectivity (ODBC) data source allowing the import of personnel data directly into the system database.

5. The system shall have the ability to connect to a directory service source via the Lightweight Directory Application Protocol (LDAP). The connection to the LDAP source shall be user-configurable directly from the SMS and shall not require custom code. The LDAP interface shall also support the automatic assignment of SMS clearances based on data contained in the LDAP record. The LDAP feature shall support the following features:

    a. LDAP server name and user-defined port number.

    b. A base distinguished name for the root of searches.

    c. A user-definable LDAP search filter to refine object search.

    d. User-defined mapping of attributes to SMS personnel fields.

    e. The use of a Distinguished Name (DN) entry for the SMS to authenticate to LDAP.

    f. Option to search all sub-levels of the directory from the base DN.

    g. Preview sample-data based on SMS LDAP import settings.

    h. Automatic roles-based SMS clearance(s) based on two fields of source data.

    i. Automatic import of directory entries from the LDAP source.

    j. Authentication via a user-definable LDAP user account and SSL.

    k. Automatic SMS clearance assignment.

6. The SMS shall provide a Data Mapping feature that provides field mapping information using the XSLT file based on the input data or an external XSLT file.

7. The SMS shall support Import and management of Operators with their respective Privilege Groups using XML and LDAP role-based templates.

GG. Objects:

1. Each object within the SMS shall be addressed by a unique operator-defined name. Object names shall be unique within object types.

2. The SMS shall provide the ability to add description text to each object definition.

HH. Reports:

1. The SMS shall support a Report Service that runs as a Windows Service. The Report Service shall operate in either 64 or 32 bit mode. The Report Service shall execute Reports that are either run on the Server by an Operator or configured to run automatically as an Event Action.

2. The SMS shall provide configurable data reports for database configuration, historical activity (Journal) and audit tracking. Pre-defined reports shall be available for download and import into the system.

3. The SMS report function shall perform the following:

    a. Create reports about any object.

    b. Create report templates to simplify report design.

    c. Run reports on demand.

    d. Save report results for sharing between different users of the application.

    e. Export reports into formats such as PDF, RTF, TXT, TIFF, Excel (XLS), and MHTML.

    f. Specify a query to select and filter the records on which to report.

    g. Specify the data fields to be included in a report.

    h. Specify a design for the report layout.

    i. Design a report form to be used as a layout for headers / footers for multiple reports.

    j. Access and use system pre-defined report forms.

    k. Select tabular, multi-line, or free form report layouts.

    l. Report on objects linked together with parent / child relations.

    m. Schedule reports to run automatically on a customized schedule.

    n. Send exported report files to the printer or to external recipients via e-mail.

4. The reporting suite shall provide an interactive user experience via any standard web browser, allowing the user to scrutinize the information without needing to print or review hard copies.

5. The reporting suite shall support connecting to one or more SMS systems. This shall provide data and reports across an enterprise solution to allow segregated reports that reflect both satellite application server data as well as master application server data.

6. The reporting suite shall allow an enterprise to share and blend data from other sources such as ERP and Time and Attendance systems to yield critical business information and reporting.

7. The reporting suite shall provide information delivery options such as email, CSV export, PDF export, XML data transfer, or database pool offerings. The suite shall also be a critical resource in system review and audit procedures such as system maintenance and performance.

8. The Reporting Suite shall:

    a. Provide Intuitive user interface and web-based reporting for SMS customers

    b. Share and blend data from other sources to yield critical business information

    c. Leverage Microsoft® Business Intelligence (BI) tools

    d. Include Reporting Service for report delivery and presentation

    e. Perform Reporting and processing from the SMS host

    f. Include Subscription options for automated delivery of reports

    g. Include Dashboard, graphical, and statistical reports, and reports customized by user

    h. Generate Reports on any PC with compatible Web browser without SMS Client software

    i. Offer and secure Data via Active Directory and SQL permissions

    j. Include Optional front end or other application integration including SharePoint

II. Dynamic Views:

1. The system shall support a grid format displayable report that will be usable to display homogeneous lists of objects within the system. This display shall be configurable both at configuration time and also at run time.

2. The Dynamic views shall have the following features:

   a. Real-time updating and display of property values.

   b. The display shall be sortable.

   c. Groupable by any number of columns.

   d. Filterable based on user selectable criteria.

   e. Printable.

   f. Can be saved as a MS Excel file from the current view.

   g. Exportable in either XML or CSV file formats.

   h. The export file shall be viewable in Excel (Excel must be installed separately).

   i. The export file shall be able to be emailed.

   j. The user shall be able to add and remove columns from the grid at runtime to enhance the user experience even if displaying a preconfigured view.

   k. The view shall be capable of pre-configuration so that repeatable displays of objects are possible.

   l. The view shall support in-place editing of properties of the object.

   m. Bulk operations shall be performed via multi-selection. The operations shall consist of (but are not limited to) setting a property to a value and deletion.

JJ. Query:

1. The SMS shall provide a Query engine to be useful for users without any knowledge of SQL or any other specific query language. It shall allow users to make requests against data sets with preconfigured relations between tables. The relations shall reflect the actual relations between database objects and the user shall be able to put conditions on any available field in the selected object type and its subordinate objects.

2. The users shall be able to construct a proper query expression selecting all available operations, column names, and table names from prompted lists. It shall eliminate the necessity to memorize any particular expression syntax. References to existing configuration objects shall also be prompted through a list of existing objects where applicable, eliminating the necessity of memorizing names. The Query feature also shall support complex logic, such as AND/OR.

3. Negative logic Queries using the new NOT IN operators.

4. The SMS shall support Query filters that perform AND/OR operations to narrow Query results. The SMS shall also support building complex query operations by use of block filters that perform AND/OR/AND NOT IN/OR NOT IN operations to further narrow Query results.

5. The SMS shall provide a Journal Query Assistant as a special method of the Query engine to query on XML fields within Journal Messages. This method shall allow the user to build queries on Journal messages. The Journal Query Assistant shall support Card Admitted, Card Rejected, Operator Login and Operator Activity message types, Area Activity, Object Changed State and Manual Action message types.

KK. Digital Video Surveillance Integration:

1. The SMS shall integrate with the video surveillance system and provide automatic call ups to the video monitor upon any and all alarms generated from the SMS system.

LL. General Purpose Interface:

1. The SMS shall support a licensable General Purpose Bi-directional Serial Interface.

2. The General Purpose Interface shall be a programmable bi-directional communication protocol that shall provide a general mode of communication between the SMS General Purpose Interface driver and a third-party device.

3. The third-party device shall send pure ASCII messages via a serial port (RS-232) or remotely via a TCP/IP port (via a Terminal Server) into the General Purpose Interface driver.

4. The SMS shall interpret messages in two ways:

5. As journal messages recorded into the SMS historical journal.

6. As any of five Monitoring Point status changes configured to trigger an SMS event.

7. The General Purpose Interface supports the following functionality:

a. Input: where the input strings are sent from the device through the Serial/Network port to the SMS Server. The General Purpose Message Protocol object is used to define and parse the information.

b. Output: where the output is an Action and requests a response from the device.

c. Poll: where the poll is an action that requires a response from the device.

MM. ID Badging Subsystem:

1. The SMS shall include an embedded ID Badging Subsystem. The ID Badging subsystem shall utilize a common database with and be an integral part of the SMS. The ID Badging Subsystem shall provide the ability to capture cardholder images and design and print user-defined badge layouts. The Badging Subsystem shall support the following capabilities:

   a. Unlimited number of badge design layouts.

   b. WYSIWYG badge designer.

   c. Background color detection in the portrait image.

   d. Threshold level selection to apply to background detection.

   e. User-defined selection of background color.

   f. User-defined selection of replacement color or transparency setting.

   g. Edge-detection setting, to aid in replacing only the selected background and not any matching color within the portrait image.

   h. Capture, import, and display portraits.

   i. Capture, import, and display signatures.

   j. Capture and display fingerprints.

   k. Insert, import, and display foreground and background images.

   l. Print two-sided badges.

   m. Encode magnetic data onto personnel badges.

   n. Insert 1D or 2D bar codes.

   o. Insert or replace color and transparent effects for image and background display.

   p. Support a variety of image formats including .bmp, .jpg, .tif, and .wmf.

   q. Custom functions using the Expression builder.

   r. Multiple images per cardholder.

s. Diagonal and Square borders. Each type of border shall support a user-defined width and height setting, and individual color settings for each border side.

t. Proper Case (first letter in string is set to uppercase, all other characters set to lowercase).

u. Year display (four- or two-digit).

v. Month display (full or abbreviated name, or numeric).

w. Day display (full or abbreviated name, or week/month numeric).

x. Hour display (12 or 24 hour format).

y. Minute display.

z. Second display.

NN. Smart Card / Proximity Card Enrollment:

1. The SMS shall provide a smart card enrollment feature as part of the ID Badging Subsystem. The smart card enrollment feature shall allow a user to enroll MIFARE, iCLASS or DESFire cards utilizing a USB wedge reader or a Manufacturer-approved badge printer.

2. The SMS shall provide a proximity card enrollment feature as part of the ID Badging Subsystem. The proximity enrollment feature shall allow a user to enroll the card number of proximity cards on a Fargo HDP 5000 printer that is equipped with an OMINKEY CardMan 5x25 encoder.

3. The ID Badging Subsystem shall support the creation of Smart Card Templates to define the smart card configuration. Templates shall be used to define the data transfer between the physical card and the Personnel Record. Templates shall define the card type as MIFARE, iCLASS or DESFire. When programming a card, the system shall be able to read and write to all relevant data such as personnel fields, card fields or card formats. The Badging Subsystem shall provide the ability to Enroll MIFARE, iCLASS or DESFire. The Badging Subsystem shall provide the ability to Program and Enroll MIFARE.

4. Templates shall also be utilized to define the Security Keys needed to access the data on the smart card. Templates shall be assignable to the enrollment device (wedge reader or printer).

5. The ID Badging Subsystem shall support both the enrollment (reading of data from the card) and programming (writing of data to the card) for MIFARE cards. The ID Badging Subsystem shall support the enrollment of DESFire cards and shall support Card Serial Number data only. The ID Badging Subsystem shall

support the enrollment of iCLASS cards and shall support Card Serial Number data only.

OO. System Parameters:

1. The Security Management System (SMS) shall have a minimum capacity of:

   a. 250,000 Global Personnel Records

   b. 16 online readers

   c. 64 online inputs

   d. 64 online outputs

   e. 7,000 credentials

   f. 6 simultaneous Clients

   g. 1 Badging Client

2. The SMS shall have a maximum capacity of:

   a. 16 online readers

   b. 2,500+ online readers

   c. 10,000+ online inputs

   d. 10,000+ online outputs

   e. 500,000 credentials

   f. 10 Simultaneous Clients (Additional clients may be added to the license up to 256)

   g. 2 Badging Clients (Additional clients may be added to the license)

3. The SMS shall support a Master Application Server (Enterprise Architecture) with maximum capacity of:

   a. 250,000 Global Personnel Records

   b. 10 Simultaneous Clients (Additional clients may be added to the license)

   c. 2 Badging Clients (Additional clients may be added to the license)

4. The SMS shall support both application and web client connections. The system shall allow the user to define the number of administration/monitoring client connections. This prevents web clients from using these reserved connections.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA/EIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.

1. Record setup data for control station and workstations.

2. For each Location, record setup of controller features and access requirements.

3. Propose start and stop times for time zones and holidays and match up access levels for doors.

4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.

5. Assign action message names and compose messages.

6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.

7. Prepare and install alarm graphic maps.

8. Develop user-defined fields.

9. Develop screen layout formats.

10. Propose setups for guard tours and key control.

11. Discuss badge layout options; design badges.

12. Complete system diagnostics and operation verification.

13. Prepare a specific plan for system testing, startup, and demonstration.

14. Develop acceptance test concept and, on approval, develop specifics of the test.

15. Develop cable and asset-management system details; input data from construction documents.

D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.03 GROUNDING:

A. Comply with Section 28 05 26.

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.

2. Bus: Mount on wall of main equipment room with standoff insulators.

3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.04 INSTALLATION:

A. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch-high

text and symbols as required. Push-button switches shall be connected to the controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.

B. Install card readers, keypads, push buttons, and biometric readers.

3.05 SYSTEM SOFTWARE AND HARDWARE:

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.06 FIELD QUALITY CONTROL:

A. Perform Tests and Inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Fluke DSX cable analyzer series . Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-C.1.

2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.

3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.07 STARTUP SERVICE:

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.

2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.08 PROTECTION:

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.09 DEMONSTRATION:

A. Train Owner's maintenance personnel to adjust, operate, and maintain security access system. Provide a minimum of 40 hours for training.

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.

2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.

3. Security personnel

4. Hardware maintenance personnel

5. Corporate management

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 28 15 00

ACCESS CONTROL HARDWARE DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide access control hardware devices as indicated and in compliance with Contract Documents.

1. The Security Management System (SMS), Access Control Software server is existing and provided by owner, relocated with existing server. Contractor to provide programming for new building.

2. The workstations located in dispatch and the CCTV rooms are to be provided and installed by contractor, provide licenses and software and programming for these workstations.

3. Field devices such as card readers, alarm inputs, control points, etc. shall be connected to fully distributed intelligent field controllers All devices and connections of the field devices shall be by the contractor.

1.02 EXISTING CONDITIONS:

A. The access control system software is existing, manufactured by Hirsch and shall be used in the new buildings.

B. The fiber infrastructure is being provided by others.

C. The Contractor is to provide access control panels and tie into the existing Hirsch Velocity system.

D. Security contractor to shall coordinate with owner the requirements to interface the existing system.

E. Security Contractor to provide and install all field devices including but not limited to, card readers, access control panels etc.

1.03 REFERENCES:

A. Institute of Electrical and Electronics Engineers (IEEE):

1. 1100: Recommended Practice for Power and Grounding Electronic Equipment

B. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

D. Security Industry Association (SIA):

1. CP-01: Security System Standard

2. DC-01: DCS Computer Interface (CIS-1) Technical Report

3. DC-03: DCS SIA Format Standard

4. DC-07: DCS Computer Interface (CIS-2) Standard

E. Telecommunications Industry Association (TIA):

1. 232-F: Interface Between Data Terminal Equipment and Data Circuit- Terminating Equipment Employing Serial Binary Data Interchange

2. 485-A: Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

3. 568-C-1: Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements.

4. 569-D: Commercial Building Standard for Telecommunications Pathways and Spaces

5. 606-B: Administration Standard for Commercial Telecommunications Infrastructure.

F. Underwriters' Laboratories, Inc. (UL):

1. 1610: Central-Station Burglar-Alarm Units

2. 2017: Standard for Safety General-Purpose Signaling Devices and Systems

3. 60950-1: Standard for Safety Information Technology Equipment – Safety – Part 1: General Requirements

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems and anchorage for equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

1.05 DEFINITIONS:

A. CCTV: Closed-circuit television

B. CPU: Central processing unit

C. SMS: Security Management System

D. Credential: Data assigned to an entity and used to identify that entity

E. GFI: Ground fault interrupter

F. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

G. I/O: Input/Output

H. LAN: Local area network

I. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

J. PC: Personal computer. Applies to the central station, workstations, and file servers.

K. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.

L. RAS: Remote access services

M. RF: Radio frequency

N. ROM: Read-only memory. ROM data are maintained through losses of power.

O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

P. UPS: Uninterruptible power supply

Q. USB: Universal serial bus

R. WAN: Wide area network

S. WAV: The digital audio format used in Microsoft Windows

T. WMP: Windows media player

U. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

V. Windows: Operating system by Microsoft Corporation.

W. Workstation: A PC with software that is configured for specific, limited security-system functions.

1.06 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

C. Shop Drawings: For access control. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.

3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.

4. UPS: Sizing calculations.

5. Wiring Diagrams: For power, signal, and control wiring.

D. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test,

set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

E. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

F. Field quality-control reports.

G. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23, include the following:

1. Microsoft Windows software documentation.

2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.

3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

4. System installation and setup guides with data forms to plan and record options and setup decisions.

H. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.

2. Fuses of all kinds, power and electronic, equal to 25 percent of amount installed for each size used, but no fewer than three units.

3. Two controller/interface board of each type used

4. Two card readers each type used.

1.07 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.08 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.09 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

C. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70, "National Electrical Code."

F. Comply with SIA DC-01, SIA DC-03 and SIA DC-07.

G. Comply with UL 294.

1.10 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Central Station, Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 degrees F, and not more than 80 percent relative humidity, noncondensing.

2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

3. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.11 PROJECT/SITE CONDITIONS:

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient

conditions of 36 to 122 degrees F dry bulb and 20 to 90 percent relative humidity, noncondensing.

2. Indoor, Uncontrolled Environment: NEMA 250, Type 3R enclosures. System components installed in non-temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122 degrees F dry bulb and 20 to 90 percent relative humidity, noncondensing.

3. Outdoor Environment: NEMA 250, Type 4 enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 degrees F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick.

4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

5. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 6P enclosures.

PART 2 - PRODUCTS

2.01 EQUIPMENT:

A. Due to the project schedule, it is expected that any specifications given for current technology will be outmoded at the time of procurement. Provide a high performance PC based Security workstations/server compatible with the SMS. The workstations/servers shall to be equipped with the latest generation of processor and graphics technology, large storage capacity with redundancy, the most current operating system, and Ethernet connectivity minimum configuration of the PC or PCs running the SMS.

B. Server Requirements: The Server is existing and shall be reused

2.02 CLIENT WORKSTATIONS:

A. The SMS client workstations are existing and shall be reused.

2.03 BADGING STATION:

A. The SMS badging workstation is existing and is to be reused.

2.04 CONTROLLER:

A. The SMS shall support Hirsch controller compatible with the Velocity SMS

2.05 CLUSTERING:

A. The SMS shall support a user-defined grouping of controllers defined as a cluster. controllers within a cluster shall be able to communicate in a peer-to-peer scheme should the SMS server lose communication with the cluster.

B. Clustering shall support the following features:

1. Assignment of Master controllers for cluster communication to the SMS server

2. Primary and backup communication paths to the SMS server

3. Up to 16 controllers per cluster

4. Logical event linking between controllers in a cluster independent of SMS server communication

5. Asynchronous communication via TCP/IP (Polled devices shall not be acceptable)

6. Encrypted communications

C. Edge FIPS 140-2 and 197 (AES) Encryption – The SMS shall support the qualification of the Edge controller at FIPS 140-2 which meets the necessary physical, operational, and cryptographic requirements for the National Institute of Standards (NIST). The Edge communicates with the host and other cluster members using FIPS 197 (AES) 256 bits.

2.06 CARD READER:

A. Card Reader shall be a multiclass type reader capable of the following:

1. 125 kHz contactless cards supported: HID Prox®, Indala® Prox, Dorado® Prox, and EM Prox legacy contactless credentials

2. 13.56 MHz contactless smart cards supported: iCLASS Seos® , iCLASS SE, iCLASS®, MIFARE® Classic, and MIFARE DESFire®EV1

3. Protocol: Open Supervised Device Protocol (OSDP) mode Wiegand or Clock & Data modes

4. Shall be HID multiclass SE RP40/SE RP10

2.07 ACCESS CARDS:

A. Provide 100 ICLASS SE cards, coordinate with owner for model.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA/EIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.

1. Record setup data for control station and workstations.

2. For each Location, record setup of controller features and access requirements.

3. Propose start and stop times for time zones and holidays and match up access levels for doors.

4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.

5. Assign action message names and compose messages.

6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.

7. Prepare and install alarm graphic maps.

8. Develop user-defined fields.

9. Develop screen layout formats.

10. Propose setups for guard tours and key control.

11. Discuss badge layout options; design badges.

12. Complete system diagnostics and operation verification.

13. Prepare a specific plan for system testing, startup, and demonstration.

14. Develop acceptance test concept and, on approval, develop specifics of the test.

15. Develop cable and asset-management system details; input data from construction documents.

D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.03 CABLING:

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Section 28 05 13.

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Install LAN cables using techniques, practices, and methods that are consistent with Category 6A rating of components and fiber-optic rating of components, and that ensure Category 6A and fiber-optic performance of completed and linked signal paths, end to end. Adhere to TIA-568 and BICSI standards to cabling installation.

E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

F. Install end-of-line resistors at the field device location and not at the controller or panel location.

G. Comply with TIA 569-D, "Commercial Building Standard for Telecommunications Pathways and Spaces."

H. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

I. TIA 232-F Cabling: Install at a maximum distance of 50 feet

J. TIA 485-A Cabling: Install at a maximum distance of 4000 feet.

K. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.

2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 feet, and install No. 20 AWG wire if maximum distance is 500 feet.

3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.

4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

L. Install minimum No. 16 AWG cable from controller to electrically powered locks.

M. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 feet.

3.04 GROUNDING:

A. Comply with Section 28 05 26.

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.

2. Bus: Mount on wall of main equipment room with standoff insulators.

3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.05 INSTALLATION:

A. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch-high text and symbols as required. Push-button switches shall be connected to the controller

associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.

B. Install card readers, keypads, push buttons, and biometric readers.

3.06 IDENTIFICATION:

A. In addition to requirements in this article, comply with applicable requirements in TIA/EIA 606-A.

B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.

2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

C. At completion, cable and asset management software shall reflect record drawing conditions.

3.07 SYSTEM SOFTWARE AND HARDWARE:

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.08 FIELD QUALITY CONTROL:

A. Perform Tests and Inspections:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Refer and comply to Division 27 requirements

2. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Fluke DSX cable analyzer series. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-C.1.

3. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.

4. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.09 STARTUP SERVICE:

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.

2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.10 PROTECTION:

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," or to owners SOC during periods when a qualified operator in the employ of Contractor is not present.

3.11 DEMONSTRATION:

A. Train Owner's maintenance personnel to adjust, operate, and maintain security access system. Provide a minimum of 40 hours for training.

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.

2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.

3. Security personnel

4. Hardware maintenance personnel

5. Corporate management

3.12 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 28 20 00

VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide video surveillance system consisting of cameras, data transmission wiring, as indicated and in compliance with Contract Documents.

B. Video surveillance system shall be integrated with monitoring and control system specified in Section 28 13 00, which specifies systems integration.

1.02 REFERENCES:

A. EN 50581: Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

B. International Electrotechnical Commission (IEC):

1. 60950: Information Technology Equipment

2. 62262: Degrees of Protection Provided by Enclosures for Electrical Equipment Against External Mechanical Impacts

C. National Electrical Contractors Association (NECA):

1. 1: Standard for Good Workmanship in Electrical Construction

D. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

E. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

1.03 EXISTING CONDITIONS:

A. The Video Surveillance system will be an extension of the existing SLCWRF system. Milestone is the installed Video Management System (VMS)

B. The VMS will change to the new Genetec standard VMS. The Genetec VMS will be provided at the new operations building when completed. The use of the Milestone VMS is to be utilized until the new Genetec VMS is provided and programmed.

C. The fiber infrastructure is provided by others into the new building Security/IT/Telecom room located on first floor. Security contractor to provide all fibers from the FDU to electronic security equipment.

D. The Contractor will provide new headend end equipment into the new building,

E. Security contractor to shall coordinate with owner the requirements to interface the existing system.

F. Security Contractor to provide and install all field devices including but not limited to, cameras, power supplies, mounts etc.

G. Integrate existing cameras in to the new video system. Route cameras to nearest network switch and connect. Coordinate with owner for required cameras.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems and anchorage for equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

C. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

D. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.

3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.

4. UPS: Sizing calculations.

5. Wiring Diagrams: For power, signal, and control wiring.

E. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

F. Field quality-control reports.

G. Product Warranty: Sample of special warranty.

H. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23, include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.05 DEFINITIONS:

A. AGC: Automatic gain control

B. BNC: Bayonet Neill-Concelman - type of connector

C. B/W: Black and white

D. CCD: Charge-coupled device

E. FTP: File transfer protocol

F. IP: Internet protocol

G. LAN: Local area network

H. MPEG: Moving picture experts group

I. NTSC: National Television System Committee

J. PC: Personal computer

K. PTZ: Pan-tilt-zoom

L. RAID: Redundant array of independent disks

M. TCP: Transmission control protocol - connects hosts on the Internet

N. UPS: Uninterruptible power supply

O. WAN: Wide area network

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.08 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NECA 1.

D. Comply with NFPA 70.

E. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

1.09 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.10 PROJECT/SITE CONDITIONS:

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 degrees F and a relative humidity of 20 to 80 percent, noncondensing.

2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 degrees F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.

3. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 degrees F dry bulb and 20 to

90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.

4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 degrees F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick. Use NEMA 250, Type 4 enclosures.

5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

6. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use NEMA 250, Type 6P enclosures.

7. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.11 WARRANTY:

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM REQUIREMENTS:

A. Video-signal format shall comply with NTSC standards.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 43 13.

2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 26 43 13 as recommended by manufacturer for type of line being protected.

C. Tamper Protection: Tamper switches on enclosures, control units, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

D. Upon any alarm generated by the access control stations, the system shall automatically display the image of the camera(s) closest to the alarm point on spot monitor next to ACS workstation.

2.02 VIDEO MANAGEMENT SYSTEM (VMS):

A. Genetec Enterprise System

2.03 VMS SYSTEM (BASE) SERVER:

A. Server shall meet the following requirements:

1. CPU: Intel® Xeon®, (Quad Core or better) or Intel® Core™ i5 or better if running on a workstation

2. RAM: Minimum 8 GB

3. Hard Drive: Minimum 500 GB, more for large systems utilizing extensive video database Bookmarking

4. Operating System 64-bit:

a. Windows 10 (Professional and Enterprise)

b. Windows Server® 2012 (Standard, Datacenter)

c. Windows Server® 2016 (Standard, Datacenter)

d. Software: Microsoft, .NET 4.0 Framework, .NET 4.6.2

5. Framework and Internet Information Services (IIS) 6.0 or newer, Microsoft SQL Express 2014 or Microsoft SQL Server 2012, 2014 and 2016.

2.04 VIDEO CLIENT WORKSTATIONS:

A. Workstation shall meet the following requirements:

1. CPU – Intel Core i5™ or better

2. RAM – 8 GB minimum (16 GB or more recommended)

3. Operating Systems (all 64-bit):

   a. Windows® 10 (Professional and Enterprise)

   b. Software – DirectX 9.0 or newer, Microsoft .NET 4.6.2 Framework

   c. Graphics Adapter – PCI-Express, minimum 256 MB RAM, Direct 3D supported

2.05 1080P COLOR DOME CAMERA:

A. Camera:

   1. Camera Image sensor: Progressive scan RGB CMOS 1/3 inch

   2. Lens Varifocal, 3.0–10.5 mm, F1.4, Horizontal field of view: 92 degrees–34 degrees, Vertical field of view: 50 degrees–20 degrees

   3. Remote focus and zoom, P-Iris control, IR corrected

   4. Day and night Automatically removable infrared-cut filter

B. Minimum illumination: HDTV 1080p 25/30 fps with WDR - forensic capture and Lightfinder:

   1. Color: 0.15 lux at 50 IRE, F1.4

   2. B/W: 0.03 lux at 50 IRE, F1.4

C. HDTV 1080p 50/60 fps:

   1. Color: 0.3 lux at 50 IRE, F1.4

   2. B/W: 0.06 lux at 50 IRE, F1.4

D. Shutter time 1/66500 s to 1 s

E. Camera angle adjustment: Pan plus or minus 180 degrees, tilt minus 5 to plus 85 degrees, rotation plus or minus 95 degrees

F. Video compression: H.264 Baseline, Main and High Profile (MPEG-4 Part 10/AVC) Motion JPEG

G. Resolution: 1920x1080 to 160x90

H. Frame rate With WDR: 25/30 fps with power line frequency 50/60 Hertz

I. Without WDR: 50/60 fps with power line frequency 50/60 Hertz

J. Video Streaming:

1. Multiple, individually configurable streams in H.264 and Motion JPEG

2. Axis Zipstream technology in H.264

3. Controllable frame rate and bandwidth

4. VBR/MBR H.264

K. Multi-view Streaming: 2 individually cropped out view areas

L. Pan/Tilt/Zoom: Digital PTZ, preset positions

M. Image Settings:

1. Compression, color, brightness, sharpness, contrast, local contrast, white balance, exposure control (including automatic gain control), exposure zones, fine tuning of behavior at different light levels, WDR - forensic capture: up to 120 dB depending on scene, text and image overlay, mirroring of images, privacy masks

2. Rotation: 0 degrees, 90 degrees, 180 degrees, 270 degrees, including Corridor Format

N. Network:

1. Security Password protection, IP address filtering, HTTPSa encryption, IEEE 802.1Xa network access control, Digest authentication, User access log, Centralized Certificate Management

2. Supported protocols: IPv4/v6, HTTP, HTTPSa, SSL/TLSa, QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnPTM, SNMP v1/v2c/v3(MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SRTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, LLDP

2.06 180 DEGREE COLOR CAMERA:

A. Camera:

1. Camera Image sensor 4 x 1/2.8 inches progressive scan RGB CMOS

2. Lens Varifocal, 2.8–6 mm, F2.0

3. 4x1080p capture mode:

a. Horizontal field of view: 108°–54°

b. Vertical field of view: 57°–30°

B. Minimum illumination Color: 0.3 lux, F2.0

C. Shutter time: 720p: 1/28000 s to 2 s, 1080p: 1/22500 s to 2 s

D. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles Motion JPEG

E. Resolution 4 x 1920x1080 (1080p) to 160x90, Quad view 1920x1440 to 480x270

F. Frame Rate:

1. Up to 50/60 Hertz with 720p capture mode

2. Up to 50/60 Hertz with 1080p capture mode

G. Video Streaming:

1. Multiple, individually configurable streams in H.264 and Motion JPEG

2. Axis Zipstream technology in H.264

3. Controllable frame rate and bandwidth

4. VBR/MBR H.264

H. Image settings: Color, brightness, sharpness, contrast, white balance, exposure control, exposure zone, fine tuning of behavior at low light, rotation: 0 degrees, 90 degrees, 180 degrees, 270 degrees including Corridor Format, text and image overlay, privacy mask, Local contrast.

I. Camera angle adjustment: Pan plus or minus 90 degrees, Tilt 28 degrees-92 degrees, Rotate plus or minus 90 degrees.

J. Network:

1. IP address: One IP address for all channels

2. Security Password protection, IP address filtering, HTTPSa encryption, IEEE 802.1Xa network access control, digest authentication, user access log, centralized certificate management

3. Supported protocols: IPv4/v6, HTTP, HTTPSa, SSL/TLSa, QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnPTM, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH

2.07 PTZ CAMERA:

A. Camera:

1. Camera image sensor: Progressive scan CMOS 1/2.8 inches

2. Lens: 4.3–129 mm, F1.6–4.7, Horizontal field of view: 65.6 degrees–2.0 degrees, Vertical field of view: 39.0 degrees–1.2 degrees Autofocus, auto-iris

3. Day and night: Automatically removable infrared-cut filter

B. Minimum Illumination:

1. Color: 0.2 lux at 30 IRE F1.6

2. B/W: 0.01 lux at 30 IRE F1.6

3. Color: 0.25 lux at 50 IRE F1.6

4. B/W: 0.02 lux at 50 IRE F1.6

5. Shutter time: 1/66500 to 2 s

C. Pan/Tilt/Zoom:

1. Pan: 360° endless, 0.1°/s–350°/s

2. Tilt: 180 degrees, 0.1°/s–350°/s

3. 30x optical zoom and 12x digital zoom, total 360x zoom, 256 preset positions, e-flip, limited guard tour, control queue, on-screen directional indicator, set new pan 0 degrees, focus window, speed zoom, focus recall

D. Video Compression:

1. H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles Motion JPEG

E. Resolution 1920x1080 (HDTV 1080p) to 320x180

F. Frame Rate:

1. Up to 50/60 Hertz in 1080p

2. Up to 50/60 Hertz in 720p

G. Video Streaming:

1. Multiple, individually configurable streams in H.264 and Motion JPEG

2. Controllable frame rate and bandwidth

3. Axis Zipstream technology in H.264 VBR/MBR H.264

H. Image settings: Compression, Color, Brightness, Sharpness, Contrast, Local contrast, White balance, Exposure control, Exposure zones, Automatic backlight compensation, Fine tuning of behavior at low light, 120 dB WDR - Forensic Capture, Manual shutter time, Text and image overlay, 20 individual 3D privacy masks, Image freeze on PTZ, Electronic Image Stabilization

I. Network:

1. Security Password protection, IP address filtering, HTTPSa encryption, IEEE 802.1Xa network access control, Digest authentication, User access log, Centralized certificate management

2. Supported protocols: IPv4/v6, HTTP, HTTPSa, SSL/TLSa, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnPTM, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SRTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, NTCIP, LLDP

2.08 CAMERA PARAPET MOUNT:

A. Minimum requirements:

1. Casing NEMA 4X- and IK10-rated impact resistant aluminum mount

a. Color: White NCS S 1002-B

2. Cable Routing:

a. Back: Cable hole

b. Side: Cable conduit holes M25 3/4 inch

3. Maximum load 22 pounds

4. Mounting option Parapet and wall

5. Environment Indoor / Outdoor

6. Approvals:

a. IEC/EN/UL 60950-1

b. IEC/EN/UL 60950-22

c. IEC 62262 IK10

d. NEMA 250 Type 4X*

e. EN 50581

f. *Corrosion protection

7. Dimensions :

a. Collapsed arm: 39.6 x 30.1 inches

b. Expanded arm: 39.6 x 40.7 inches

8. Weight: 13 pounds

9. Included accessories:

a. Installation Guide

b. Pull-string

10. Optional accessories:

a. AXIS T91D62 Adapter Mounting Bracket

b. AXIS ACI Conduit Adapters

c. AXIS T91B52 Extension Pipes 0.98/3.2 feet

d. AXIS Bird Control Spike

e. Network Cable Coupler IP66

11. Shall be AXIS T94A01D

2.09 POWER SUPPLIES:

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera and lens.

1. Enclosure: NEMA 250, Type 1.

2.10 CAMERA-SUPPORTING EQUIPMENT:

A. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.

B. Pan Units: Motorized automatic-scanning units arranged to provide remote-controlled manual and automatic camera panning action and equipped with matching mounting brackets.

1. Scanning Operation: Silent, smooth, and positive.

2. Stops: Adjustable without disassembly, to limit the scanning arc.

C. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation and equipped with matching mounting brackets.

1. Panning Rotation: 0 to 355 degrees, with adjustable stops.

2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.

3. Speed: 12 degrees per second in both horizontal and vertical planes.

4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.

5. Built-in encoders or potentiometers for position feedback**,** and thermostat-controlled heater.

6. Pan-and-tilt unit shall be available with preset positioning capability to recall the position of a specific scene.

D. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

E. Protective Housings for Fixed and Movable Cameras: Steel enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.

2.11 MONITORS:

A. 24 inch Color Monitor:

1. Display Type: LED

2. Brightness: 250cd/m2

3. Max. Resolution:

4. VGA(D-SUB): 1,920 x 1,080

5. BNC(CVBS): 600TVL

6. Contrast Ratio: 1,000 : 1

7. Aspect Ratio: 16 : 9

8. Viewing Angle (H/V): 170 degrees / 160 degrees

9. Display Color: 16.7 million

10. Response Time: 5 ms

11. Video System: NTSC / PAL

12. Panel Life: 30,000 hours

13. Filter Type: 3D comb filter

14. RGB Connector: 1 Analogue RGB 15-pin D-sub, Input Signal 0.7 Vp-p, plus or minus 5 percent

15. HDMI Connector: 1 HDMI input (Type A connector)

2.12 NETWORK VIDEO RECORDER AND DEVICE MANAGER:

A. Recorder and device manager shall meet the following requirements:

1. CPU: Intel Core i7-4930K @ 3.40GHz or Intel Xeon E5-2640 v3 @ 2.60GHz

2. RAM: 8 GB (16 GB or more recommended)

3. Available hard disk space: min. 50 GB and additional storage space for image recordings HDD with 7200 RPM minimum

4. Network: Minimum Gigabit Ethernet Connection

5. Operating Systems (all 64-bit):

a. Windows 10 (Professional and Enterprise)

b. Windows Server® 2012 (Standard, Datacenter)

c. Windows Server® 2016 with Desktop Experience

d. (Standard, Datacenter)

B. Network Video Recorder (NVR) equipment is required for the storage of video images. The NVR will consist of a device with minimum recording/storage specifications of 15 frames per second (FPS), 80 pixels per foot or better resolution at scene target and RAID 6 to capture minimum of 30 days of recorded surveillance. The interview room camera shall be 30 FPS. The Contractor will determine and document the capacity of the

NVR. The Contractor shall provide a Video solution with a minimum of 20 percent free channels to allow cameras to be added in the future.

1. Coordinate with owner to match existing equipment

2.13 IP VIDEO SYSTEMS:

A. Description:

1. System shall provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.

2. System shall have seamless integration of all video surveillance and control functions.

3. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.

4. System design shall include all necessary compression software for high-performance, dual-stream, MPEG-2/MPEG-4 video. Unit shall provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.

5. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.

6. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.

7. Encoder/decoder combinations shall place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.

8. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices shall be provided for full performance of specified system.

2.14 SECURITY NETWORK SWITCHES:

A. Switches shall provide network paths for all Electronic Security Systems components

B. Use Layer 3 switches on the edge and at the core with the required buffer size such that the system shall operate as specified for the overall video system functionality. All switches must be set up with multicasting.

C. Edge Switches:

1. Provide enterprise-class stackable Layer 3 edge switches with 24 or 48 ports in compact 1U form factor.

2. Provide 24 or 48 port POE+ switches as required with 10/100/1000 ports.

3. Provide dual fiber optic uplinks at each switch location. Uplinks to be 10 Gigabit Ethernet.

4. Provide SFP's as required to dual home to fiber optic core switches.

5. Optional hot swappable onboard load sharing redundant power supply capability.

6. Support automatic QOS, VLANS and auto-negotiation on all ports.

7. Layer 3 routing support for static or dynamic routing using OSPF, RIP, or BGP.

8. High availability stacking with hitless failover and hot insertion/removal of stacked units.

9. Model: Cisco 3850 series

D. Core Switches:

1. Provide data center class layer 3 switches supporting redundant load sharing hot swappable power supplies and fan trays.

2. Provide 10 Gigabit SFP Fiber ports to support all edge switches.

3. Optional Redundant power supply.

4. Support automatic QOS, VLANS and auto-negotiation on all ports. Full support for private, port based, protocol based, and MAC based VLANS. Auto-negotiated supported on all ports.

5. Layer 3 routing support for static or dynamic routing using OSPF, RIP, or BGP.

6. Model: Cisco 6880 series

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WIRING:

A. Comply with requirements in Section 26 05 33.

3.03 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform Tests and Inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

a. Prepare equipment list described in "Informational Submittals" Article.

b. Verify operation of auto-iris lenses.

c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.

d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.

e. Set and name all preset positions; consult Owner's personnel.

f. Set sensitivity of motion detection.

g. Connect and verify responses to alarms.

h. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Video surveillance system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.04 ADJUSTING:

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

1. Check cable connections.

2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.

3. Adjust all preset positions; consult Owner's personnel.

4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.

5. Provide a written report of adjustments and recommendations.

3.05 CLEANING:

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.06 DEMONSTRATION:

A. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 28 31 00

FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide fire detection and alarm as indicated and in compliance with Contract Documents.

B. Provide, test, and place into operating condition an electrically operated, microprocessor based, FM Global Approved, four-wire, analog/addressable, electrically supervised fire detection and evacuation system as indicated and specified.

C. The System shall include, but not be limited to: Fire Alarm Control Panel (FACP) (or panels required for each building), remote Annunciator Command Center (ACC), power supplies and fire alarm initiating and notification devices including addressable monitor and control modules.

D. The fire alarm system shall include conduit, wire, fittings, and accessories required to provide a complete operating system.

E. Connect fire alarm control panels in a local area network via twisted pair cable for data communication with other areas. Display local information at each network node and the entire network monitored at the network remote annunciator panel.

F. All charges and fees required by the local Authority having jurisdiction (AHJ) to inspect the installation and implement fire alarm notification are to be included by the Contractor under this section at no additional cost to the Owner.

1.02 REFERENCES:

A. ASME International (ASME):

1. A17.1: Safety Code for Elevators and Escalators

B. Factory Mutual (FM):

1. P7825: Approved Guide

C. Institute of Electrical and Electronics Engineers (IEEE):

1. C62.41.1: IEEE Guide on the Surges Environment in Low-Voltage (1000V and Less) AC Power Circuits.

2. C62.41.2: IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

2. 72: National Fire Alarm Code

3. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems

4. 101: Life Safety Code

E. Underwriters' Laboratories (UL)

1. Fire Protection Equipment Directory

2. 268: Standard for Smoke Detectors for Fire Alarm Signaling Systems

3. 464: Standard for Audible Signal Appliances

4. 864: Control Units for Fire Protective Signaling Systems

5. 1971: Signaling Devices for the Hearing Impaired

F. State and Local Building Codes.

1.03 SYSTEM DESCRIPTION:

A. Type of System:

1. Fire Alarm System: The fire alarm system shall operate as a low voltage analog/addressable type system and shall automatically initiate fire alarm signals whenever any manual or automatic fire detecting devices are placed into an alarm mode. The system shall indicate areas of alarm and sound local alarms. Initiating loops and notification loops shall be wired as four-wire class B Circuits. Initiating loops and notification loops shall be complete with necessary switches, meters, relays, pilot lights, surge arresters and addressable modules as required. A minimum of one thermal cut-out or fuse and surge arrestor for every notification circuit shall be provided.

2. The system shall be capable of operating with a single break or ground fault condition in the initiating or alarm sounding circuits.

3. Evacuation Alarms: Coded evacuation alarm: A fire alarm signal shall be employed for notifying the occupants to evacuate.

4. Trouble Signals: During abnormal conditions such as an open wire or a ground fault, or where both conditions occur at one point, the system shall be capable of automatically transmitting clear, intelligible trouble signals.

5. Power Supply for the System: A dedicated branch-circuit for supplying power to the alarm system shall be provided for the Fire Alarm Control Panel (FACP). The branch circuits shall be automatically energized from an auxiliary electrical power system during failures of the normal power supply. Provide battery backup power consisting of rechargeable, sealed type storage batteries and battery charger.

6. The system shall interface to HVAC system and other building systems as shown on the Contract Drawings and required by applicable codes to provide all required monitoring and control functions.

B. Sequence of Operation:

1. When a fire-alarm condition is detected by one of the system initiating devices, the following functions shall immediately occur:

   a. Automatic programs assigned to the alarm point shall be executed and the associated indicating devices and relays activated.

   b. Fire-alarm notification devices in the building shall operate.

   c. An exterior strobe at the building in alarm shall energize and the fire alarm notification devices in only that building shall operate.

   d. The system alarm on the Fire Alarm Control Panel and Remote Annunciator Command Center will indicate condition.

   e. The alarm shall be signaled automatically to the local Central Station Monitoring System

   f. Shutdown of HVAC equipment and associated exhaust and pressurization operations to be initiated.

2. When a trouble condition is detected by one of the system initiating or indicating circuits, the following functions shall immediately occur:

   a. System Trouble will be indicted on FACP and Annunciator Command Center.

   b. A local trouble-sounding device in the FACP and Annunciator Command Control shall be activated. This sound shall be distinct from the alarm sound.

   c. The appropriate message will appear on the LCD display at the FACP and Annunciator Command Center.

1.04 SUBMITTALS

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Copy of this specification section with addenda and all referenced specification sections with addenda check-mark each paragraph to indicate specification compliance or indicate deviation and reason for deviation.

a. Failure to include a copy of the marked-up specification sections will result in return of the entire submittal with no further review and consideration.

2. Installer and system supplier qualifications and list of three similar projects with name and phone number of contact person.

3. Complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts. Shop drawings shall contain complete conduit riser diagrams, wiring diagrams, and schematic diagrams for the equipment furnished. Riser diagrams shall identify cable sizes and quantities, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

4. Manufacturer’s printed installation instructions.

5. Battery capacity calculations to demonstrate that the battery size selected is a minimum of 125 percent of the calculated requirement. Calculation to include supervisory power requirements for all equipment, and alarm power requirements for all equipment.

6. Wiring diagrams from the fire alarm system integrator or supplier differentiating clearly between factory and field installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Identify all diagrams to be specific to this project and distinguish between field and factory wiring.

7. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

8. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct detectors and access to them.

B. Spare Parts Data:

1. After approval of the list of shop drawings, and not later than six months prior to the date of substantial completion, furnish copies of spare parts data for each different item of materials and equipment specified. The data shall include a complete list of parts and supplies with current unit prices and source of supply, a list of supplies that are either normally furnished at no extra cost with the purchase of the

equipment, or specified to be furnished in accordance with paragraph Special Tools and Spare Parts and a list of additional items recommended by the manufacturer to assure efficient operation for a period of 120 days.

C. Operating and Maintenance Instruction Manuals:

1. At end of project, submit operating instruction manuals as specified in Section 01 78 23, outlining the step-by-step procedures required for system startup and operation shall be furnished. The instructions shall include the manufacturer's name, model number, service manual parts list and brief description of all equipment and their basic operating features.

2. Maintenance instructions manuals outlining maintenance procedures shall be furnished. The manual shall include a troubleshooting guide listing possible breakdown and repairs and a simplified connection wiring diagram for the system as installed. Provide the names, addresses, and telephone numbers of service organizations that provide technical assistance and carry stock of repair parts for the system to be furnished.

3. Performance Test Reports: Upon completion of the installed system, submit in booklet form field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.

D. Submit Certificate of Compliance, signed by manufacturers of fire alarm system components certifying that their products comply with specified requirements.

E. Submission to Authorities Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authorities having jurisdiction. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Upon receipt of comments from the authorities having jurisdiction, submit them for review. Resubmit if required to make clarifications or revisions to obtain approval.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide one spare FACP mother board and 10 percent or a minimum of 2 devices of the total devices provided for this Contract as listed below.

1. Pull Stations

2. Manual Pull Stations

3. Weatherproof Smoke Detectors

4. Photoelectric Smoke Detectors

5. Thermal Detectors, 135 degrees F

6. Thermal Detectors, 190 degrees F

7. Alarm Audible Devices

8. Alarm Strobes

C. Three sets of special tools necessary for the maintenance of the equipment shall be furnished. Two spare sets of fuses of each type and size required and five spare lamps for each type shall be furnished. Spare parts shall be listed on submittal list.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Standard Products: Material and equipment shall be the latest standard products of a single manufacturer regularly engaged in the manufacture of the product for the 5 years as a minimum.

C. Qualifications of the installer before commencing work: Submit information demonstrating that the supplier has successfully installed fire alarm systems of the same scope, type and design as specified.

1. Submit copies of all required Licenses and Bonds as required in the State having jurisdiction.

2. Employ on staff a minimum of one full time NICET level 2 Technicians or a professional engineer.

3. Certify that the completed system conforms with FM Global standards upon completion of the installation.

4. Ongoing maintenance and testing shall be provided to the Owner under a maintenance contract to maintain the FM Global Approval.

D. Nameplates: The components of equipment shall have the manufacturer's name, address, type or style, and catalog number on a plate securely attached to the equipment.

E. Tags: Tags with stamped identification number shall be furnished for keys and locks. Tags shall be furnished to identify cable and conduit runs, wiring circuits, and all spare parts furnished for Authority's stock to maintain the system.

F. Keys and Locks: All locks shall be keyed alike.

G. Verification of Dimensions: Become familiar with details of the work and verify dimensions in the field.

H. Compliance: The fire detection and internal alarm system shall be configured in accordance with NFPA 72. The equipment furnished shall be compatible and be FM Global approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

I. Accessibility: Enclosures shall be provided with ample gutter space to allow proper clearance between the enclosure and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate all units, and allow ample gutter space for interconnections of panels and field wires.

J. Verify conduit size and wire quantity, size, and type are suitable for the equipment supplied. Review the proper installation of each type of device with the equipment supplier.

K. Review selected arrangement with local fire authority for conformance with local and state requirements.

L. On-Site Technician Services:

1. Provide the services of a representative or technician certified by the manufacturer of the system, experienced in the installation and operation of the type of system provided.

2. The representative shall be licensed in the State if required by law.

3. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system, and Underwriters Laboratories listing certification requirements.

4. The technician shall provide the required instruction to the Owner’s personnel in the system operation, maintenance and programming.

5. Provide services of the manufacturer's service representative during installation, startup and testing, for a period of three working days plus travel where a working day is equivalent to 8 hours.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Equipment placed into storage shall be protected from the weather, humidity and temperature variations, dirt, dust, and other contaminants.

1.08 SEISMIC DESIGN REQUIRMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. It shall be the responsibility of the manufacturer and supplier along with the Electrical Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. A single manufacturer shall be used throughout all buildings on site.

B. Notifier

C. Honeywell Gamewell

D. SimplexGrinnell

E. Fike

F. Siemens

2.02 MATERIAL AND EQUIPMENT:

A. General Product Description:

1. Each Fire-Alarm Control Panel (FACP) shall be capable of fire detection, equipment supervision and control, alarm management, and historical data collection and archiving. The system components shall be FM Global approved.

B. Communications:

1. The FACP shall have sufficient memory to support its operating system and databases including:

a. Fire Management

b. Alarm Management

c. Historical/Trend Data

d. Maintenance Support Applications

e. Custom Processes

f. Operator I/O

2. Communication Ports: Provide data communication ports for simultaneous operation of devices such as industry standard printers, programming terminal, PC, transponder and annunciator.

3. Integrated On-Line Diagnostics: The FACP shall continuously perform self-diagnostics, communication diagnostics and diagnostics on all subsidiary equipment.

4. Surge and Transient Protection: Isolation shall be provided at all field point terminations to suppress induced voltage transients where required. Surge arrestors shall provide protection from all non-signal electrical surges that could cause damage to the equipment. Line surge arrestors shall be isolated from the electrical circuitry that they are protecting.

C. System Software Features:

1. Provide software to form a complete operating system as described in this specification shall be provided.

2. The software programs specified in this section shall be provided as an integral part of the panel and shall not be dependent upon any higher level computer for execution.

3. Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. The control unit shall have capability of performing alarm analysis and signaling. At no time shall the panel's ability to report alarms be affected by operator activity.

4. Status Change Report: All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.

5. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided.

6. Report Routing: Alarm reports shall be archived for future recall.

7. Alarm Messages: In addition to the point's description and the time and date, the user shall be able to print, display or store a custom alarm message to more fully describe the alarm condition or direct operator response.

8. The FACP shall be capable of storing a library of at least 900 events.

9. History Mode:

a. The system shall be able to store and display at least 900 system events that have occurred in a non-volatile buffer memory. Display of these events shall be accomplished on-site through the use of the front control panel indicators and switches.

10. Field Configurable:

    a. The system shall be fully configurable and expandable without the need for EPROM programmers. All configurations shall be accomplished through downloading of programs from a computer. Reconfiguration shall not require knowledge of any programming languages or require any special training. All programs shall be stored in non-volatile memory. Entry into program mode shall require a special key and a special password entered into the front panel.

D. Analog Device Interface:

1. The Analog Device Interface will be capable of supporting devices as indicated on drawings with 25 percent spare slots for future devices.

2. The analog addressable device interface shall contain its own microprocessor control.

3. The analog addressable device interface shall communicate and provide power to all devices on its loop over a single pair of wires. The fire-alarm system shall function as a Class B system.

4. The analog interface board shall receive analog information from intelligent detectors and shall process this information to determine normal, alarm, or trouble conditions. The analog information may also be used for automatic test and determination of maintenance requirements.

5. Communication with connected devices shall be performed every 5 seconds or less. Average time to detect an alarm shall be less than 10 seconds (longer for alarm verification detectors).

E. Notification Appliance Circuit:

1. The FACP shall provide supervised Class B notification circuits as indicated on drawings with 50 percent spare capacity for future devices. The circuit capacity shall be 2.0 amperes maximum per circuit, maximum of 8.0 amperes from the FACP's power supply. If a short-circuit trouble occurs on one of the circuits it will not affect the operation of the remaining circuits.

F. Function Relays:

1. The FACP shall provide of Form "C" relay contacts, quantity as required, rated at 2 A at 120 VAC. These relays may be programmed to activate on alarm from any initiating zone or any combination of initiating zones, analog devices or addressable modules.

G. Central Processing Unit (CPU):

1. The CPU shall communicate with the operator interface, LCD display, LED display and control other modules in the panel. Removal, disconnection or failure of any control panel shall be detected and reported by the Central Processing Unit.

2. The CPU shall contain and execute all control-by-event programs for specific action to be taken if a fire situation is detected in the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs. The CPU shall also provide a real time clock for time annotation on the display and remote optional printer.

H. Operator Display:

1. The operator display shall provide controls and indicators used by the system operator. The display shall contain, and display as needed, custom alphanumeric message for all intelligent detectors and addressable modules. Such message information shall be stored in programmable non-volatile memory.

2. The display board shall provide an 80-character alphanumeric Liquid Crystal Display (LCD). It shall also 24 LEDs for system indication such as AC POWER; SYSTEM ALARM; SYSTEM TROUBLE; ACKNOWLEDGE; SIGNAL SILENCE, etc.

3. Factory programmable system indications and keys shall be available for unique functions. Keys shall be referred to as “Hot Keys”.

4. The Display Interface shall provide a 15-key touch keypad with control capability to command all system functions, and entry of any numeric information. The keypad shall include means to enter a minimum of two different passwords to prevent unauthorized manual control.

5. Ground fault indication shall be displayed on a system and initiating zone basis.

I. Communications Ports:

1. The system shall provide the following interfaces:

a. One port for remote annunciator command center.

b. One port for central station communication.

c. One port for service and field programming.

d. One port for Printer.

J. Mechanical Design:

1. The Fire Alarm Control Panel (FACP) shall be housed in a cabinet designed for mounting recessed or directly to a wall or vertical surface. The back box and door shall be constructed with provisions for electrical conduit connections. The door shall provide a key lock and shall include an opening for viewing.

2. The FACP shall be modular in structure for ease of installation and maintenance.

K. One Person Test Feature: The control unit shall include a special one person test feature, which will allow a single person to test all initiating devices and indicating appliance in a system without returning to the panel to reset the system. A special password shall be required to enter the test mode. The service-technician shall be able to re-select the initiating and indicating circuits that are to be included in the one person test mode. The Walk-Test shall include a special audible indication that a trouble has been detected on an analog device, for the service-technician to check proper system wiring.

L. Provide addressable monitor modules to interface manual FACP to stations and other non-addressable detection components as required. The modules shall be capable of being mounted in a 4 x 4 x 2 1/8 inch junction box.

M. Provide addressable control modules to interface FACP to fire alarm reporting panel, audible and visual devices and other control components as required. The modules shall be capable of being mounted in a 4 x 4 x 2 1/8 inch junction box.

N. Fire-Alarm Initiating Devices:

1. Addressable Devices: All addressable detectors shall:

a. Provide a test means whereby they will simulate an alarm condition and report that condition to the FACP. Such a test may be initiated at the detector itself, by activating a magnetic switch, or may be activated remotely on command from the control panel.

b. Provide address-setting means on the detector head using switches. The detectors shall also store an internal identifying code which the FACP shall use to identify the type of detector.

c. Provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED.

2. Addressable pull stations shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable

communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key. Operated stations shall have a positive, visual indication of operation and utilize a key type reset. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inch or larger. Mount stations inside a red, weatherproof enclosure with a clear polycarbonate hinged front cover where station is indicated on the drawings as NEMA 4, NEMA 4X and hazardous areas including Class I, Division 1 and 2.

3. Analog/Addressable Area Photoelectric Smoke Detectors: Photoelectric Smoke Detectors shall use the photoelectric principle to measure smoke density and shall, on command from the control panel send data to the panel representing the analog level of smoke density. These addressable detectors shall connect with two wires to one of the control addressable input circuits.

4. Analog/Addressable Thermal Detectors: Thermal detectors shall use an electronic sensor to respond to temperatures exceeding 135 degrees F or 190 degrees F as noted on the plans. Sensing elements shall be replaced without removing the detector base. The detector shall, on command from the control panel, send data to the panel representing the analog temperature level. These addressable detectors shall connect with two wires to one of the control addressable input circuits.

5. Each detector shall be provided with a steel mounting plate, and the entire unit shall mount on a double gang electrical box.

6. Analog/Addressable Duct Smoke Detectors:

   a. Photoelectric-type, duct-mounted smoke detector.

   b. The detectors shall, on command from the control panel, send data to the panel representing the analog level of smoke intensity.

7. Provide devices suitable for the area classifications as indicated on the Contract Drawings (i.e., NEMA 1, NEMA 4, NEMA 4X, and NEMA 7 (Class I, Division 1 or 2) NEMA 4X, etc.).

8. Where located in a chemically corrosive environment, all fire alarm initiating devices shall be corrosive resistant.

O. Fire Alarm Indicating Devices:

1. Visual appliances shall be installed as shown on the drawings in accordance with the requirements of FM Global and NFPA 72. Where multiple visual signals are

visible from any location, circuitry shall be incorporated for the synchronization of the flash rate.

a. FM Global approved for Emergency Devices for Hearing Impaired in all public mode installations.

b. Strobes shall meet FM Global approved flash rate.

c. Visual signals shall incorporate a Xenon flashtube enclosed in a rugged Lexan lens or equivalent with solid state circuitry.

d. The strobe intensity shall be rated per FM Global.

e. The strobes shall be available for semi-flush or surface mounting and in conjunction with audible signals as required.

2. Audible Devices: Audible evacuation signals shall be provided meeting the following requirements:

a. Audible Notification appliance shall be electronic and use solid state components.

b. Each electronic signal shall provide four field selectable alarm tones. The tones shall consist of: slow hoop, continuous, temporal or interrupted.

c. The device shall provide UL dBA measurement at 10 feet shall be a minimum of 85 dBA for separately mounted audible signals.

d. The device shall have provisions for standard reverse polarity type supervision and in/out field wiring using terminals that accept 14 AWG wiring.

e. Combination audiovisual alarm horns shall have a high intensity flashing light and alarm horn as an integral unit. Both audio and visual components shall operate from the 24 volt dc polarized indicating circuits. The horn assembly shall be housed in a rugged, die-cast enclosure, and the electronic light source shall be sealed in silicone and protected by a Lexan lens. The word FIRE shall appear on the lens. Audiovisual alarm devices shall meet the requirements of visual appliances and alarm horns above. Single and/or dual projectors shall be supplied as shown on the plans.

3. Where located in a chemically corrosive environment, all fire alarm indicating devices shall be corrosive resistant.

P. Power Supply:

1. The power supply for the FACP and fire alarm peripherals shall be integral to the FACP. The power supply shall provide FACP and peripheral power needs.

2. Positive-temperature-coefficient thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs.

3. Input power shall be 120 VAC, 60 Hertz. The power supply shall provide internal batteries and charger. Internal battery capacity shall be sized as required to meet system requirements.

4. The main power supply shall provide a battery charging circuit consisting of a fully automatic standby battery charger, rate compensated, capable of maintaining battery in fully charged state and be capable of recharging batteries to 70 percent of alarm capacity within 12 hours. Provide for normal operation of entire system for 24 hours with power remaining to sound alarms for 5 minutes for detection-only systems, fixed extinguishing, suppression system controls, and other fire alarm signaling equipment. For remote stations, provide battery capacity to operate for 60 hours followed by 5 minutes of alarm in accordance with NFPA 72B. Alarm control panels for automatic release of preaction or deluge sprinkler systems to have 90 hours of secondary power followed by 10 minutes of release power and alarm operations.

5. Provide charger with the following supervised functions: circuit protection for shorts, open, disconnected or reversed polarity battery connection, supervision or protection of high or low voltage, overcharging and charger failure. Automatic load shedding or battery disconnect on deep discharge to prevent battery damage.

6. Batteries shall be 24 volt, rechargeable, gelled electrolyte, totally sealed, fully charged with al interconnections ready for service, maintenance free, long-life.

Q. Wiring within Cabinets, Enclosures, Boxes, Junction Boxes, and Fittings:

1. Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet.

2. Conductors which are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box shall be connected to terminal blocks.

3. Mark each terminal in accordance with the wiring diagrams of the system.

4. Make connections with approved pressure type terminal blocks, which are securely mounted.

5. The use of wire nuts or similar devices shall be prohibited.

R. Terminal Cabinets:

1. Provide a terminal cabinet at the base of any circuit riser, and where indicated on the drawings.

2. Terminal size shall be appropriate for the size of the wiring to be connected.

3. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the terminal cabinet.

4. Minimum size is 8 inch high by 8 inch.

S. Alarm Wiring:

1. Signaling line circuits and initiating device circuit field wiring shall be copper, 18 AWG size conductors at a minimum.

2. Notification appliance circuit conductors, that contain audible alarm devices, shall be solid copper 14 AWG size conductors at a minimum.

3. Where a voice evacuation system is specified, speaker circuits shall be copper 16 AWG size conductors at a minimum.

4. Wire size shall be sufficient to prevent voltage drop problems.

5. Power wiring, operating at 120 VAC minimum shall be 12 AWG solid copper having similar insulation.

6. Provide all wiring in rigid metal conduit

T. Conductor Terminations:

1. Labeling of conductors at terminal blocks in terminal cabinets, FACP, and remote fire alarm control units shall be provided at each conductor connection.

2. Each conductor or cable shall have a shrink-wrap label to provide a unique and specific designation.

3. Each terminal cabinet, FACP, and fire alarm control unit shall contain a laminated drawing which indicates each conductor, its label, circuit, and terminal.

4. The laminated drawing shall be neat, using 12 point lettering minimum size, and mounted within each cabinet, panel, or unit so that it does not interfere with the wiring or terminals.

5. Maintain existing color code scheme where connecting to existing equipment.

U. Wiring to Station Fire Alarm Circuit:

1. Wiring from the master fire alarm box to the state telegraphic fire alarm circuit shall be a two-conductor 10 AWG type UF cable in conduit.

V. Remote Annunciator Command Center:

1. The remote Annunciator Command Center (ACC) shall be an 80 (4 x 20) character back-lit LCD type capable of displaying up to 3200 point messages. The remote annunciator shall have the capability of driving up to 576 LEDs for future graphic notification. They shall be sixteen switch inputs that can be used for various system functions; lamp test, trouble silence, general alarm, scroll, system reset, network reset, etc. All fire-alarm controls shall be operational from the Annunciator Command Center.

2. The ACC shall have non-volatile memory. Annunciators which rely on the FACP for memory will not be accepted.

3. The ACC shall be surface mounted with switches located with a locked panel, and easily visible through a glass or plastic viewing plate. Panel door shall have a keyed lock identical to the lock on the fire alarm control panel (FACP).

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install fire alarm system as indicated on the drawings, in accordance with the manufacturer's diagrams and printed instructions, except where otherwise indicated.

1. Wiring: Wiring for systems shall be installed in conduit. Ruse existing fire alarm conduit system where applicable; otherwise, provide conduit as specified in Section 26 05 33. Where located in a chemically corrosive environment, corrosive resistant conduit shall be used.

2. Station loops shall be arranged to permit disconnecting and bypassing the system at the base of each riser. External wiring between the control panel and the stations and horns/lights shall connect to terminal strips in accessible locked cabinets. Connections to the terminal strips shall be made with terminal spade lugs or with approved type terminal blocks. Terminal cabinets shall be installed at each point where a station circuit riser originates or any point along a circuit where a tap is made. The conductors for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. The sum of the cross-sectional areas of individual conductors shall not exceed 40 percent of the interior cross-sectional area of the conduit. Gutter space to accommodate all necessary wiring shall be provided.

3. Panels: Panel enclosures shall comply with the requirements of FM Global. Enclosures having doors over 48 inch in height shall be provided with a three-point catch and lock; all other doors shall contain a cabinet type cylinder lock. Inserts shall be blind fastened so that no screws show on the panel front. Where located in

a chemically corrosive environment, panel shall be located in a NEMA 4X enclosure.

4. Detectors: Detectors shall be installed in accordance with manufacturer's printed instructions.

5. Provide complete wiring and conduit between all equipment. Devices shall be mounted upon UL listed boxes. Wiring splices and transposing or changing of colors will not be permitted.

6. Junction boxes shall be painted red and labeled as “Fire Alarm System” with decal or approved markings.

7. Firm Alarm control systems and equipment shall be connected to separate dedicated branch circuits, sized as required for proper service. Circuits shall be labeled “FIRE ALARM.”

8. Review the design drawings and perform a walk-through of all areas with the AHJ.

3.02 PERMITS AND CERTIFICATIONS:

A. Obtain required local permits.

1. Provide FM Global certification of the installation.

3.03 FIELD TESTING:

A. Notify the AHJ and the Owner 30 days before the performance and acceptance tests are to be conducted. The tests shall be performed in the presence of the Owner or his authorized representative. Furnish instruments and personnel required for the tests. Tests shall be conducted for the following:

1. Verify that the system is free of grounds or open circuits. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. The FACP shall indicate when a ground or open circuit exists.

2. Alarm initiating devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installing technician and date.

3. Verify that all strobes, audible devices, pull stations, transmitters, automatic detectors and supervisory devices are functioning as specified.

a. Strobes shall deliver the correct foot-candle. Audible devices shall delivery the correct sound pressure levels decibels of the specified device.

b. Stations shall close the circuits specified and deliver specified alarm codes. Verify central station receives alarm.

c. Automatic detectors shall actuate the specified zones when the appropriate fire or smoke conditions are generated. The detectors shall be exposed to actual smoke used to simulate this test on each and every smoke detector as located in the building; no other test will be accepted.

d. Panels and supervisory devices shall display and control functions as specified. Loss of AC system power shall also be tested.

e. Close each sprinkler system valve and verify proper supervisory alarm.

f. Verify activation of all water flow switches.

B. System tests to be performed under the supervision of a qualified representative and the AHJ.

C. Perform all tests to verify the correction of defects found in the initial testing. If testing identifies system modifications are required to accomplish the required operation, perform work at no additional cost to the Owner and retest the system.

D. Perform an acceptance test on 100% of the system as described in the checklist in Table 1 of FM Global Property Loss Prevention Data Sheet 5-40, Fire Alarm Systems. Have all testing performed by qualified service people and only after the building owner and authority having jurisdiction (AHJ) have been notified and output circuits have been disabled.

E. Furnish training as follows:

1. Training in the receipt, handling and acknowledgment of alarms

2. Training in the system operation including manual control of output functions from the system control panel

3. Training in the testing of the system

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 28 33 34

COMBUSTIBLE GAS DETECTION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide a combustible gas detection system as indicated and in compliance with Contract Documents.

B. This section includes materials, installation, and testing of calibrated field-mounted combustible gas detectors and monitors, including alarms, sample pumps, calibration kits, and stainless steel gas sampling tubing.

1.02 REFERENCES:

A. National Fire Protection Association (NFPA):

1. 820: Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit certified dimensional drawings and catalog cuts for each size and type of instrument, cabinet, and alarm beacon. Catalog cuts are to be highlighted to define specific materials of construction and specified features.

C. Submit installation, operation and maintenance manuals, and wiring diagrams.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide one spare detector and new, unused, calibration gas kit.

1.05 MANUFACTURER'S SERVICES:

A. Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

B. One labor day to check the installation and advise during start-up, testing, and adjustment of the equipment.

C. One-half labor day to instruct the Owner's personnel in the operation and maintenance of the equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURER:

A. The combustible gas detection system shall be manufactured by MSA Instruments.

2.02 COMBUSTIBLE GAS DETECTOR:

A. The combustible gas detector shall be the catalytic-bead type designed to measure concentrations of combustible gases. The detector calibration shall be based on methane with an adjustable range of 0 percent to 100 percent of the Lower Explosive Limit (LEL), a maximum zero drift of plus or minus 1 percent of full scale per week, and a repeatability of plus or minus 1 percent of full scale. The detector shall be resistant to hydrogen sulfide in concentrations up to 100 ppm. The detector shall be FM and UL listed.

B. Mount the detector and its electronics in a cast aluminum, NEMA 4 enclosure, meeting FM Class 1, Division 1, Group C and D requirements. Detector shall operate on voltage up to 14 volt DC.

C. The detector head, with the catalytic bead, shall be removable and replaceable without replacement of electronics. Detector life shall be guaranteed for two years of continuous operation, minimum.

2.03 COMBUSTIBLE GAS MONITOR:

A. Connect the monitor to each detector by 3-wire shielded cable in conduit. The signal from the detector to the monitor shall be 4 to 20 mA.

B. The monitor shall be capable of monitoring two combustible gas detectors and gas sample pump. Equip with separate three-digit LED readouts for each detector, displaying a direct readout of 0 percent to 99.9 percent of the LEL. Provide a minimum of two separate adjustable alarm set point levels for each detector. Set points shall operate user interface relays that are Form C, single pole, double throw with contacts rated for 5 ampere resistive load at 120 volt AC. Provide a trouble relay to indicate trouble when there is a system power loss, a signal loss from a sensor, a control module malfunction, or a loss of flow to the detector.

C. Provide a local flashing warning light to operate for any alarm condition. Mount the warning light above the monitor panel. Unit shall flash a minimum of 60 cycles per minute with red Lexan lamp cover and a copper-free aluminum body or stainless steel housing. Benjamin Model KL-4111-12 or Crouse Hinds Model VDAS/R/012.

D. Provide the monitor with terminals for output of each detector's 4 to 20 mA signal and alarm contacts.

E. The front panel of the monitor shall incorporate push-button switches that will permit the following operations:

1. Display combustible gas concentration

2. Adjustment of alarm set points

3. Alarm reset

4. Temporary alarm disable

5. Relay reset

6. Lamp test

F. The monitor shall operate on 115 volt AC and be enclosed in a NEMA 4X enclosure for mounting on a wall surface. Access door shall be hinged and shall have a shatterproof window to allow viewing of meters and indicator lights.

2.04 GAS SAMPLING SYSTEM:

A. The gas sampling system shall draw a gas sample from the wet well through the detector using a direct-current electric pump. The pump shall provide a flow rate of 1 cubic foot per hour through the tubing shown in the drawings. Equip the system with a flow switch that will signal when flow is interrupted.

B. Mount the gas sampling system in a NEMA 4X enclosure with exterior wall mounting lugs. Mount a flowmeter to indicate the flow rate without opening the enclosure. Provide a valve and tee for test gas calibration.

2.05 GAS SAMPLE TUBING:

A. The gas sample tubing shall be 1/4-inch outside diameter, Type 316 stainless steel tubing with a minimum wall thickness of 0.028 inch. Fittings shall be Swagelok type as manufactured by Crawford Fitting Company. Tubing bends shall be long sweep made with tubing bending tools. Make bends greater than 45 degrees using fittings. Use flexible tubing from the wet well up to the junction box at grade. Flexible tubing shall be Tygon inner-braid, 1/4-inch inside diameter, rated at 100 psig at 70 degrees F, Ryan Herco No. B-44-4X.

2.06 COMBUSTIBLE GAS CALIBRATION KIT:

A. The combustible gas calibration kit shall provide flow-type calibration for methane in air at 50 percent LEL. Flow rate shall be preset, not to exceed 2 scfh, and shall provide a minimum of two, 3.6-liter gas cylinders.

B. The kit shall include a carrying case, gas cylinder regulator, hose, and adapter for gas detectors.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install components per manufacturer's recommendations, with the detectors, sample pumps, monitor, and beacon located in close proximity. Install monitor above the sample points. Install tubing such that there are no low points between the monitor and the sample points.

3.02 TESTING:

A. Test tubing using nitrogen or oil-free compressed air. Test for leakage at 50 psig for one hour prior to connection to the detector. No leakage is acceptable during test. Repair leaks and retest until tubing installation is pressure tight.

B. After units have been energized and functions completely checked, set combustible gas alarm signals at 20 percent and 50 percent of LEL. Label detector for "HIGH" and "LOW" sample locations.

C. Inject calibration gas at wet well end of sample tubing to demonstrate operation of system to the Owner.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 28 33 36

HYDROGEN SULFIDE GAS DETECTION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide a hydrogen sulfide gas detection system as indicated and in compliance with Contract Documents.

B. This section includes materials, installation, and testing of calibrated field-mounted hydrogen sulfide gas detectors, monitors, alarms, and calibration kits.

1.02 REFERENCES:

A. National Fire Protection Association (NFPA):

1. 820: Standard for Fire Protection in Wastewater Treatment and Collection Facilities

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit certified dimensional drawings and catalog cuts for each size and type of instrument, cabinet, and alarm beacon. Catalog cuts are to be highlighted to define specific materials of construction and specified features.

C. Submit installation, operation, and maintenance manuals and wiring diagrams.

1.04 MANUFACTURER'S SERVICES:

A. Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

B. One-half labor day to check the installation and advise during start-up, testing, and adjustment of the equipment.

C. One-half labor day to instruct the Owner's personnel in the operation and maintenance of the equipment.

1.05 SPARE PARTS:

A. Provide to the Owner necessary spare parts of components required to maintain the system. Prior to final acceptance of work, provide a spare parts listing of necessary spare

parts and quantities for review by the Owner's Representative. The spare parts shall include the following minimum requirements:

MINIMUM SPARE PARTS LIST	
Part Description	**Quantity**
Transmitter	1 each
Sensor	1 each

PART 2 - PRODUCTS

2.01 HYDROGEN SULFIDE GAS DETECTOR:

A. The hydrogen sulfide gas detector shall be the electrochemical type designed to measure concentrations of hydrogen sulfide. The detector shall have an adjustable range of 0 to 50 ppm hydrogen sulfide, a maximum zero drift of plus or minus 5 percent of span per year, a maximum span drift of plus or minus 10 percent per year, and a repeatability of plus or minus 1 percent of full scale. The detector shall be UL and FM listed.

B. Calibration of the hydrogen sulfide gas detector shall not require opening the transmitter enclosure or declassification of the area.

C. House the detector and its electronics in a Type 316 stainless steel NEMA 4 enclosure, UL approved for Class 1, Division 1, Group B hazardous locations.

D. The detector head, with the electrochemical bead cell, shall be removable and replaceable without replacement of electronics, without the need to open the sensor housing, and without the need to declassify the area. The detector head shall be “smart” and shall store all calibration data and sensor identification data, such as type of gas monitored and range. Upon installation into the housing, this data shall be recognized and uploaded into the transmitter electronics. This shall allow sensors to be bench calibrated then taken to the field and installed. Detector life shall be guaranteed for one year of continuous operation, minimum.

2.02 HYDROGEN SULFIDE GAS TRANSMITTERS:

A. The gas concentration shall be continuously displayed in engineering units at the integrally mounted local display.

B. The transmitter shall be capable of storing and displaying average, minimum, and maximum gas concentrations over selected periods of time.

C. The transmitter shall give an indication of when sensor is nearing the end of its useful life by means of the front panel LCD. Indication that the sensor is nearing its useful life shall be based on the sensor output, not on the time the sensor has been in service.

D. The transmitter shall have the following internal relays for remote alarm annunciation:

1. Gas concentration medium

2. Gas concentration high

3. Gas concentration high-high

4. Fault relay

E. The three gas concentration alarm relays shall have normally open and normally closed contacts. The relays shall be energized as long as the gas concentration exceeds the set points adjustable with a hand-held controller.

F. Normally open contact of the fault relay shall be open (relay energized) during normal operation. The relay shall operate in steady mode and in pulsed mode.

1. Steady Mode: Relay shall be de-energized when any of the following occurs:

a. Gas sensor is disconnected

b. Transmitter internal problem

c. Power off

2. Pulsed Mode: Relay shall be de-energized for five seconds every minute when any of the following occurs:

a. Under-range reading on the display

b. Improper calibration

G. The transmitter shall be housed in a NEMA 4X enclosure.

H. Provide a dc power supply with the appropriate voltage and amperage levels to power the required transmitters.

2.03 HYDROGEN SULFIDE GAS CALIBRATION KIT:

A. The gas calibration kit shall provide flow-type calibration for 40 ppm hydrogen sulfide in nitrogen. Flow rate shall be preset, not to exceed 0.25 liter per minute.

B. Provide a gas cylinder capable of providing 57 liters of calibration gas.

C. The kit shall include a carrying case, gas cylinder regulator, hose, adapter for gas detectors, and infrared nonintrusive controller.

2.04 HYDROGEN SULFIDE GAS DETECTION SYSTEM MANUFACTURERS:

A. The hydrogen sulfide gas detection systems shall be the UltimaX Gas Monitor as manufactured by Mine Safety Appliances.

B. Deliver to the Owner the required spare parts upon final acceptance of the work. The spare parts shall not be used as replacement parts during the guarantee period.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install components per manufacturer's recommendations.

3.02 FIELD TESTING:

A. After units have been energized and functions completely checked, set hydrogen sulfide alarm set points at 10 and 20 ppm.

3.03 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

DIVISION 31

EARTHWORK

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SECTION 31 05 19.13

GEOTEXTILES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide geotextiles as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. M288: Standard Specifications for Geotextile Specification for Highway Applications

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Manufacturer's product data sheet and recommended installation instructions.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.07 PACKAGING, SHIPPING, AND STORING:

A. Protect the geotextile from direct sunlight, chemicals, mud, dirt, and debris during shipment and storage.

B. Labeling and Tagging:

1. Identify each package by a tag or label securely affixed to the outside of the roll on at least one end.

2. Provide the following required information on the tag:

a. Name of the geotextile manufacturer.

b. Brand name of the product, width, length, and package weight of geotextile.

PART 2 - PRODUCTS

2.01 SILT FENCE GEOTEXTILE:

A. Conforming to AASHTO M288.

2.02 EROSION CONTROL GEOTEXTILE:

A. Conforming to AASHTO M288.

2.03 DRAINAGE GEOTEXTILE:

A. Class 1 non-woven drainage geotextile according to AASHTO M288.

2.04 SEPARATION GEOTEXTILE:

A. Class I fabric according to AASHTO M288 with Apparent Opening Size of 0.60 mm maximum average roll value.

2.05 STABILIZATION GEOTEXTILE:

A. Class I fabric according to AASHTO M288 with Apparent Opening Size of 0.43 mm maximum average roll value.

2.06 WEED BARRIER GEOTEXTILE:

A. Woven, needle-punched, polypropylene, 5.0 oz, weed barrier geotextile designed for commercial use.

2.07 TEMPORARY SLOPE REINFORCEMENT GEOTEXTILE:

A. TENCATE RS280i geogrid or approved equal.

PART 3 - EXECUTION

3.01 GENERAL:

A. Place geotextile on areas that are smooth and free of projections or depressions.

1. Do not drag the geotextile across the subgrade.

2. Roll geotextile out as smoothly as possible in the direction of vehicle travel.

B. Do not operate construction equipment or traffic directly on geotextile.

C. Cover the geotextile with indicated cover material as soon as possible when placed for construction.

1. Do not leave uncovered for more than five days.

D. Place cover material on the geotextile in a manner that the geotextile is not torn, punctured, or shifted.

1. Use at least a 6 inch thick cover layer or twice the maximum aggregate size, whichever is thicker.

2. Do not end-dump cover material directly on the geotextile except as a starter course.

E. Limit construction vehicles in size and mass so rutting in the initial layer above the geotextile is not more than 3 inches deep or half the layer thickness, whichever is less.

1. Do not turn vehicles on the first layer.

3.02 INSTALL SILT FENCE GEOTEXTILE:

A. Conforming to AASHTO D6462.

3.03 INSTALL EROSION CONTROL GEOTEXTILE:

A. Install at locations shown.

B. Overlap the geotextile at least 2 feet at all longitudinal and transverse joints or sew the geotextile unless otherwise specified.

C. Place overlapped geotextile so that the upstream sheet overlaps the downstream sheets.

D. Overlap each sheet over the next downhill sheet for placement on slopes.

E. Anchor the geotextile using key trenches or aprons at the crests and toes of the slope.

F. Repair: Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

3.04 INSTALL DRAINAGE GEOTEXTILE:

A. Install at locations shown.

B. Place and secure geotextile to provide direct contact against the excavated surface.

C. Overlap successive sheets of geotextile at least 1 foot (applies to Early Works Package 2 only) or 2 feet in the down-gradient direction of flow.

D. Overlap geotextile at least 1 foot at the top of the trench, where applicable.

E. Place fill beginning with the sheets overlapped above subsequent sheets to hold geotextile in place.

F. Repair: Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

3.05 INSTALL SEPARATION GEOTEXTILE:

A. Install for pavement sections or other applications at locations shown.

B. Overlap the geotextile at least 1 foot (applies to Early Works Package 2 only) and 2 feet at all longitudinal and transverse joints or sew the geotextile unless otherwise specified.

C. Repair: Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

D. Place fill, beginning with the sheets overlapped, above subsequent sheets to hold geotextile in place.

E. Use pins 18 inches long to help secure the geotextile during installation.

3.06 INSTALL STABILIZATION GEOTEXTILE:

A. Install stabilization geotextile at locations shown.

B. Overlap the geotextile at least 2 feet at all longitudinal and transverse joints or sew the geotextile unless otherwise specified.

C. Overlap each sheet over the next downhill sheet for placement on slopes.

D. Repair: Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

E. Place fill to hold geotextile in place beginning with the sheets overlapped above subsequent sheets.

F. Use pins 18 inches long to help secure the geotextile during installation.

G. The requirements for combined drainage and stabilization geotextile for the underdrain systems at the Biological Nutrient Removal facility, Primary and Secondary Clarifiers, and Thickeners are addressed in Section 31 34 19.

3.07 INSTALL WEED BARRIER GEOTEXTILE:

A. Preparation:

1. Remove sharp objects, large stones, and undesirable vegetation.

2. Cut an “X” over each plant and push geotextile under plant base if placing geotextile over an existing bed.

3. Roll geotextile over soil and cut an “X” for each plant hole if placing over a new bed.

4. Fold excess geotextile under and cover with specified landscaping materials.

B. Surface Cover:

1. Provide at least 4 inches of cover on all areas on the geotextile.

2. Increase thickness of cover material over geotextile to three times the diameter of the largest rock material if using large landscape rock.

3. Do not leave any portion of geotextile exposed to direct sunlight.

C. Repair:

1. Repair immediately if damaged.

2. Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

D. Maintenance:

1. Maintain surfaces and supply additional landscape materials where necessary including areas affected by erosion.

3.08 INSTALL TEMPORARY STABILIZATION GEOTEXTILE:

A. Install stabilization geotextile at locations shown for surcharge slope stabilization.

B. Place the geotextile on the subgrade or fill as shown, before placing the barrier. Place the barrier. Place fill behind the barrier to the elevation shown. Wrap the barrier and place the geotextile on the compacted fill behind the barrier before placing additional fill.

C. Overlap the geotextile at least 2 feet laterally or sew the geotextile unless otherwise specified.

D. Repair: Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

3.09 SEW:

A. Perform sewing as specified in AASHTO M288, Appendix, Seaming.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide site clearing as indicated and in compliance with Contract Documents.

B. Section Includes:

1. Clearing and grubbing.

2. Removal of debris related to clearing and grubbing operations.

1.02 DEFINITIONS:

A. Caliper: Instrument used to measure tree diameter.

B. Clearing: Removal and disposal of above ground, i.e., trees, shrubs, bushes, and other vegetation, items defined herein.

C. Grubbing: Removal and disposal of below-ground items defined herein.

D. Stripping: Removal and stock piling of all soil material containing sod, grass, or other vegetation and topsoil as defined herein.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Permits

a. Copy of Notice of Intent submitted to the State of Utah, Department of Environmental Quality, Division of Water Quality

2. Certificates

a. Copy of herbicide label bearing EPA registration number.

b. Copy of Arborist Certification

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Permits:

1. Obtain Land Disturbance Permit from an accepted Erosion and Sediment Control Plan. See General Conditions for additional requirements. Submit copy of permit to Engineer.

C. Certifications:

1. Certified Arborist: All tree pruning, tree repair, and tree removal shall be performed by competent workers, under the supervision of an arborist holding certification from the International Society of Arboriculture (ISA) or equivalent education and experience.

1.05 DELIVERY STORAGE AND HANDLING:

A. Herbicide: Comply with Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) – Title 7 U.S.C. Section 136. Submit copy of herbicide label, bearing EPA registration number.

1.06 SITE CONDITIONS:

A. Existing facilities, structures, and utilities are shown in accordance with available surveys and record drawings. The indicated locations of underground utilities and structures are approximate. Other utilities may exist which are not indicated.

PART 2 - PRODUCTS

2.01 ACCESSORIES:

A. Herbicide: Registered EPA Pesticide.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify survey benchmarks and intended elevations for the Work are as indicated.

B. Verify temporary erosion and sediment control measures are installed before commencing with any other work at the site.

C. Verify location and existence of all underground utilities and structures by contacting utility owners, as required by law. Go to “Call Before You Dig” to receive state-specific information. Access this information by dialing 811 or 1-800-662-4111 or going to www.bluestakes.org.

D. Provide 72-hour notice to existing utility owners, prior to beginning construction.

E. Contact utility companies and authorities to make arrangements for handling and disposal of utilities encountered during construction.

3.02 PREPARATION:

A. Site clearing activities may be performed prior to placement of preload fill, or after removal of preload fill, at the contractor's discretion, as long as permitting, protection, preloading, construction, and any other time sensitive activities are performed per the project schedule.

B. Protect bench marks, survey control points, and existing structures to remain from damage or displacement.

C. Protect trees and vegetation to remain. Do not cut or injure trees and vegetation outside easement lines and outside designated clearing areas.

D. Protect all underground utilities and structures that are to remain. If damage occurs, immediately notify the utility owner within the hour.

E. Protect site features to remain from damage by construction equipment and vehicular traffic.

F. Identify waste and salvage area(s) for stockpiling of removed materials.

3.03 RESTORATION:

A. Existing surfaces, features, utilities, or structures that are to remain but are damaged during construction shall be restored to at least the condition in which they were found immediately before work began, unless noted otherwise. Repair immediately any damage done to tree crowns or root systems. Cutting to be done by licensed arborist. Paint cuts over 1-inch in diameter with a tree dressing or paint specifically designed for this purpose.

B. Restore damaged utilities to the satisfaction of the utility owner.

C. Restore damaged private property to the satisfaction of the property owner.

3.04 CLEARING:

A. Remove and dispose of off-site:

1. Trees, snags, brush, shrubs, downed timber, decayed wood, and other vegetative growth.

2. Rocks, tiles, lumps of concrete, trash piles, debris, refuse, and rubbish. Remove all evidence of their presence from the surface.

B. Clear ground within limits of work, unless otherwise noted.

C. Manual cutting of trees, stumps, and stubs during clearing shall be as close to ground surface as practicable but no higher than 6 inches above ground for small trees (8 inches or less), and not higher than 12 inches above ground for larger trees (greater than 8 inches).

D. Obey all federal, state and local regulations and guidance regarding the cutting, burning, and disposal of diseased trees and vegetation.

3.05 GRUBBING:

A. Remove and dispose of all stumps, buried logs, matted roots, roots larger than 2 inches, and organic materials off site.

B. Roots larger than 2 inches in diameter shall be removed to a depth of 12 inches, and roots larger than 1/2-inches in diameter to a depth of 6 inches.

C. Areas designated to receive pavement or structures shall be grubbed a depth of 18 inches. Measure depths of cut from existing ground surface or proposed finished grade, whichever is lower.

D. Apply herbicide to remaining roots and vegetation to inhibit growth.

E. Depressions made by grubbing shall be filled with suitable material and compacted to conform to original adjacent grade.

F. Do not grub areas within drip line of trees to remain to avoid damage to roots.

3.06 STRIPPING:

A. Soil material containing sod, grass, or other vegetation and topsoil shall be removed to a minimum depth of twelve (12) inches from all areas to receive fill from the area within lines 5 feet outside all foundation walls, over all trenches, and from beneath pavement and curb and gutter areas. The stripped material shall be deposited in such locations as are acceptable to Engineer.

3.07 TREE AND SHRUB REMOVAL:

A. Remove trees and shrubs within permanent and temporary easement by felling or cutting individual vegetation and grubbing.

3.08 TREE AND SHRUB PROTECTION:

A. Protect and prune indicated trees and shrubs within the clearing limits.

3.09 PRUNING:

A. Trim dead branches 1-1/2-inches or more in diameter and branches to heights and in a manner as indicated. Neatly cut limbs and branches close to the bole of the tree or main branches. Paint cuts more than 1-1/4-inches in diameter tree wound paint.

3.10 BURNING:

A. Burning is not permitted on site.

3.11 CLEANING:

A. Promptly dispose of excess and unsuitable material off site.

B. Remove debris, junk, and trash from site.

C. Leave site in clean condition, ready for subsequent work.

D. Clean up spillage and wind-blown debris before entering public or private property, adjacent to site.

END OF SECTION

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SECTION 31 22 00

GRADING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide grading as indicated and in compliance with Contract Documents.

B. Section Includes:

1. Rough grading

2. Finish grading

3. Stockpiling of topsoil and subsoil

4. Disposal of unsuitable and excess materials

1.02 DEFINITIONS:

A. Unsuitable Material: Defined in Section 31 23 00.

B. Foundation Influence Zone (under foundations, pavements, or sidewalks): Area below base bounded by 1/2H:1V slope extending outward from 1 feet beyond outer edges.

C. Utility Influence Zone (around piping or ducts): Area below with limits bounded by perpendicular line, 6 inches below pipe or duct with a 1/2H:1V slope extending outward from that line, 1 feet beyond the edge of pipe or duct.

1.03 SUBMITTALS:

A. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.05 SITE CONDITIONS:

A. Existing Conditions:

1. See Section 01 14 14 for additional requirements.

2. Verify location of existing underground utilities and structures by contacting utility owners, as required by law. Go to “Call Before You Dig” to receive state-

specific information. Access this information by dialing 811 or going to http://call811.com/state-specific.aspx.

B. Geotechnical Report: The report has been provided separately and is for information only. Logs of borings are included in the report and indicate conditions encountered only at test boring locations. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify survey benchmarks and intended elevations for the work are as indicated.

B. Verify temporary erosion and sediment control measures are installed before commencing with any other work at the site.

C. Immediately notify the Engineer if suspected hazardous materials are encountered and cease operations in that area.

D. Identify areas loosened by frost action, softened by flooding or weather, or containing unsuitable material.

3.02 PREPARATION:

A. Remove material loosened by frost action, softened by flooding or weather, or containing unsuitable material. Replace and compact to same requirements as for specified fill in Section 31 23 00.

B. Identify required lines, levels, grades, and datum.

C. Stake and flag locations of known utilities.

D. Locate, identify, and protect from damage all above- and below-ground utilities to remain.

E. Notify utility owner prior to removal or relocation of utility. See Section 01 11 00 and Section 01 50 00 for notification requirements.

F. When necessary to excavate through roots of trees or vegetation to remain – perform work by hand and cut roots with sharp axe.

3.03 ROUGH GRADING:

A. Topsoil Removal and Stockpiling:

1. Strip 6 inches or more of topsoil from areas that are to be excavated, landscaped, or graded.

2. Separate organic matter (e.g. root zones) from topsoil. Dispose of organic material off-site.

3. Do not strip topsoil while wet.

4. Stockpile excavated topsoil on site. Do not mix topsoil with foreign materials.

B. Subsoil Removal and Stockpiling:

1. Remove subsoil, including undocumented fill material, from areas that are to be excavated, landscaped, or graded.

2. Remove surcharge material at sole direction of geotechnical engineer of record and shall be removed in uniform layers.

3. Do not remove wet subsoil unless it is subsequently processed to obtain optimum moisture content.

4. Stockpile suitable subsoil on-site.

C. Provide for free drainage of construction site.

D. Benching Slopes: Horizontally bench existing slopes greater than 4H:1V to key fill material to slope for firm bearing.

E. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill in Section 31 23 00.

F. Disc level surfaces.

G. Rough grade site to achieve lines and grades indicated with allowances for imported fill thicknesses.

H. Provide positive drainage away from buildings and structures by sloping minimum of 2.4 inches over 10 feet on impervious surfaces or 6 inches over 10 feet.

3.04 FINISH GRADING:

A. Before finish grading:

1. Verify subgrade is contoured and compacted.

2. Verify backfill has been inspected.

B. Fine grade to eliminate uneven areas and depressions. Follow profiles and contours of subgrade and bring to finish grade as indicated.

3.05 STOCKPILING:

A. Location: As indicated or directed. Do not locate stockpiles over existing or new utilities unless directed.

B. Height: 8 feet maximum

C. Slope: 2H:1V, maximum

D. Drainage: Grade to prevent standing water

E. Provide erosion and sediment control around downhill-side of stockpile perimeter.

F. Immediately stabilize dormant stockpiles within 7 days with tackifier. Stockpiles and portions of stockpiles that will not be actively used for at least 30 days shall be considered dormant.

3.06 EXCESS MATERIAL:

A. Excess grading material, suitable for backfilling or site grading, that is not necessary to complete the work at the project site belongs to the Owner and shall be delivered to an off-site designated location within 1 mile from project site or on-site as directed by the Engineer.

B. Dispose off-site, unsuitable materials and excess materials not received by Owner.

3.07 TOLERANCES:

A. Subgrade:

1. Elevation: 2 inches, from required elevation

2. Grade: 1 inch per 10 feet

B. Finish Grade:

1. Elevation: 1/2 inch, from required elevation

3.08 FIELD QUALITY CONTROL:

A. See Section 31 23 00 for compaction and testing requirements.

3.09 CLEANING:

A. See Section 01 14 14 and Section 01 74 23 for additional requirements.

B. Remove unused stockpiles, grade area to prevent standing water, protect from erosion, and stabilize.

C. Leave site clean and raked, ready to receive landscaping.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

B. Submit existing utility location information as part of record drawings. Include ticket numbers and original information from utility owners.

END OF SECTION

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SECTION 31 23 00

EXCAVATION AND FILL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide excavation and fill as indicated and in compliance with Contract Documents.

B. Section includes:

1. Excavation and fill for: Foundations, structures, and pavement; site drainage, structures, and features.

2. Embankments.

3. Controlled fill using materials from imported and on-site sources.

4. Soil and aggregate materials.

5. Compaction and testing.

1.02 REFERENCES:

A. American Association of State and Highway Transportation Officials (AASHTO):

1. M147: Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.

2. T180: Standard Method of Test for Moisture-Density Relations for Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

B. ASTM International (ASTM):

1. C33: Specification for Concrete Aggregates.

2. C88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

3. C131: Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

4. C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

5. C330: Standard Specification for Lightweight Aggregates for Structural Concrete

6. D421: Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants.

7. D4318: Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

8. D6913: Test Method for Particle-Size Distribution of Soils.

9. D698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).

10. D1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

11. D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft3 (600 kN-m/m3)).

12. D2167: Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

13. D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

14. D2940: Standard Specification for Graded Aggregate Material For Bases or Subbases for Highways or Airports.

15. D4318: Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

16. D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

C. Occupational Safety and Health Administration (OSHA) Standards and Regulations:

1. 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations.

1.03 DEFINITIONS

A. Percent Compaction or Compaction Density: The field dry density of compacted material, expressed as a percentage of the maximum dry density.

B. Field Dry Density or Field Density: In-place density as determined by ASTM D1556 (Sand Cone Method), ASTM D2167 (Rubber Balloon Method), or ASTM D6938 (Nuclear Method).

C. Maximum Dry Density: Laboratory density as determined by ASTM D698 (Standard Proctor) or ASTM D1557 (Modified Proctor) and occurring at the optimum moisture content of the material being tested.

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Gradation analysis.

2. Materials Sources: Name of source, location, date of sample, sieve analysis, and laboratory compaction characteristics.

3. Test and Evaluation Reports:

a. Field density testing reports: Provide results from field density testing of prepared subgrade and compacted fill.

b. Grain-size analysis.

c. Laboratory compaction characteristics of soils.

d. Water content.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sustainability Standards Certifications.

C. Testing will be provided by the Owner as specified. Contractor shall be responsible for cost of testing and inspection conducted as a result of non-conforming work.

D. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in of loose soil. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P.

1.07 DELIVERY STORAGE AND HANDLING:

A. Geotextile Fabric:

1. See AASHTO 288 and Section 31 34 19.

1.08 SITE CONDITIONS:

A. Existing Conditions:

1. The contractor shall be prepared to excavate and work with very soft clay subgrade soils, loose flowing sands, sands, and wet conditions.

2. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.

PART 2 - PRODUCTS

2.01 FILL MATERIALS:

A. Suitable Material: Material from on-site excavation and permitted off-site sources that meets all of the specified requirements for its intended use and is not unsuitable. Wet subgrade material which meets other requirements for suitable material is suitable.

B. Unsuitable Material: Material that fails to meet requirements for suitable materials; or contains any of the following:

1. Organic clay, organic silt, or peat; as defined in ASTM D2487.

2. Vegetation, wood, roots, leaves, and organic, degradable material.

3. Stones or rock fragments over 6 inches in any dimension.

4. Porous biodegradable matter, excavated pavement, construction debris, rubbish, or refuse.

5. Ice, snow, frost, or frozen soil particles.

C. Untreated Base Course: Refer to APWA 2017 Standard Specifications Section 32 11 23 Grade 1-1/2 Untreated Base Course.

D. Granular Borrow: Refer to APWA 2017 Standard Specifications Section 31 05 13 Common Fill.

E. Free Draining Granular Backfill: Refer to UDOT 2017 Standard Specifications Section 02056 Embankment, Borrow, and Backfill.

F. General Fill:

1. Material shall consist of well graded material meeting the following gradation and plastic index should be equal to or less than 6.

Sieve Size	Percent Passing
2-inch	100
3/4 inch	90 – 100
3/8 inch	70 – 90
No. 4	55 – 70
No. 10	40 – 60

Sieve Size	Percent Passing
No. 40	20 – 50
No. 200	0 – 25

G. Structural Fill:

1. Material shall consist of well graded granular material meeting the following gradation, have a plastic index equal to or less than 6, and CBR greater than 50 at 0.2 inches.

Sieve Size	Percent Passing
2-inch	100
1 inch	80 – 100
3/4 inch	70 – 80
1/2 inch	60 – 70
3/8 inch	40 – 65
No. 4	30 – 50
No. 10	20 – 40
No. 40	10 – 30
No. 200	0 – 15

H. Lightweight Structural Fill:

1. Material shall have LA abrasion (ASTM C131) less than 31 percent and a soundness loss (ASTM C88) of 1 percent or less.

2. Natural Scoria

a. Material shall consist of natural scoria aggregate that is chemically inert, durable, and conforms to the requirements of ASTM C330 but meeting the following gradation.

Sieve Size	Percent Passing
1 inch	80 – 100
3/8 inch	40 – 100
No. 4	10 – 70
No. 10	0 – 40
No. 40	0 – 25
No. 200	0 – 15

3. Expanded Shale, Slate, or Clay Aggregate:

a. Material shall consist of expanded shale, slate, or clay aggregate that is chemically inert, durable, and conforms to the requirements of ASTM C330 but meeting the following gradation.

Sieve Size	Percent Passing
1 inch	100
3/8 inch	80 – 100
No. 4	10 – 70
No. 10	0 – 30
No. 40	0 – 15
No. 200	0 – 8

2.02 EQUIPMENT:

A. Compaction equipment shall be capable of consistently achieving the specified compaction requirements.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that dewatering support systems are in place before commencing with excavation.

B. Verify that excavation safety and support systems meeting the requirements of OSHA 29 CFR 1926, Subpart P are in place before commencing with excavation.

1. Minimum slopes for laying back excavations or materials are contained in OSHA 29 CFR 1926, Subpart P; Appendices A and B.

2. Minimum requirements for shoring and bracing are contained in OSHA 29 CFR 1926, Subpart P; Appendix C.

C. Verify that fill materials submittals have been accepted by Engineer before commencing with work requiring the use of these materials.

D. Verify that erosion and sediment control measures are in place and functioning properly.

E. Immediately notify the Engineer if unexpected subsurface facilities or suspected hazardous materials are encountered during excavation. Discontinue affected work in area until notified to resume work.

F. HydroVac Pot-Holing:

1. Comply with the requirements in Section 01 14 14 and Section 02 32 19.

2. Pot-Hole using Hydro Vac to field verify the locations of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Engineer if conflicts are encountered.

3.02 PREPARATION:

A. Underpin adjacent structures that could be damaged by excavation work.

B. Cut pavement with saw or pneumatic tools to prevent damage to remaining pavement. Dispose of large pieces of demolished pavement before proceeding with excavation.

C. Remove subsurface structures and related obstructions.

D. Remove boulders within excavation limits.

3.03 PROTECTION OF IN-PLACE CONDITIONS:

A. Comply with the requirements specified in Section 01 14 14 and Section 02 01 20.

B. Support and protect from damage – existing pipes, poles, wires, fences, curbs, property line markers, and other features or structures which must be preserved in place to avoid being temporarily or permanently relocated.

C. Excavation Near Existing Structures:

1. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.

2. Excavate test pits near, or at intersection with, existing utilities or underground structures to determine the exact location of existing features.

D. Excavation Near Private Property:

1. Record existing condition of features on adjacent property by means of dated photographs or cameras. Provide construction photographs according to Section 01 32 33.

2. Enclose uncut tree trunks adjacent to work in wooden boxes of such height necessary to protect tree from injury due to piled material, equipment, or operations. Operate excavating machinery and cranes so as to prevent injury to overhanging branches and limbs.

3. Protect cultivated hedges, shrubs, and plants which would otherwise be damaged by the work.

4. Where protection of vegetation is not possible, dig up, temporarily transplant, and maintain. After active construction operations in the area have ceased, transplant vegetation to the original positions and provide water and nursery care until growth is re-established.

5. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved surfaces. Provide protection on pavement if construction traffic is unavoidable.

3.04 RESTORATION:

A. Restore private property and structures promptly. Begin restoration work within 24 hours of when damage occurred.

B. Existing surfaces, features, or utilities that are to remain but are damaged during construction shall be repaired or replaced to at least the condition in which they were found immediately before work began, unless noted otherwise.

C. Damaged Trees to Remain: Cut all damaged branches, limbs, and roots smoothly and neatly without splitting or crushing. Neatly trim, cut the injured portions and cover with an application of grafting wax or tree healing paint. Replace damaged trees which subsequently die or continue to show lack of growth due to damage.

D. Cultivated Vegetation: Includes, but is not limited to: hedges, shrubs, and plants. Vegetation that is damaged shall be replaced with equal kind and of the same quality after construction activities in the area are complete.

3.05 EXCAVATION:

A. Excavate to accommodate new structures and construction operations.

B. Excavate to lines and grades necessary to provide finish grades.

C. Excavations that are not shored and deeper than 4 feet shall meet the requirements of OSHA 29 CFR 1926.

D. Workers shall have an adequate means of exit from excavations that are 4 feet or greater in depth. The means of exit shall not require more than 25 feet of lateral travel.

E. Establish limits of excavation to allow adequate working space for installing forms and for safety of personnel.

F. Carry out program of excavation, dewatering, and excavation support systems to eliminate possibility of undermining or disturbing foundations of existing structures or the work.

G. Preserve material below and beyond the lines of excavations.

H. Locate stockpiled excavated material away from edge of excavations per OSHA 29 CFR 1926 to prevent cave-ins or bank slides.

I. Excavate for depressed mat foundations so that adjacent sections of foundation mat will rest on structural fill or drain materials.

J. Control and lower groundwater as needed for excavation.

K. Perform over-excavation as needed for work in soft clayey soils and as approved by the Engineer. Backfill of over-excavation shall be performed in accordance with Paragraph 3.08.P.

3.06 SUBGRADE PREPARATION:

A. Where vegetation or topsoil or both are present, clear as specified in Section 31 10 00. Contractor shall remove surcharge material from all work areas in accordance with Section 31 22 00.

B. Excavate and shape subgrade to line, grade, and cross section shown in the drawings. The subgrade shall be considered to extend over the full width of the fill lift.

C. Where the subgrade consists of predominantly fine-grained soil, excavate using a smooth cutting blade to minimize disturbance to the native subgrade soil left in place. After excavation, do not disturb the native subgrade soil. Do not run any equipment over the subgrade or separation fabric before placing the first lift of fill. Consult the Engineer prior to placement of overlying materials. Over-excavation and replacement may be required to prepare firm and unyielding subgrade using fill materials and methods described in Section 3.08.

D. The exposed surface shall be examined by the Engineer to determine that the proper bearing material has been exposed.

E. Where the subgrade consists of predominantly non-plastic, granular soils, scarify and recompact the top 6 inches of subgrade. Recompact the top 6 inches of subgrade to a minimum of 95 percent of the maximum dry density based on Modified Proctor (ASTM D1557 or AASHTO T180). Remove soft material identified during the subgrade preparation, replace with the overlying material and recompact to a minimum of 95 percent of the maximum dry density using Modified Proctor (ASTM D1557 or AASHTO T180).

F. Control and lower groundwater as needed for subgrade preparation.

3.07 UNAUTHORIZED EXCAVATION:

A. Contractor is responsible for backfilling unauthorized excavations with material selected by the Engineer. Unauthorized Excavation consists of removal or loosening of materials beyond indicated subgrade elevations or dimensions without specific directions of the Engineer.

3.08 FILL:

A. Fill to lines and grades necessary to provide finish grades. Limit loose lift thickness to 8 inches, except where specified elsewhere. Do not place fill until the Engineer has approved the subgrade for fill placement.

B. Use a placement method that does not disturb or damage other work or existing features. Keep construction vehicles and end-dumped material off of geotextiles until a minimum thickness of 18 inches of material has been placed.

C. Moisture condition fill materials as needed to obtain compaction and moisture requirements specified herein.

D. Provide for drainage so that surface water from rain and snowmelt, can be managed without impacting construction. At the contractor's discretion, the drainage measures may include existing granular fill, imported drainage layer, drainage pipe(s), drains, synthetic drainage materials, drainage ditches, sloping ground surface, other methods, or any combination of these. Install temporary dewatering sumps in low areas during filling operations as shown on the plans. Install additional sumps if needed to drain the drainage layer.

E. Provide surface grading and working pad, as needed, for installation of wick drains in the areas shown on the project drawings.

F. Control and lower groundwater as needed for fill placement.

G. Begin filling in lowest section of work area. Grade surface of fill approximately horizontal but provide with sufficient longitudinal and transverse slope to allow for runoff of surface water from every point.

H. Reduce moisture content of fill material, if necessary, in source area by aerating it during warm and dry atmospheric conditions. A large disc harrow with two to three foot diameter disks may be required for working soil in a drying operation.

I. Compact uniformly throughout. Keep fill surfaces sufficiently smooth and free from humps and hollows to allow for proper and uniform compaction. Do not permit hauling equipment to follow a single track on the same lift but direct equipment to spread out to prevent over compaction in localized areas. Take care in obtaining thorough compaction at edges of fill.

J. Slightly slope surface of fill to ensure drainage during periods of wet weather. Do not place fill while moderate or heavy rain is falling or after a rain-storm until the Engineer considers conditions satisfactory. During such periods and upon suspension of filling operations for periods in excess of 12 hours, roll smooth the surface of fill using a smooth wheel static roller to prevent excessive absorption of rainfall and surface moisture. Prior to resuming compaction operations, remove muddy material off surface to expose firm, compacted material, as determined by the Engineer.

K. When fill is placed against an earlier fill or against in-situ material under and around structures, including around piping beneath structures or embankments, slope junction between two sections of fill at 3 to 1 (horizontal to vertical). Bench edge of existing fill in steps 12 inches high and 36 inches wide to 24 inches high by 72 inches wide against which to place and compact the new fill. Ensure that rolling extends over junction between fills.

L. Remove debris, remove loose material, scarify, and recompact previously placed fill which has become desiccated or littered with debris.

M. After spreading each loose lift to the required thickness and adjusting its moisture content, roll with sufficient number of passes to obtain the required compaction. One pass is defined as the required number of successive trips which by means of sufficient overlap will insure complete coverage and uniform compaction of an entire lift. Do not make additional passes until previous pass has been completed.

N. Remove material and replace work if material fails testing requirements after repeated attempts to compact.

O. Placing Fill on Firm Subgrade:

1. Transport materials and deposit them by means of spreading equipment on the subgrade or prior lift. Place the lifts so that when compacted they will be true to the grades or levels required. Make such adjustments in placing procedures or equipment to obtain true grades, minimize segregation and degradation, reduce or increase moisture content, and assure an acceptable placement.

2. Spread and compact the material to the required density in one or more lifts, as specified below, and of such width and thickness that, after compacting, the finished material will conform to the required grade and cross section. Spread the material for each separate lift over the full length and width of the section to be compacted before placing the succeeding lifts. Stagger longitudinal and transverse joints a minimum of 12 inches in each succeeding lift.

3. Place material in lifts with maximum loose thicknesses of 8 inches. Compact all the fill, including the edges of fill areas to meet specified density requirements.

4. For Roadways:

a. After testing the blended and flattened windrow of aggregate base or gravel material mixed on the subgrade or prior lift, spread it uniformly as specified above over the full length and width of the section to be compacted. Do this spreading in such a manner as to prevent segregation of the mixture.

P. Bridging Zone - Placing Fill on Relatively Soft (medium stiff, soft or very soft) Subgrade:

1. Do not allow any equipment directly on the subgrade or geotextile fabric. Do not allow haul, spreading, or compaction equipment to cause rutting, pumping or other disturbance to the subgrade.

2. Place a minimum of 18 inches of fill on the geotextile fabric ahead of any equipment. Use low-ground pressure equipment or a light weight skid steer for spreading as conditions dictate.

3. Keep all haul trucks off the fill until the full thickness of the fill lift is in place and compacted.

4. Place the first 18-inch lift of fill before attempting to compact. If vibratory compaction causes the subgrade to soften and pump, turn off vibration and static roll. If static rolling continues to cause pumping, Stop all compaction activity and wait for the following day to resume. Place an additional lift of fill, 8 inches maximum loose thickness before again attempting compaction. If attempts to compact still result in disturbance or pumping, contact the engineer.

5. Spread and compact the remaining fill to the required density in one or more lifts, as specified below, and of such width and thickness that, after compacting, the finished fill will conform to the required grade and cross section. Spread the material for each separate lift for the full width and length of the area to be compacted before placing the succeeding lifts. Stagger longitudinal and transverse joints a minimum of 12 inches in each succeeding lift.

6. Place the remaining fill material in maximum loose thicknesses of 8 inches. Compact all the fill, including the edges of fill areas to meet specified density requirements.

7. Overexcavation and backfill may be required to prepare a firm and unyielding surface suitable to support foundations as determined by the Engineer and as shown on the plans. Backfill materials may consist of General Fill in non-structural applications, Structural Fill below foundations, or Free Draining Granular Backfill Borrow. Coordinate with the Engineer on all overexcavation and backfill.

8. Overexcavation and bridging may be required to prepare a firm and unyielding surface or stable working platform suitable to support compacted structural fill, compacted general fill, underdrains, and foundations as determined by the Engineer and as shown on the plans. Bridging materials may consist of General Fill, Structural Fill, or Drain Gravel. Coordinate with the Engineer on all overexcavation and bridging.

9. Geotextiles may be used for bridging activities at the preference of the contractor as allowed in Sections 31 34 19 and 31 23 19.

Q. Placing Fill over Prepared Subgrade:

1. Place Fill in uniformly thick lifts with a maximum loose thickness of 8 inches.

R. Placing Lightweight Structural Fill over Prepared Subgrade:

1. Place geotextile on prepared subgrade, up the sides of excavation. Place over the top of the lightweight fill after fill placement.

2. Place the lightweight fill in uniformly thick lifts with a maximum loose thickness of 8 inches.

3. Place lightweight fill at sufficient moisture content to meet compaction requirement while remaining below the maximum allowable average compacted moist in-place density.

4. Compact the lightweight fill with smooth-drum vibratory equipment having an operating weight no heavier than 12 tons. Take necessary measures to avoid crushing the aggregate. If crushing occurs, remove the damaged material and make adjustments to the compaction equipment, lift thickness, and/or the number of passes.

S. Rolling and Compaction: Begin rolling and compaction at the outer edges of the surfacing and continue toward the center. Compact each lift until the specified density is achieved. Maintain the surface of each lift during the compaction operations to provide a uniform texture, with the aggregates remaining firmly keyed. Apply water uniformly over the base materials during compaction in the amount necessary for proper compaction.

3.09 COMPACTION:

A. Compact to density specified and indicated for various types of material. Control moisture content of material being placed as specified.

B. Subgrade: Where scarification is required, compact to a minimum of 90 percent of maximum dry density using Modified Proctor (ASTM D1557 or AASHTO T180). Moisture condition and compact material within 2 percentage points of the optimum moisture content as determined by Modified Proctor (ASTM D1557 or AASHTO T180).

C. Granular Borrow: Compact to a minimum of 95 percent of maximum dry density using Modified Proctor (ASTM D1557 or AASHTO T180). Moisture condition and compact material within 2 percentage points of the optimum moisture content as determined by Modified Proctor (ASTM D1557 or AASHTO T180).

D. Untreated Base Course: Compact to a minimum of 95 percent of maximum dry density using Modified Proctor (ASTM D1557 or AASHTO T180). Moisture condition and compact material within 2 percentage points of the optimum moisture content as determined by Modified Proctor (ASTM D1557 or AASHTO T180).

E. General Fill: Compact to a minimum of 95 percent of maximum dry density using Modified Proctor (ASTM D1557 or AASHTO T180). Moisture condition and compact material within 2 percentage points of the optimum moisture content as determined by Modified Proctor (ASTM D1557 or AASHTO T180).

F. Free Draining Granular Backfill Borrow: Where required, compact to a minimum of 90 percent of maximum dry density using Modified Proctor (ASTM D1557 or AASHTO T180).

G. Structural Fill: Compact to a minimum of 95 percent of maximum dry density using Modified Proctor (ASTM D1557 or AASHTO T180). Moisture condition and compact material within 2 percentage points of the optimum moisture content as determined by Modified Proctor (ASTM D1557 or AASHTO T180).

H. Lightweight Structural Fill:

1. Scoria:

a. Provide an in-place density within plus or minus 5 pcf of the result of a One Point Proctor (a modification of ASTM D698) tested at the moisture content of the sample to the approval of the Engineer, but no more than 75 pcf.

(1) Modification of ASTM D698: The lightweight aggregate shall be placed in three layers in a standard 0.5 cubic foot bucket, with each layer compacted by 25 blows from a 5.5 pound hammer dropped from a distance of 12 inches. The aggregate is compacted at the received moisture content and may not be reused for testing.

2. Expanded Shale, Slate, or Clay Aggregate:

a. Do not add moisture to expanded aggregate unless specifically approved by the Engineer. Cover stockpiles and keep covered during periods of precipitation. Do not place expanded shale below high groundwater elevation.

b. Provide an in-place density within plus or minus 5 pcf of the result of a One Point Proctor (a modification of ASTM D698) tested at the moisture content of the sample to the approval of the Engineer.

(1) Modification of ASTM D698: The lightweight aggregate shall be placed in three layers in a standard 0.5 cubic foot bucket, with each layer compacted by 25 blows from a 5.5 pound hammer dropped from a distance of 12 inches. The aggregate is compacted at the received moisture content and may not be reused for testing.

3. Use a nuclear density gage in the direct transmission method to test the density of the compacted production material. Wherever possible, extend the densometer

probe a minimum of 10 inches. Do not use backscatter to evaluate the density of the compacted material.

4. Provide a small test pad with the dimensions 20 foot by 20 foot to determine the required number of passes and moisture content to provide the required moist density without crushing the particles.

5. Compaction shall be with smooth drum vibratory roller at low amplitude. Avoid crushing the aggregate. Reduce the number of passes or switch to lighter equipment if crushing occurs.

3.10 FIELD QUALITY CONTROL:

A. See Section 01 45 00 for general requirements for field inspection and testing.

B. Perform inspection at least once daily to confirm lift thickness and compaction effort for entire fill area.

C. Perform particle size distribution and gradation analyses using ASTM D6913 and following standard practices in ASTM D421. Perform 1 test for every source and submit results to Engineer for acceptance. Repeat the moisture density test for every 1,000 cubic yard of material used.

D. Perform field density testing in accordance with ASTM D6938.

E. Evaluate field density test results in relation to maximum dry density as determined by testing material in accordance with the compaction criteria listed in Section 3.09.

F. Perform tests in accordance with ASTM D4318 to determine Liquid Limit, Plastic Limit and Plasticity Index and submit test results to Engineer for acceptance. Minimum of one test per 1,000 cubic yard of soil for use as fill material and whenever classification of material is in doubt as determined by the Engineer.

G. Location of field density and post-compaction gradation tests shall be as recommended by the Engineer.

H. In the event compacted material does not meet specified in-place density, re-compact material and re-test area until specified results are obtained.

I. Frequency of field density tests: 1 per lift for every 200 linear feet of roadway. 1 per lift every 1,000 square feet below structures with a minimum of three tests for a given fill lift. 1 per lift every 10,000 square feet for preload fills of all types.

3.11 ADJUSTING:

A. Shrinkage:

1. Build fill or backfill to a height above finished grade which will, in the opinion of the Engineer, allow for the shrinkage or consolidation of material. Initially, provide at all points, an excess of at least one percent of total height of backfill measured from stripped surface to top of finished surface.

2. Supply specified materials to build up low places when embankment or backfill settles below the finished grade at any time before package substantial completion.

3.12 TOLERANCES:

A. Construct finished surfaces to plus or minus and 1/2 inch of the elevations indicated.

B. Grade areas of cut and fill and material layer thicknesses to plus or minus 0.20 foot of the grades indicated.

C. Complete embankment edges to plus or minus 6 inches of the slope lines indicated.

D. Provide the Engineer with adequate survey information to verify compliance with above tolerances.

E. The minimum radial thickness of drain gravel around perforated drainpipes shall be 12 inches, and the minimum perpendicular thickness of filter sand below, above, and adjacent to drain gravel shall be 18 inches, unless noted or shown otherwise on drawings.

3.13 PROTECTION:

A. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide dewatering as indicated and in compliance with Contract Documents.

B. Design, furnish, operate, maintain, and remove temporary dewatering systems to control groundwater and surface water to maintain stable, undisturbed subgrades, and permit work to be performed under dry and stable conditions. Work to be done as part of dewatering includes, but is not limited to:

1. Lower the groundwater level

2. Lower hydrostatic pressure

3. Prevent and control surface water from entering the excavation during construction

4. Implement erosion control measures for disposing of discharge water

5. Provide groundwater recharging systems as specified and as indicated.

6. Provide and monitor observation wells and geotechnical instrumentation as specified and indicated.

C. Groundwater within the excavation area shall be lowered to at least 2 feet below the lowest excavation levels as specified and as indicated. Dewatering for the shaft construction is not mandatory if the Contractor selects to utilize a positive-sealed support system and it is submitted and approved by Engineer.

D. Common dewatering methods include, but are not limited to, sump pumping, deep wells, well points, vacuum well points, vacuum-assisted sealed deep wells, sealed jet educator wells or combinations thereof.

E. The Contractor is responsible for obtaining and following all required local, state, and federal discharge permits. Coordinate with the Owner for the location of the discharge and the allowable discharge rates and required effluent limits.

F. Discharge in accordance with the discharge permit, in accordance with 40 CFR Part 122, and all other applicable federal, state, and local rules and regulations.

1. Discharge Limits for the Water Reclamation Facility are identified in Table 31 23 19-1.

TABLE 31 23 19-1 – WASTEWATER DISCHARGE LOCAL LIMITS
SALT LAKE CITY WATER RECLAMATION FACILITY

POLLUTANT OF CONCERN (POC)		Local Limit	
METAL POLLUTANTS	Arsenic (As)	0.2	mg/L
	Cadmium (Cd)	0.2	mg/L
	Chromium (Cr)	5.0	mg/L
	Copper (Cu)	6.2	mg/L
	Lead (Pb)	1.5	mg/L
	Mercury (Hg)	0.2	mg/L
	Molybdenum (Mo)	0.8	mg/L
	Nickel (Ni)	1.4	mg/L
	Selenium (Se)	1.0	mg/L
	Silver (Ag)	--	--
	Zinc (Zn)	12.0	mg/L
ORGANIC/ CONVENTIONAL POLLUTANTS	Biochemical Oxygen Demand (BOD)	11,000	mg/L
	Total Suspended Solids (TSS)	7,200	mg/L
	Chemical Oxygen Demand (COD)	--	--
	Biodegradable Oil and Grease	500	mg/L
	Petroleum, Non-biodegradable Oil	100	mg/L
	pH (range)	≥ 5.0 and ≤11.0	standard units

NOTES:

mg/L – milligrams per liter

pH is an instantaneous limit. All other Local Limits are expressed as a daily maximum

G. Sample and test water quality for the constituents identified in Table 31 23 19-1. Samples shall be tested by an independent certified water quality testing laboratory. Sampling and testing shall follow current standards and protocols identified by the Salt Lake City Water Reclamation Facility and/or as required by the independent water quality testing laboratory. Continuously monitor common constituents' concentration levels using field instruments to provide timely notification if a specified constituent level is exceeded. If discharging water back into the existing Salt Lake City Influent Pump Station Influent it must pass through a Baker Tank prior to discharge.

H. Comply with all applicable environmental protection laws and requirements in operation of the dewatering system.

1.02 REFERENCES:

A. Code of Federal Regulations, Title 40 – Protection of Environment (CFR):

1. 40 CFR Part 122: EPA Administered Permit Programs: The National Pollutant Discharge Elimination System.

B. Salt Lake City Ordinances.

1. Title 17 Public Services

C. Section 31 23 00

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Qualification of the Contractor's own dewatering specialist or subcontracted firm's qualifications a minimum of 4 weeks prior to dewatering work. The submittal shall include, but not be limited to:

a. Qualifications of specialist or firm responsible for dewatering system design.

b. Qualifications of specialist's or firm's field representative who will oversee the installation, operation, and maintenance of dewatering systems.

2. Submit a dewatering plan, and, if applicable, a groundwater recharge plan at least two weeks prior to start of dewatering work. Do not submit design calculations. The review will be only for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor shall remain responsible for the adequacy and safety of the means, methods, and sequencing of construction. The plan shall include the following items as a minimum:

a. Dewatering plan and details stamped and signed by a Registered Professional Engineer licensed in the State of Utah.

b. Certificate of Design: Refer to Section 01 33 00.

c. A list of equipment including, but not limited to, pumps, prime movers, and standby equipment.

d. Detailed description of dewatering, maintenance, and system removal procedures.

e. Monitoring plan and details, including, but not limited to, number, depth and locations of observation wells (minimum of two or as noted on drawings if more than two), and geotechnical instruments such as settlement markers

(reference points on structures; minimum of two per structure within the zone of influence as measured by the piezometers) and piezometers (as needed to determine the zone of influence), and frequency of reading the monitoring devices. Locations and screened interval elevations of piezometer / observation wells shall be submitted to the Engineer for approval.

f. Erosion and sedimentation control measures, and methods for disposal of pumped water.

g. List of all applicable laws, regulations, rules, and codes to which dewatering design conforms.

h. List of assumptions made for design of dewatering and for groundwater recharge systems, including but not limited to design groundwater levels, soil stratigraphy, permeabilities, and duration of pumping and or recharge.

3. Measurement records consisting of observation well and piezometer groundwater depths / elevations and other geotechnical instrumentation readings within one day of monitoring.

4. A modified dewatering plan within 24 hours, if open pumping from sumps and ditches results in subgrade uplift (heaving), boils, loss of fines or softening of the ground.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Dewatering: Employ the services of a dewatering specialist or firm having the following qualifications:

1. Have completed at least 5 successful dewatering projects of equal size and complexity and with equal systems within the last 5 years.

2. Retain the services of a Registered Professional Engineer (in the state where the project is located) having a minimum of 5 years' experience in the design of well points, deep wells, recharge systems, or equal systems.

3. Retain the services of a field representative having a minimum of 5 years' experience in installation of well points, deep wells, recharge systems, or equal systems.

C. If subgrade soils are disturbed or become unstable due to dewatering operation or an inadequate dewatering system, notify the Engineer, stabilize the subgrade, and modify system to perform as specified.

D. Notify the Engineer immediately if settlement or movement is detected on structures. If the settlement or movement is deemed by the Engineer to be related to the dewatering,

take actions to protect the adjacent structures and submit a modified dewatering plan to the Engineer within 24 hours. Implement the modified plan and repair damage incurred to adjacent structures.

E. Immediately notify the Engineer if oil or other hazardous materials are encountered after dewatering begins.

1.05 HYDRAULIC UPLIFT OF STRUCTURES:

A. The Contractor shall be responsible for the protection of all structures against hydraulic uplift until such structures have been accepted finally by the Owner.

B. In this regard, the Contractor is advised that all tanks when completed are designed to resist hydraulic uplift from groundwater up to the elevation indicated on the structural drawings when the structure is completed. The concrete slab bottoms shall be placed in the dry, with the use of wellpoints or other dewatering means to keep the water elevation sufficiently low to carry on the work. For the shafts appurtenant to the tunnel construction, the invert can be placed using a tremie-method approach.

C. Buildings with basements are designed to resist hydraulic uplift from groundwater against the weight of the completed structure, including all masonry, and structural steel frames.

1.06 PRECAUTIONS AGAINST HYDROSTATIC UPLIFT DURING CONSTRUCTION:

A. Maintain a low groundwater elevation in accordance with this specification, i.e., 2 feet below bottom of excavations in the vicinity of the structures until they are complete. In case of extremely high groundwater during construction of the structures, it may be necessary to flood excavations and / or the partially completed structures to counteract hydraulic uplift forces.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.08 SITE CONDITIONS:

A. Subsurface Conditions: Refer to Geotechnical reports.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Provide settlement markers, piezometers and other geotechnical instruments in accordance with the submitted dewatering plan or as specified.

B. Provide casings, well screens, piping, fittings, pumps, temporary power and other items required for dewatering system. Provide and maintain sufficient standby system

components onsite as recommended by Contractor's dewatering designer and approved by Engineer.

C. Provide sand and gravel filter around the well screen. Wrapping geotextile fabric directly around the well screen shall not be allowed.

D. Provide sand filter around the well / wellpoint screens designed to reduce sand concentrations in the well / wellpoint discharge to 5 ppm by volume or less.

E. When deep wells, wellpoints, vacuum-assisted sealed deep wells, sealed jet eductor wells or vacuum wellpoints are used, provide pumping units capable of maintaining high vacuum and handling large volumes of air and water at the same time.

F. Provide backup dewatering equipment in the event of breakdown. Equipment shall consist of pumps, hoses, discharge pipe, and fittings and be stored onsite. Provide at least 1 standby pump for every 4 pumps used.

G. Provide on-site standby generators for dewatering systems connected to commercial electric power. Provide automatic switching so that Generators start automatically start in the event of a power failure and are designed to provide at least 110 percent of the continuous power required by the dewatering system. If appropriate provide time delays to stagger restarts of motors to limit aggregate inrush current loads. Provide adequate winterization of generators if operation is required during cold weather. Provide standby fuel tanks with appropriate spill containment measures that are connected to generators with sufficient fuel capacity to operate the dewatering system(s) for at least 48 hours following a power outage.

H. Test automatic starting and generating equipment quarterly by switching to standby power and running the system for at least one hour.

I. Provide and maintain erosion and sedimentation control devices as indicated or specified and in accordance with the dewatering plan.

J. Provide temporary pipes, hoses, flumes, or channels for conveying discharge water to the discharge location(s).

K. Provide cement grout having a water cement mix of 11.3 gallons per 94.5-pound cement bag.

3.01 INSTALLATION:

A. Execution of earth excavation, installing earth retention systems, and dewatering shall not commence until the related submittals have been reviewed by the Engineer with all Engineer's comments satisfactorily addressed and the geotechnical instrumentation has been installed.

B. Provide and maintain dewatering system in accordance with the dewatering plan.

C. Carry out dewatering program in such a manner as to prevent undermining or disturbing foundations of existing structures or of work ongoing or previously completed.

D. Do not excavate until the dewatering system is operational.

E. Unless otherwise specified, continue dewatering uninterrupted until all structures, pipes, and appurtenances below groundwater level have been completed such that they will not be floated or otherwise damaged by an increase in groundwater elevation.

F. Discontinue open pumping from sumps and ditches when such pumping results in subgrade uplift, boils, loss of fines, softening of the ground, or instability of the slopes. Modify dewatering plan and submit revised plan to the Engineer for acceptance.

G. Where subgrade materials are disturbed or become unstable due to dewatering operations, remove and replace the materials in accordance with Section 31 23 00.

H. Dewatering Discharge:

1. Install sand filters in conjunction with well points and deep wells to prevent the migration of fines from the existing soil during the dewatering operation. Pump test all wells and 10 percent of wellpoints for sanding for a minimum of 15 minutes each, and if tests indicate excessive sand is produced (greater than 5 ppm by volume), replace sanding wells and/or wellpoints.

2. Measure sand content of discharge using a Rossum centrifugal sand tester or equal and limit sand concentration to less than 5 ppm by volume. Perform tests in the presence of the Engineer in accordance with the testing equipment manufacturer's recommendations.

3. Convey pumped or drained water to discharge location(s) as coordinated with the Engineer and Owner without interference to other work, damage to pavement, other surfaces, or property.

4. Provide valves in the discharge lines on both sides of equipment traffic crossings.

5. The Engineer reserves the right to sample discharge water at any time.

6. Immediately notify the Engineer if contaminated groundwater is suspected / encountered. Do not pump water found to be contaminated with oil or other hazardous material to the discharge locations.

I. Monitoring Devices and Records:

1. Install, maintain, monitor, and take readings from the observation wells, piezometers, and geotechnical instruments in accordance with the dewatering plan.

2. Install settlement markers on structures within the zone of influence for dewatering a distance equal to twice the depth of the excavation, from the closest edge of the excavation. Measure settlements to an accuracy of ±0.01 ft (1/8-inch).

3. For all excavations the zone of influence shall be defined by the actual cone of dewatering influence corresponding to a radius to zero drawdown.

4. If dewatering is planned, submit a comprehensive workplan that covers the instrumentation and monitoring plan and submit for approval. Include alarms and alert levels in plan with appropriate actions for each.

J. Install and maintain erosion/sedimentation control devices at the point of discharge as indicated or specified and in accordance with the dewatering plan.

K. Removal:

1. Do not remove dewatering system without approval of the Engineer.

2. Backfill and compact sumps or ditches with screened gravel or crushed stone wrapped with geotextile fabric in accordance with Section 31 23 00.

3. All dewatering wells shall be abandoned upon completion of the work, and completely backfilled with cement grout.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 31 23 33

TRENCHING AND BACKFILL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide trenching and backfill as indicated and in compliance with Contract Documents.

B. Section includes:

1. Trench excavation width and safety.

2. Backfill materials and placement.

3. Utility identification using marking tape and trace wire

4. Soil and aggregate materials.

5. Compaction and testing.

1.02 REFERENCES:

A. American Association of State and Highway Transportation Officials (AASHTO) Publications:

1. M147: Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.

B. American Public Works Association (APWA):

1. Public Works Management Practices Manual; latest edition.

C. ASTM International (ASTM):

1. D75: Standard Practice for Sampling Aggregates.

2. D421: Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants.

3. D422: Test Method for Particle-Size Analysis of Soils.

4. D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft3 (600 kN-m/m3)).

5. D2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

6. D2419: Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

7. D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

8. D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

9. D4318: Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

10. D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

D. Occupational Safety and Health Administration (OSHA) Standards and Regulations:

1. 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations.

1.03 CLASSIFICATION OF EXCAVATION:

A. Excavation is not classified.

1.04 DEFINITIONS:

A. Percent Compaction, or Compaction Density: The field dry density of compacted material, expressed as a percentage of the maximum dry density.

B. Field Dry Density or Field Density: In-place density as determined by ASTM D6938 (Nuclear Method).

C. Maximum Dry Density: Laboratory density as determined by ASTM D1557 (Modified Proctor used for cohesive soils) and occurring at the optimum moisture content of the soil being tested. Similarly, the laboratory density is determined by ASTM D4253 and D4254 for non-cohesive soils.

D. Pipe Embedment: Comprised of the following or combination thereof:

1. Foundation: Required only when the native trench bottom does not provide a firm working platform or the necessary uniform and stable support for the install pipe.

2. Bedding: Placed directly underneath the pipe and brings the trench bottom to grade. Provides a firm, stable, and uniform support of the pipe.

3. Haunching: From bottom of pipe to springline.

4. Initial Backfill or Pipe Zone Backfill: From top of bedding or foundation to 12 inches above top of pipe, unless noted otherwise.

5. Final Backfill or Trench Backfill: Above the initial backfill to a level below that required for the trench restoration area.

6. Backfill: Includes initial and final backfill.

1.05 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Temporary excavation and shoring drawings for worker protection in accordance with the General Conditions.

2. Gradation analysis.

3. Dewatering plan including disposition of groundwater.

4. Manufacturer's catalog data and a sample of filter fabric with manufacturer's installation instructions and details.

5. Materials Sources: Name of source, location, date of sample, sieve analysis, and laboratory compaction characteristics.

6. Test and Evaluation Reports:

a. Field density testing reports: Provide results from field density testing of prepared subgrade and compacted fill.

b. Grain-size analysis.

c. Laboratory compaction characteristics of soils.

d. Water content.

7. Geotextile:

a. At least two weeks prior to shipment, submit manufacturer's certificate of compliance and physical property data sheet indicating that requirements for materials and manufacture are in conformance as specified.

b. For informational purposes only, submit manufacturer’s printed installation instructions.

8. Compaction method and removal sequence of shoring.

B. Submit Excavation Support Systems plan per Section 31 50 00.

1.06 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sustainability Standards Certifications.

C. Sample backfill materials in accordance with ASTM D75.

D. Testing will be provided by the Owner as specified. Contractor shall be responsible for cost of testing and inspection conducted as a result of non-conforming work.

E. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in of loose soil. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Provide geotextile fabric in rolls wrapped with protective covering to protect geotextile fabric from mud, dirt, dust, and debris. Label each roll of geotextile fabric with number or symbol to identify production run.

C. Protect geotextile fabric from sunlight during transportation and storage. Do not leave geotextile fabric exposed to sunlight for more than two weeks during installation operations.

1.09 SITE CONDITIONS:

A. Existing Conditions:

1. Geotechnical Report: The report has been provided, is for information only, and is not part of the contract documents. Logs of borings are included in the report and indicate conditions encountered only at test boring locations. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.

PART 2 - PRODUCTS

2.01 BACKFILL MATERIALS:

A. Suitable Material: Material from on-site excavated fill and/or permitted off-site sources that meets all of the specified requirements for its intended use and is not unsuitable. Wet subgrade material which meets other requirements for suitable material is suitable.

B. Unsuitable Material: Material that fails to meet requirements for suitable materials; or contains any of the following:

1. Organic clay, organic silt, or peat; as defined in ASTM D2487 and visually determined in ASTM D2488.

2. Vegetation, wood, roots, leaves, and organic, degradable material.

3. Stones or rock fragments over 3 inches in any dimension.

4. Porous biodegradable matter, excavated pavement, construction debris, rubbish, or refuse.

5. Ice, snow, frost, or frozen soil particles.

C. Stabilization Material: Stabilization material shall consist of hard, durable particles of stone or gravel, screened or crushed to the required size and gradation. The material shall be free from vegetation matter, lumps or balls of clay, or other deleterious matter and shall conform to the following gradation when tested in accordance with AASHTO T 27 or ASTM C 136.

1. Coarse material shall be crushed or washed and fine material shall be wasted to meet the grading requirements set forth below. Note that if stabilization material is required, an 8 oz. non-woven filter fabric shall be placed between the stabilization material and the pipe zone material.

2. Coarse aggregate, retained on the No. 4 sieve, shall have a percentage of wear not greater than 40 percent when tested by the Los Angeles Test, AASHTO T-96 or ASTM C131.

Sieve Size	Percent Passing By Weight
2 inch	100
1-1/2 inch	10 to 50
3/4 inch	0 to 25
No. 4	0 to 10
No. 200	0 to 3

D. Force Mains 3/4-inch Drain Rock (Lower) Pipe Zone: Provide open-graded, hard, durable crushed rock, wrapped in geotextile (free of clay lumps, organics and other deleterious matter) and meeting ASTM C33 Coarse Aggregate Size Number 67 and the gradation below per ASTM C136:

Sieve Size	Percent Passing By Weight
1 inch	100
3/4 inch	90-100
3/8 inch	20 to 55
No. 4	0 to 10
No. 200	0 to 3

1. Geotextile wrap (atop this material) may be discontinued beneath and between force mains (see typical force mains trench section).

2. Where Drawings require it (i.e. Sta 30+00 to 41+00), omit "Force Mains Dense Cohesive (Upper) Pipe Zone, and provide instead ¾-inch Drain Rock to the top of pipe zone and provide 4-inch HDPE perforated drains in geotextile sock (at 100-ft intervals) across bottom full width of trench (see force mains trench section at liquefiable layer).

E. Force Mains Dense Cohesive (Upper, except as noted above) Pipe Zone: Provide a homogenous, dense (137 lbs/cu ft min), cohesive, processed mixture of rock particles and fines with sufficient fines to thoroughly bind material together when compacted. UDOT Standard Spec 02721 road base complies, but also other homogenous mixtures with more fines. Obtain Engineer approval of samples and source if UDOT road base is not used. Non-homogenous mixtures of rock and fines are NOT acceptable. Mixture shall be free of organics and other deleterious matter.

1. Material available for Contractor use, which should meet this specification, has been stockpiled beside the Work Limits from Sta 27+00 to 33+00 (see Drawing 0100-R310).

F. 3/4-inch Minus Well Graded Pipe Zone Fill for RCP: Select material shall consist of 3/4-inch minus, well-graded import material, shall be free from vegetative matter, or other deleterious matter, and shall meet manufacturer's recommendations for the type of pipe installed. The 3/4 inch Minus Pipe Zone Material shall be capable of meeting the compaction requirements. "Squeegee" or any other flowable material shall not be permitted.

Sieve Size	Percent Passing By Weight
1 inch	100
3/4 inch	95 to 100
1/2 inch	25 to 60
No. 4	5 to 25
No. 8	0 to 10
No. 200	0 to 5

G. 1-inch Untreated Base Course for Bedding and Pipe Zone Material for PVC, HDPE, glass fiber reinforced (GFRP), and Ductile Iron Pipe shall meet the requirements in APWA Section 32 11 23 Grade 1.

H. Native Trench Backfill: Trench backfill may consist of native fill material meeting soils classifications A-1, A-2 or A-3 (A-1-a for Granular Borrow material) of AASHTO M145, with a maximum particle size no greater than 3-inches in any dimension and shall be capable of meeting the compaction requirements. Trench backfill shall be non-plastic. Trench backfill shall be free from alkali, salt, petroleum products, vegetative matter or other deleterious matter, slag, cinders, ashes and rubbish or other material that in the opinion of the Engineer may be objectionable or deleterious. "Squeegee" or any other flowable material shall not be permitted.

I. Imported Granular Trench Backfill: Where native materials are unable to achieve satisfactory compaction or meet the required soils classification, imported granular trench backfill shall be used and shall consist of imported materials meeting soils classifications A-1, A-2 or A-3 (A-1-a for Granular Borrow material) of AASHTO M145 and shall be non-plastic. Maximum particle size for backfill shall be no greater than 3 inches. Imported granular trench backfill shall be capable of meeting the compaction requirements.

J. Granular Trench Backfill (HDPE Pipe): Class I or Class II in accordance with ASTM D2774; except that (dual 48-inch, +/-1-mile long) HDPE force mains from IPS have pipe zone per paragraphs D and E above, and trench zone per paragraph H above.

2.02 EQUIPMENT:

A. Compaction equipment shall be capable of consistently achieving the specified compaction requirements.

2.03 UTILITY IDENTIFICATION:

A. Trace Wire: Continuous, single-strand copper wire, insulated, maximum 12 AWG. Tracer wire is not required on plant and storm drain lines.

B. Marking Tape: Use type specifically manufactured for marking and locating underground utilities. Acid- and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch, minimum strength of 1,750 psi lengthwise and 1,500 psi crosswise. Provide tape manufactured with foil core at least 0.35-mil thick to enable detection by metal detection when tape is buried up to 3 feet deep. Tape shall bear continuous printed inscription describing specific utility. Tape color shall be as follows:

1. Electric conduits, duct banks, and cable: Red.

2. Potable water systems: Blue.

3. Non-potable water (NPW) systems: Purple.

4. Gas, oil, dangerous materials: Yellow.

5. Telephone, CCTW, fire communications: Orange.

6. Sanitary sewer systems (forcemains only): Green.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that dewatering systems are in place before commencing with excavation.

B. Verify that excavation safety and support systems meeting the requirements of OSHA 29 CFR 1926, Subpart P are in place before commencing with excavation.

1. Minimum slopes for laying back excavations or materials are contained in OSHA 29 CFR 1926, Subpart P; Appendices A and B.

2. Minimum requirements for shoring and bracing are contained in OSHA 29 CFR 1926, Subpart P; Appendix C.

C. Verify that fill materials submittals have been accepted by Engineer before commencing with work requiring the use of these materials.

D. Verify that erosion and sediment control measures are in place and functioning properly.

E. Immediately notify the Engineer if unexpected subsurface facilities or suspected hazardous materials are encountered during excavation. Discontinue affected work in area until notified to resume work.

3.02 PREPARATION:

A. Underpin adjacent structures that could be damaged by excavation work.

B. Cut pavement with saw or pneumatic tools to prevent damage to remaining pavement. Dispose of large pieces of demolished pavement before proceeding with excavation.

3.03 PROTECTION OF IN-PLACE CONDITIONS:

A. Comply with the requirements specified in Section 01 14 14.

B. Support and protect from damage – existing pipes, poles, wires, fences, curbs, property line markers, and other features or structures which must be preserved in place to avoid being temporarily or permanently relocated.

C. Excavation Near Existing Structures:

1. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.

D. Excavation Near Private Property:

1. Record existing condition of features on adjacent property by means of dated photographs or cameras.

2. Enclose uncut tree trunks adjacent to work in wooden boxes of such height necessary to protect tree from injury due to piled material, equipment, or operations. Operate excavating machinery and cranes so as to prevent injury to overhanging branches and limbs.

3. Protect cultivated hedges, shrubs, and plants which would otherwise be damaged by the work.

4. Where protection of vegetation is not possible, dig up, temporarily transplant, and maintain. After active construction operations in the area have ceased, transplant vegetation to the original positions and provide water and nursery care until growth is re-established.

5. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved surfaces. Provide protection on pavement or tracks if construction traffic is unavoidable.

3.04 RESTORATION:

A. Restore private property and structures promptly. Begin restoration work within 24 hours of when damage occurred.

B. Existing surfaces, features, or utilities that are to remain but are damaged during construction shall be repaired or replaced to at least the condition in which they were found immediately before work began, unless noted otherwise.

C. Damaged Trees to Remain: Cut all damaged branches, limbs, and roots smoothly and neatly without splitting or crushing. Neatly trim, cut the injured portions and cover with an application of grafting wax or tree healing paint. Replace damaged trees which subsequently die or continue to show lack of growth due to damage**,** one year after substantial completion.

D. Cultivated Vegetation: Includes, but is not limited to: hedges, shrubs, and plants. Vegetation that is damaged shall be replaced with equal kind and of at least the quality before work began.

3.05 TRENCH EXCAVATION:

A. Provide dewatering system to allow for working conditions in dry, stable soil. Properly dispose of water to avoid damage to property and in accordance with laws and regulations. Lower groundwater table prior to excavation and keep a minimum of 24 inches below lowest excavation subgrade until structure has sufficient strength to withstand soil and water pressures.

B. Sheet and brace trenches, excavations, and adjacent structures to comply with laws and regulations and to provide protection of life, property, and the Work. Where close sheeting is necessary, drive to prevent adjacent soil from entering excavation. Remove close sheeting only when removal would not damage property or the Work. Sheeting left in place shall be cut off 18 inches below ground surface.

C. Preserve material below and beyond the lines of excavations.

D. Locate stockpiled excavated material at least 3 feet from edge of excavations to prevent cave-ins or bank slides.

3.06 AUTHORIZED OVER-EXCAVATION:

A. Remove rock for a depth of 6 inches and backfill with bedding material.

3.07 UNAUTHORIZED EXCAVATION:

A. Contractor is responsible for backfilling unauthorized excavations with material selected by the Engineer. Unauthorized Excavation consists of removal or loosening of materials beyond indicated subgrade elevations or dimensions without specific directions of the Engineer.

3.08 BACKFILL:

A. Fill to lines and grades necessary to provide finish grades.

B. Use a placement method that does not disturb or damage other work or existing features.

C. Maintain fill materials within 3 percent of optimum moisture, to attain required compaction density.

D. Place and compact material in equal continuous layers.

E. Maximum compacted depth is 6 inches for aggregate materials and 8 inches for soil materials, unless noted otherwise. For deep trenches, deeper than 20 feet, maximum compacted depth shall be 6 inches for all materials.

F. Flexible Pipe

1. The haunch area shall be completely filled and free of voids. Shovel and compact material evenly on both sides of pipe in lifts not more than 4 inches.

2. Above the haunch area place the material in lifts not exceeding 6 inches.

G. Before placing IPS force mains, survey compacted drain rock bedding surface (to be bottom CL of both force mains) at 25-foot intervals and obtain Engineer approval of same. Limit thermal induced vertical undulation of HDPE pipe during backfilling. Submit how Contractor will keep HDPE pipe bottom within 1/2-inch vertically of design grade.

3.09 COMPACTION:

A. Compact to density specified and indicated for various types of material. Control moisture content of material being placed as specified, or if not specified - at a level slightly lower than optimum.

B. Compaction Density: Provide trench backfill densities according to Table 31 23 33-1. The values listed are minimum percentages, unless noted otherwise.

Table 31 23 33-1

Area	Percentage of Maximum Dry Density as defined by ASTM D1557 (Modified Proctor)
Trench Granular Backfill (under pavement, slabs)	96
Trench Granular Backfill (under structures or within 25 feet of structures)	96
Trench Backfill (below granular backfill borrow)	95
Trench Backfill (under exterior concrete slab and sidewalks)	95
Trench Backfill (in open or grassed areas)	90
Pipe Zone and Bedding (cohesive)	95% per ASTM D1557
Pipe Zone and Bedding (non-cohesive)*	*80% per ASTM D4253 and D4254
*Compact bottom of force mains pipe zone (non cohesive 3/4" drain rock) to 80% relative density per ASTM D4253 and D4254, which is nearly same compaction effort required to compact top of force mains pipe zone (cohesive material) to 95% per ASTM D1557.	

3.10 UTILITY IDENTIFICATION:

A. Install marking tape over all site utilities, 12 inches above pipe zone.

B. Install trace wire at top center; pull wire taut to remove any slack; secure tracer wire to pipe at 10 foot intervals, maximum.

C. Extend trace wire to utility boxes, maintenance holes and junctions to allow for connection to subsurface location equipment.

3.11 FIELD QUALITY CONTROL:

A. See Section 01 45 00 for general requirements for field inspection and testing.

B. Compaction shall be deemed to comply with the specifications when no more than 1 test of any 3 consecutive tests falls below the specified relative compaction. The one test shall be no more than 3 percentage points below the specified compaction. The Contractor shall pay the costs for any retesting or additional testing of work not conforming to the specifications.

C. Where compaction tests indicate a failure to meet the specified compaction, the Owner will take additional tests every 50 feet in each direction until the extent of the failing area is identified. Rework the entire failed area until the specified compaction has been achieved.

D. Perform particle size distribution and gradation analyses using ASTM D422 and following standard practices in ASTM D421. Perform 1 test for every source and submit results to Engineer for acceptance. Repeat the moisture density test for every 5,000 cubic yards of material used.

E. Perform field density testing in accordance with ASTM D6938.

F. Evaluate cohesive soils field density test results in relation to maximum dry density as determined by testing material in accordance with ASTM D1557 (Modified Proctor).

G. Perform tests in accordance with ASTM D4318 to determine Liquid Limit, Plastic Limit and Plasticity Index and submit test results to Engineer for acceptance. Minimum of one test per 5,000 cubic yards of soil for use as fill material and whenever classification of material is in doubt as determined by the Engineer.

H. Location of field density tests shall be mutually acceptable to testing laboratory and the Engineer.

I. Frequency of field density tests:

Table 31 23 33-2	
Area	**Minimum Frequency**
Trench (Structural Areas)	1 per lift for each 200 linear feet of trench
Trench (Non-Structural Areas)	1 per lift for each 250 linear feet of trench
Regardless of the minimum testing frequency specified, field density tests shall be performed by the Contractor in sufficient number for the Contractor's quality control purposes to ensure that specified density is obtained.	

3.12 ADJUSTING:

A. Shrinkage:

1. Backfill to a height above finished grade which will allow for the shrinkage or consolidation of material. Initially, provide at all points, an excess of at least one percent of total height of backfill measured from stripped surface to top of finished surface.

2. Supply specified materials and build up low places, without additional cost if embankment or backfilling settles so as to be below the indicated level for proposed finished surface at any time before final acceptance of the work.

3.13 PROTECTION:

A. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.

3.14 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 31 34 19

GROUND STABILIZATION WITH GEOSYNTHETICS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide ground stabilization with geosynthetics as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Association of State and Highway Transportation Officials (AASHTO):

1. M288: Standard Specification for Geotextile Specification for Highway Applications

B. ASTM International (ASTM):

1. D1683: Standard Test Method for Failure in Sewn Seams of Woven Apparel Fabrics.

2. D4355: Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon ARC Type Apparatus.

3. D4491: Test Methods for Water Permeability of Geotextile by Permittivity.

4. D4533: Standard Test Method for Trapezoid Tearing Strength of Geotextiles

5. D4632: Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

6. D4751: Standard Test Method for Determining Apparent Opening Size of a Geotextile

7. D6241: Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

C. Geosynthetic Institute (GSI):

1. GRI GG4a: Determination of the Long-Term Design Strength of Stiff Geogrids

2. GRI GG4b: Determination of the Long-Term Design Strength of Flexible Geogrids

1.03 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00.

B. General:

1. Producer of geosynthetics to maintain competent laboratory at point of manufacture to ensure quality control in accordance with ASTM testing procedures. Laboratory to maintain records of quality control results.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00 prior to start of excavation. Submittal shall be approved by the Engineer prior to start of excavation.

1. Product Data:

a. Manufacturer's Certification of Product Conformance

(1) Test results of geotextile physical properties.

(2) Affidavit certifying that the raw and roll material test results submitted are accurate and meet the requirements of the Project specifications.

(3) A sample of the material to be provided as part of the certification submittal.

b. Geotextile Deployment Information

(1) Manufacturer's installation recommendations for geotextile fabric/geogrid.

(a) Submit Manufacturer's printed installation instructions (for informational purposes only).

(2) Geotextile layout plan along with anchorage and joint details, overlaps, sequencing, and installation procedures.

(a) If using overlap to connect geogrids in the field, provide for review prior to field installation the calculations used to support the use of any overlap connection.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver fabric/geogrid to Project site in such quantities and at such times to ensure continuity of installation.

C. Provide geotextile fabric in rolls wrapped with protective covering to protect geotextile fabric from mud, dirt, dust, and debris. Label each roll of geotextile fabric with number or symbol to identify production run.

D. Store material in accordance with ASTM D4873 and Manufacturer's recommendations and protect material from exposure to direct sunlight and damage by construction activities.

E. Do not leave deployed geotextile exposed to sunlight for more than 5 days during installation operations.

F. Handle and unload geogrid rolls by hand, or with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Geotextile rolls shall not be dragged, lifted by one end, lifted by cables or chains, or dropped to the ground.

G. During shipping and storage, protect the fabric from direct sunlight, ultraviolet rays, temperature greater than 140 degrees F, mud dirt, dust, and debris. To the extent possible, keep the fabric wrapped in a heavy-duty protective covering.

H. Schedule the work so that the fabric is covered or otherwise protected within 30 days after it is placed. Failure to comply with this requirement shall require replacement of the fabric

PART 2 - PRODUCTS

2.01 MATERIAL:

A. Geotextile Fabric:

1. Physical property requirements of nonwoven geotextile fabrics are as follows:

Offsite IPS - Nonwoven Geotextile Properties			
Property	Test Method	Units	Value
Permittivity	ASTM D4491	sec -1	0.05 (min.)
Apparent Opening Size (AOS or O95)	ASTM D4751	mm	0.21
Ultraviolet Stability	ASTM D4355	Percent	50 (min.)

2. Refer to Section 31 23 19 for additional requirements. For other uses, refer to Section 31 05 19.13.

3. Class 1 fabric according to AASHTO M288.

4. Geotextile fabric strength properties shall be in accordance with AASHTO M288.

B. Manufacturing quality control testing shall be performed at a frequency of one test per 50,000 square feet of manufactured material to evaluate the material's physical properties.

1. A sample of the manufactured material shall be submitted to the Contractor's Independent Testing Laboratory for duplicate testing.

2. Samples not satisfying the specifications shall result in rejection of the applicable rolls.

C. Dewatering Base Course Material:

1. Placed and compacted base course material shall comply with Section 31 23 00 requirements.

D. Bridging Zone Materials:

1. Placed bridging materials shall comply with Section 31 23 00 requirements.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

A. Perform excavation in accordance with Section 31 23 00. Install in accordance with AASHTO M288, Appendices A1 and A3, except as modified below.

B. Remove surface protrusions, debris, sharp objects, trees, stumps, or large roots during excavation. Do not operate equipment on excavated surface.

C. Dewatering: Grade smooth and compact the subgrade prior to base course material placement.

1. Subgrade shall be dry and well drained with no standing water or puddles.

D. Dewatering: Place materials to the widths and depths indicated on the contract drawings and compact in accordance with Section 31 23 00.

E. Place bridging materials as indicated on the contract drawings. No compaction of the first 18 inches of bridging material is allowed. See Section 31 23 00 for additional information.

F. Prior to placement of bridging, areas on which geotextile is to be placed shall have a uniform slope and be reasonably smooth, free from mounds and windrows, and free of any debris or projections which could damage the fabric to be placed on it. Loosely lay the material (do not stretch it). Support the fabric at all times to maintain its intended position.

G. If there is any fabric damage or displaced before fabric placement or during fabric placement, replace or repair it.

3.02 GEOTEXTILE FABRIC DEPLOYMENT:

A. Installation of Geotextile Fabric:

1. Dewatering: The geotextile shall be placed on the prepared surface at the locations and to the dimensions shown on the construction drawings.

2. The geotextile shall be placed on the prepared surface at the locations and to the dimensions shown on the construction drawings.

3. Install geotextile in accordance with the Manufacturer's written instructions.

4. The geotextile shall be placed loosely, but without wrinkles and creases. Apply temporary ballast to prevent movement and wind damage.

5. Seams shall be overlapped a minimum of 24 inches when unsewn and 6 inches when sewn, or as indicated in the Manufacturer's instructions.

   a. If sewn, the seam efficiency shall be equal to or greater than 75 percent of the grab tensile strength of fabric when tested wet using ASTM D1683.

   b. Thread used in sewing shall be of same or greater durability than fabric material.

6. The condition of the deployed geotextile shall be inspected by the Engineer before cover placement,

3.03 FILL PLACEMENT OVER GEOTEXTILES:

A. Place material on geotextile beginning at the outer edge of the geotextile covered area.

B. To prevent tearing, crushing or shifting of geotextile, keep tire and track mounted construction vehicles and end-dumped material off the geotextile cover until minimum of 18 inches of has been placed in accordance with Section 31 23 00.

C. Materials shall be placed in lifts and compacted in accordance with Section 31 23 00.

D. Materials shall be placed, spread, and compacted in such a manner that minimizes wrinkles, distortions or movement of the geotextile and pumping of the subgrade in accordance with Section 31 23 00.

3.04 FIELD QUALITY CONTROL:

A. Repair or replace damaged fabric/geogrid.

1. Torn fabric may be patched in place by placing fabric over tear.

   a. Dimensions of patch shall meet lap requirements.

   b. Secure to prevent base course material from causing lap separation.

2. Any geogrid damaged during installation shall be replaced by the Contractor at no additional cost to the Owner.

END OF SECTION

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SECTION 31 50 00

EXCAVATION SUPPORT SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide excavation support systems as indicated and in compliance with Contract Documents.

B. Design, furnish and install excavation support systems to maintain lateral support, prevent loss of ground, limit soil movements to acceptable limits and protect from damage existing and proposed improvements including pipelines, utilities, structures, roadways, railroads and other facilities.

C. The requirement of specified excavation support systems in areas indicated on the drawings does not relieve the Contractor from the responsibility of furnishing and installing proper temporary excavation support systems in other areas.

D. Common types of excavation support system include, but are not limited to; singular or multiple stages comprised of cantilevered or internally braced soldier piles and lagging, steel sheetpile wall, timber sheetpile wall, trench box, or combinations thereof. Trench box temporary excavation support system is only acceptable for pipe or utility trench excavations approved by the Engineer. Temporary unsupported open cut excavation with stable sloping sides is allowed where applicable.

E. Extraction of steel sheetpile wall, timber sheetpile wall, or solider piles are not permitted unless approved in writing by Engineer and designer of shoring system. Designer of shoring system shall certify that no adverse effects to permanent construction will be caused by removal of shoring system.

F. Wherever the word "sheeting" is used in this section or on the contract drawings, it shall be in reference to any type of excavation support system specified except trench box.

G. Construction of the excavation support systems shall not disturb the existing structures or the completed proposed structures. Damage to such structures shall be repaired at Contractor’s expense.

H. Adjacent structures are those that are bear upon soils above the proposed excavation depth and within a distance equal to twice the total depth of the excavation away from the closest edge of the excavation. Monitor and protect adjacent structures as specified and indicated.

I. Vibration monitoring for excavation support systems shall be performed as specified in Section 02 32 14.

J. Construction operations not to exceed specified noise limits in permits.

K. Bear the entire cost and responsibility of correcting any failure, damages, subsidence, upheaval or cave-ins as a result of improper installation, maintenance or design of the excavation support systems. Pay for all claims, costs and damages that arise as a result of the Work performed at Contractor's expense.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

B. ASTM International (ASTM):

1. A36: Standard Specification for Structural Steel.

2. A416: Standard Specification for Strand Steel, Uncoated Seven Wire for Prestressed Concrete.

3. A572: Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel.

4. A615: Standard Specifications for Deformed and Plain Billet Steel Bars for Concrete Reinforcement

5. A722: Specification for Uncoated High Strength Steel Bar for Prestressing Concrete

C. American Wood-Preserves Association (AWPA) Standards.

1. P23-10: Standard for Chromated Copper Arsenate Type C (CCA-C).

2. P50-10: Standard for Fire Retardant FR-2 (FR-2).

D. American Welding Society (AWS)

1. D1.1: Structural Welding Code.

E. Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29: Subpart P - Excavations, Trenching and Shoring.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00.

1. Submit the following qualifications four (4) weeks prior to the construction:

a. Qualifications of Contractor's excavation support system designer as specified in Paragraph 1.04.G.

b. Qualifications of Contractor's excavation support system installer as specified in Paragraph 1.04.H.

c. Qualifications of Contractor's independent tieback testing laboratory as specified in Paragraph 1.04.I, if a tieback system is utilized.

d. Qualifications of Contractor's excavation support system installation supervisor as specified in Paragraph 1.04.J.

e. Qualifications of vacuum excavation subcontractor as specified in Paragraph 1.04.F, if DMPs for utilities are utilized.

2. Submit an excavation support plan stamped and signed by a Registered Professional Engineer in the State of Utah at least two weeks prior to start of the construction. Do not submit design calculations. The review will be only for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor remains responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include the following items as a minimum:

a. Proposed excavation support system(s), details, location, layout, depths, extent of different types of support relative to existing features and the permanent structures to be constructed, and methods and sequence of installation and removal.

b. Certificate of Design: Refer to Section 01 33 00.

c. A list of all design assumptions, including safety factors used for the excavation support system(s) and all lateral pressures used for each system.

d. If utilizing a tieback system, include tieback installation procedures and criteria for acceptance of tiebacks for performance and proof tests. Submit the tieback testing results to the Engineer for information only.

e. Requirements of dewatering during the construction.

f. Minimum lateral distance from the edge of the excavation support system for use for vehicles, construction equipment, and stockpiled construction and excavated materials.

g. List of equipment used for installing the excavation support systems.

h. Monitoring schedule, installation procedures and location plans for vibration/noise monitoring, geotechnical instrumentation (deformation monitoring points and inclinometers) and observation wells/piezometers to monitor ground, excavation support system, adjacent structures and groundwater fluctuation during the entire construction period.

3. Submit a Construction Contingency Plan specifying the methods and procedures to maintain excavation support system stability if the allowable movement of the adjacent ground and adjacent structures is exceeded. Include movement thresholds that trigger review and/or remediation measures to be implemented.

4. Monitoring data within one (1) day of data collection from vibration and noise recording equipment, observation wells, deformation monitoring points and offset lines. Data shall include:

a. Horizontal and vertical movements of geotechnical instruments and groundwater readings.

b. New movements since the initial readings of the geotechnical instruments.

c. Weekly summary in tabular and graphic form at the end of each week.

d. A schematic plan of excavation and/or relevant construction activities at the time of monitoring.

5. For excavation support systems left in place, submit the following as-built information prior to backfilling and covering the excavation support systems:

a. Survey locations of the excavation support systems, including coordinates of the ends and points of change in direction.

b. Type of the excavation support system.

c. Elevations of top and bottom of the excavation support systems left in place.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00.

B. Conform to the requirements of the OSHA Standards and Interpretations: "Part 1926 Subpart P - Excavation, Trenching, and Shoring".

C. Construction operations to conform to noise regulations provided in the Noise Control Plan and this Section.

D. Retain the services of an independent vibration consulting firm meeting the requirements as specified in Section 02 32 14.

E. The peak particle velocity for pile driving, or other vibration-inducing operations, shall meet the requirements as specified in Section 02 32 14.

F. If utilizing deformation monitoring points (DMPs) for utilities, vacuum excavation shall be performed by subcontractor having five (5) years of experience in non-destructive vacuum excavation methods for utilities.

G. Prepare design, including calculations and drawings, under the direction of a Professional Engineer registered in the State of Utah and having the following qualifications:

1. Not less than ten (10) years' experience in the design of specific excavation support systems to be used.

2. Completed not less than five (5) successful excavation support system projects of equal type, size, and complexity within the last five (5) years.

H. Excavation Support System Installer's Qualifications:

1. Not less than three (3) year experience in the installation of similar types and equal complexity as the proposed system.

2. Completed not less than three (3) successful excavation support systems of similar type and equal complexity as the proposed system.

I. If utilizing a tieback system, employ an independent testing laboratory to test the tieback system with the following qualifications:

1. Be accredited by the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program.

2. Employ personnel conducting testing who are trained in the methods and procedures to test and monitor tieback systems of similar type and equal complexity, as the proposed system.

3. Have not less than five (5) years' experience in testing of tieback systems of similar type and equal complexity as the proposed system.

4. Have successfully tested at least three (3) tieback systems of similar type and equal complexity as the proposed system.

J. Install all excavation support systems under the supervision of a supervisor having the following qualifications:

1. Not less than five (5) years' experience in installation of systems of similar type and equal complexity as the proposed system.

2. Completed at least five (5) successful excavation support systems of similar type and equal complexity as the proposed system.

K. All welding shall be performed in accordance with AWS D1.1.

1.05 DESIGN CRITERIA:

A. Design of excavation support systems shall meet the following minimum requirements:

1. Support systems shall be designed for earth pressures, hydrostatic pressure, equipment, temporary stockpiles, construction loads, roadways, railroads, and other surcharge loads.

2. Design a bracing system to provide sufficient reaction to maintain stability.

3. Limit movement of ground adjacent to the excavation support system to be within the allowable ground deformation as specified.

4. Design the embedment depth below bottom of excavation to minimize lateral and vertical earth movements and provide bottom stability. Toe of braced temporary excavation support systems shall not be less than 5 feet below the bottom of the excavation.

5. Design excavation support systems to withstand an additional 2 feet of excavation below proposed bottom of excavation without redesign except for the addition of lagging and/or bracing.

6. Maximum width of pipe trench excavation shall be as indicated on the drawings.

7. Do not cast permanent structure walls directly against excavation support walls.

8. The design location of the excavation support wall shall be determined such that the installed wall and bracing system components are all located outside the limits of the permanent structure. Construction tolerances (e.g. wall verticality) shall be considered in determining the plan location.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with APWA Sections 01 66 00 and as specified.

B. Store sheeting and bracing materials to prevent sagging which would produce permanent deformation. Keep concentrated loads which occur during stacking or lifting below the level which would produce permanent deformation of the material.

1.07 PROJECT CONDITIONS:

A. Subsurface Conditions: Refer to Section 00 21 13.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Structural Steel: All soldier piles, wales, rakers, struts, wedges, plates, waterstop and accessory steel shapes shall conform to ASTM A36.

B. Steel Sheet Piling: ASTM A572, continuous interlocking type.

C. Timber Lagging Left in Place: Pressured treated per AWPA standards.

D. Tieback Tendons: Tieback tendons shall be high strength steel wire strand cables conforming to ASTM A416, or bars conforming to ASTM A722. Splicing of individual cables shall not be permitted.

E. Raker Ties: ASTM A615 Grade 60.

F. Cement Grout Materials and Admixtures For Tieback Anchorages: Grout cube strength shall be a minimum 3500 psi at 7 days and 5000 psi at 28 days.

G. Concrete: Section 03 30 00.

H. Tamping tools adapted for backfilling voids after removal of the excavation support system.

I. Provide specific trench box sizes for each pipe and utility excavation with structural capacity of retaining soil types as described in OSHA's 29 CFR Part 1926 Subpart P.

2.02 EQUIPMENT:

A. Install shoring to required depth with suitable equipment for installation of shoring materials. Equipment can include vibratory hammers, impact hammers, hydraulic push-in tools, drills or other equipment that meets vibration and noise requirements.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Installation of the excavation support systems shall not commence until the related earth excavation and dewatering submittals have been reviewed by the Engineer with all Engineer's comments satisfactorily addressed.

B. Install excavation support systems in accordance with the excavation support plan.

C. If utilizing a tieback system, all performance and proof tests shall be conducted in the presence of the Engineer. Testing performed without the Engineer present is considered invalid. Repeat testing in the Engineer's presence at Contractor's expense.

D. Do not drive sheeting within 100 feet (30 m) of concrete less than seven (7) days old.

E. Carry out program of excavation support in such a manner as to prevent undermining or disturbing foundations of existing structures of Work ongoing or previously completed.

F. Bottom of the trench box excavation support system shall be above the pipe invert prior to installing the pipe.

G. Install and read geotechnical instrumentation in accordance with the excavation support plan. Notify the Engineer immediately if any geotechnical instrumentation is damaged. Repair or replace damaged geotechnical instrumentation at the sole option of the Engineer and at Contractor's expense.

H. Continuously monitor movements of the ground adjacent to excavation support systems and adjacent structures. In events of the measured movements approaching or exceeding the allowable movements, take immediate steps to arrest further movement by revising procedures such as providing supplementary bracing, filling voids behind the trench box, supporting utilities or other measures (Construction Contingency Plan).

I. Notify utility owners if existing utilities interfere with the excavation support system. Modify the existing utility with the utility owner's permission or have the utility owner make the modifications at Contractor's expense.

3.02 GROUND DEFORMATION ADJACENT TO EXCAVATION SUPPORT SYSTEMS:

A. Allowable Vertical (heave/settlement) and Lateral Movements: 2 inches maximum for the trench box excavation support system, and 1 inch maximum for other types of excavation support systems at any location behind the excavation support system.

B. Monitoring personnel shall use a procedure for reading and recording geotechnical instrumentation data which compares the current reading to the last reading during data collection to eliminate spurious readings.

C. Plot the observed ground deformation readings versus time. Annotate the plots with construction loading and excavation events having an impact on the readings. Evaluate plots by means of secondary rate-of-change plots to provide early warning of accelerating ground movements.

D. Notify the Engineer when the allowable ground deformation is exceeded.

E. Implement Construction Contingency Plan under direction of the temporary excavation support system designer and the Engineer.

3.03 REMOVAL OF EXCAVATION SUPPORT SYSTEMS:

A. Sheeting shall be left in place unless otherwise indicated.

B. When indicated, remove the excavation support system without endangering the constructed or adjacent structures, utilities, or property. Immediately backfill all voids left or caused by withdrawal of excavation support systems with bank-run gravel, screened gravel or select borrow by tamping with tools specifically adapted for that purpose.

C. When tiebacks are used, release tension in tiebacks as the excavation is backfilled. Do not leave tensioned tieback in place at the completion of the Work.

D. The excavation support system left-in-place shall be cut-off a minimum of 2 feet below the bottom of the next higher foundation level or a minimum of 5 feet below finished grade.

E. Conduct survey of the locations and final cut-off elevations of the excavation support systems left in place.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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DIVISION 32

EXTERIOR IMPROVEMENTS

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SECTION 32 12 00

FLEXIBLE PAVING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide flexible paving as indicated and in compliance with Contract Documents.

1. Scope includes:

a. Aggregate base course (Untreated Base Course)

b. Asphalt concrete pavement

B. Salt Lake City Department of Public Utilities follows the requirements of the American Public Works Association (APWA) Utah Chapter – 2017 Standards and Specifications. Follow the APWA Specifications as modified herein

C. Survey, remove and rebuild all existing flexible paving disturbed by construction including that described in Force Mains Drawing from Station 36+00 to 45+30.

1.02 REFERENCES:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. M147: Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.

2. T89: Standard Method of Test for Determining the Liquid Limit of Soils.

3. T90: Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils.

4. T99: Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International (ASTM):

1. C125: Standard Terminology Relating to Concrete and Concrete Aggregates.

2. D242: Standard Specification for Mineral Filler For Bituminous Paving Mixtures.

3. D977: Standard Specification for Emulsified Asphalt.

4. D2027: Standard Specification for Cutback Asphalt (Medium-Curing Type).

5. D6373: Standard Specification for Performance Graded Asphalt Binder.

C. American Public Works Association – Utah Chapter (APWA):

1. APWA Specifications: 2017 Standards and Specifications

1.03 DEFINITIONS:

A. Gravel: Coarse aggregate resulting from natural disintegration and abrasion of rock or processing of weakly bound conglomerate.

B. Crushed Gravel: The product resulting from the artificial crushing of gravel with substantially all fragments having at least one face resulting from fracture.

C. Crushed Stone: The product resulting from the artificial crushing of rocks, boulders, or large cobblestones, substantially all faces of which have resulted from the crushing operation.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Aggregate Base Course: Submit Untreated Base Course (UTBC) submittals per APWA Section 32 11 23.

2. Pavement Material: Submit bituminous concrete hot mix asphalt (HMA) submittals per APWA Section 32 11 05.

3. Tack Coat: Submit asphaltic materials per APWA Section 32 12 13.13.

4. Prime Coat: Submit asphaltic materials per APWA Section 32 12 13.19.

B. Test Results:

1. Base course testing results.

2. Asphalt pavement testing results.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Codes and Standards: Comply with the latest edition of State highway or transportation department standard specifications, APWA 2017 Standards and Specifications, and with Salt Lake City regulations.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Transport bituminous mixtures in covered trucks whenever:

1. Rainy weather, or

2. Air temperature is less than 60 degrees F.

C. Adjust weight, type, capacity, haul routes, and method of operation of hauling vehicles so that:

1. No damage results to existing streets, subgrade or base course, and

2. Noise and air pollution levels are not noticeably increased along selected haul route.

D. Haul routes through residential areas shall be avoided.

1.08 PROJECT CONDITIONS:

A. Weather Limitations: Apply prime and tack coats when ambient temperature is above 50 degrees F, and when temperature has not been below 35 degrees F for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.

PART 2 - PRODUCTS

2.01 AGGREGATE MATERIALS:

A. According to AASHTO M147, unless noted otherwise.

B. Aggregate, including blended filler, shall have:

1. Liquid limit (LL) of not more than 25 as determined by AASHTO T89.

2. Plasticity index (PI) of not more than 6 as determined by AASHTO T90.

C. Remove oversized material by screening or crushing to required sizes.

D. Filler for Blending:

1. Use filler for meeting gradation requirements or for satisfactory binding of material. Uniformly blend with base course material at screening plant.

2. Obtain material from sources accepted by Engineer.

3. Material shall be free of agglomerations or lumps, and contain no more than 15 percent of material retained on No. 4 sieve.

2.02 AGGREGATE BASE COURSE:

A. Aggregate Base Course shall be Untreated Base Course (UTBC) per APWA Section 32 11 23.

B. Gradation: Grade 1-1/2 per Table 4 – Master Grading Bands, APWA Section 32 11 23.

2.03 PAVEMENT MATERIALS:

A. Provide Hot Mix Asphalt (HMA) materials in accordance with APWA Section 32 11 05 Bituminous Concrete as modified below.

B. Crushed stone, crushed gravel, slag, sand, or combination per Table 3, Road Class III per APWA Section 32 11 05.

C. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with ASTM D242.

D. Aggregate: APWA DM-1/2 per Table 5 per APWA Section 32 11 05.

E. Reclaimed Asphalt Pavement (RAP): Allowed up to 25 percent by weight of RAP or binder, whichever is lesser, with no change in specified binder grade.

F. Asphaltic Materials:

1. Prime Coat: APWA Specifications, Section 32 12 13.19.

2. Tack Coat: APWA Specifications, Section 32 12 13.13.

3. Asphalt Cement:

a. Performance Grade: ASTM D6373

(1) PG 58-28

4. Prime Coat: Cut-back asphalt type; ASTM D2027 MC-30, MC-70 or MC-250.

5. Tack Coat: Emulsified asphalt; ASTM D977 or D2397; SS-1, SS-1h, CSS-1 or CSS-1h, diluted with one part water to one part emulsified asphalt.

2.04 ACCESSORIES:

A. Herbicide:

1. Provide herbicide in accordance with APWA Section 31 31 19.

2. Manufacturers:

b. Agsurf Corporation

c. Bayer

d. Dow Chemical U.S.A.

e. E.I. DuPont De Nemours & Co., Inc.

f. FMC Corporation

2. Commercial chemical for weed control, registered by Environmental Protection Agency (EPA).

3. Provide granular, liquid, or wettable powder form.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Check subgrade as to soundness, outline, and contour.

3.02 SUBGRADE PREPARATION:

A. Preparation shall be in accordance with APWA Section 32 12 16.13.

B. Scrape down subgrade bumps and irregularities to obtain smooth, even surface.

C. Proof roll

D. Remove and replace soft or spongy areas as specified in Section 31 23 00.

3.03 PAVEMENT PREPARATION:

A. Remove loose material from compacted base course immediately before applying herbicide treatment or prime coat.

B. If base course becomes rutted, loose or uneven due delays in placing subsequent courses then proof roll prepared surface to check for unstable areas. Provide additional compaction or remove unstable areas, backfill and compact. Do not begin paving work until deficient areas have been re-graded and corrected and are ready to receive paving.

C. Herbicide Treatment: Apply chemical weed control agent in compliance with manufacturer's recommended dosage and application instructions.

D. Prime Coat: Apply primer in accordance with APWA Section 32 12 13.19.

1. Apply at rate of 0.10 to 0.50 gallons per square yard over compacted subgrade.

2. Apply material to penetrate and seal, but not flood, surface.

3. Cure and dry as long as necessary to attain penetration and evaporation of volatile.

E. Tack Coat: Apply tack coat in accordance with APWA Section 32 12 13.13.

1. Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into asphalt concrete pavement.

2. Distribute at rate of 0.05 to 0.15 gallons per square yard of surface.

3. Allow to dry until at proper condition to receive paving.

4. Exercise care in applying bituminous materials to avoid smearing of adjoining concrete surfaces. Remove and clean damaged surfaces.

3.04 BASE COURSE INSTALLATION:

A. Placements of UTBC shall be per APWA Section 32 11 23 as modified as follows.

B. Place materials when surface is dry and atmospheric temperature is above 40 degrees F.

C. Construct in two or more layers of approximate equal lifts; maximum compacted lift is 6 inches.

D. Deposit material on foundation or previously placed layer to minimize segregation and facilitate spreading to uniform layer.

E. Place and spread each layer to thickness, width, and contour.

F. Compact each layer before proceeding to subsequent layers. Compact to 95 percent of maximum dry density, unless noted otherwise.

G. Prior to and during compaction shape material and maintain to dimensions and contour. Keep surface of each layer true and smooth.

3.05 PLACING MIX:

A. Place asphalt pavement in accordance with APWA Section 32 12 16.13.

B. Place in strips not less than 10 feet wide, unless otherwise acceptable to Engineer.

C. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips.

D. Grade Control: Establish and maintain required lines and elevations to within 3/8 inches.

E. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density, and smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.

3.06 ROLLING:

A. General: Begin rolling when mixture will bear roller weight without excessive displacement. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.

C. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

D. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

E. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut-out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

3.07 FIELD QUALITY CONTROL:

A. Base Course Testing:

1. Optimum Moisture Content and Maximum Density: Comply with AASHTO T99, Method C, with replacement of fraction of aggregate retained on 3/4 inch sieve. Replace with No. 4 to 3/4 inch material.

B. Pavement Testing:

1. General: Test in-place asphalt concrete courses for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable paving.

2. Thickness Tolerances: In-place compacted thickness will not be acceptable if exceeding following allowable variation from required thickness:

a. Base Course Thickness: Less than 1/4-inches, plus or minus.

b. Surface Course Thickness: Less than 1/4-inches, plus or minus.

3. Surface Smoothness Tolerances: Test finished surface of each asphalt concrete course for smoothness, using 10-foot straightedge applied parallel with, and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding following tolerances for smoothness.

a. Binder Course: 1/4-inches.

b. Surface Course: 1/8-inches.

c. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template, 1/4 inches.

d. Profile and Section: Variation from true shall not exceed +/- 3/8-inches.

3.08 PROTECTION:

A. After final rolling:

1. Do not permit vehicular traffic on pavement until it has cooled and hardened.

2. Protect paving from traffic until mixture has cooled enough not to become marked.

3.09 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 32 13 00

RIGID PAVING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Section includes:

1. Provide rigid paving as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 305R: Hot Weather Concreting

2. 306R: Cold Weather Concreting

3. 330.1: Specification for Unreinforced Concrete Parking Lots

B. APWA Manual of Standard Specifications 2017:

1. 32 11 23: Aggregate Base Courses

2. 32 13 13: Concrete Paving

3. 32 13 73: Concrete Paving Joint Sealants

C. ASTM International (ASTM):

1. A307: Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

2. C33: Standard Specification for Concrete Aggregates.

3. C138: Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.

4. C150: Standard Specification for Portland Cement.

5. C173: Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

6. C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

7. C260: Standard Specification for Air-Entraining Admixtures for Concrete.

8. C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

9. C494: Standard Specification for Chemical Admixtures for Concrete.

10. C1315: Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

11. C1602: Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

12. D1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

13. D5249: Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

14. D6690: Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

D. UDOT Specifications: 2017 Standard Specifications For Road and Bridge Construction

1.03 DEFINITIONS:

A. Cold Weather: Refer to ACI 306R. A period when for more than three successive days the average daily outdoor temperature drops below 40 degrees F. The average daily temperature is the average of the highest and lowest temperature during the period from midnight to midnight. When temperatures above 50 degrees F occur during more than half of any 24-hour duration, the period shall no longer be regarded as cold weather.

B. Hot Weather: Refer to ACI 305R. Any combination of the following conditions that tend to impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration, or otherwise resulting in detrimental results.

1. High ambient temperature

2. High concrete temperature

3. Low relative humidity

4. Wind velocity

5. Solar radiation

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Concrete: Aggregate, cement, and admixtures product data

2. Joint material product data

3. Compound product data

4. Concrete test results

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Work shall conform to all requirements of ACI 330.1 published by the American Concrete Institute, Fannington Hills, Michigan, except as modified by these contract documents.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Aggregate Base: Minimum 12 inches thick, unless noted otherwise.

1. Aggregate: APWA Specifications, Grade 3/4

2.02 CONCRETE FORMWORK:

A. Forms: Section 03 10 00.

1. Forms shall be made of steel or wood or other material capable of supporting concrete and mechanical concrete placing equipment that is sufficiently rigid to maintain the specified tolerances.

2. Forms shall be clean and free of dirt, rust, and hardened concrete.

2.03 CONCRETE:

A. Concrete: APWA Specification Section 03 30 04, Class 4000, with 0.44 maximum water-cement ratio.

1. Cement: Portland cement, ASTM C150 Type V, with tricalcium aluminate content not to exceed 8 percent.

2. Strength: Minimum compressive strength of 4,000 psi at 28 days.

3. Aggregate: ASTM C33 physical properties; nominal maximum size, 1 inch.

4. Admixtures:

a. Air Entrainment: ASTM C260 to provide air content (at delivery) between 5.0 to 7.5 percent as measured by ASTM C138, ASTM C173, or ASTM C231.

b. Water Reducing: ASTM C494, Type D, slump 4-1/2 inches for non-vibrated placement.

B. Water: Clean, non-staining, and not detrimental to concrete per ASTM C11602.

C. Thickness: 6 inches minimum or as indicated.

2.04 CONCRETE REINFORCEMENT:

A. Reinforcing Steel: Section 03 21 00

1. Tie Bar: Grade 60 or higher deformed billet steel bars, epoxy coated.

2. Dowel Bar: Grade 60 or high billet steel, epoxy coated with plastic expansion cap on one (1) end.

3. Chair and Basket Assemblies: Plastic chairs. Epoxy coated Grade 60 billet steel bar basket assemblies.

4. Hook Bolts: Galvanized ASTM A307, Grade A steel, nuts and shaft internally and externally threaded.

2.05 CONCRETE FINISHES:

A. See Section 03 35 00 for additional requirements.

B. Float (non-steel) and heavy broom finish.

2.06 JOINTS:

A. Expansion Joint Filler: APWA Specifications, 32 13 73.

1. Expansion Joint Filler: F1 Sheet

2. Contraction Joint Filler (Backer Rod): Type 1 round, ASTM D5249

3. Contraction Joint Sealer: HAS1, HAS4, or CAS6

2.07 ACCESSORIES:

A. Curing Compound: Type II Class A or B, white pigmented liquid membrane forming compound, ASTM C1315.

1. Manufacturers:

a. BASF; MasterKure CC 1315WB

b. W.R. Meadows; 2200 – White Anti-Spall Compound:

1. Compound shall be composed of 50 percent boiled linseed oil and 50 percent commercial grade kerosene or mineral spirits, by volume. Commercially prepared linseed oil mixtures are acceptable provided they are non-emulsified mixtures which are specifically for protection from de-icing chemicals.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Do not place pavement on frozen subgrade.

3.02 PREPARATION:

A. Excavate and shape subgrade to line, grade, and cross-section.

B. Remove all soft subgrade material encountered while compacting and backfill with aggregate base.

C. Repeat fine grading and compaction of subgrade areas which have been subjected to vehicular construction traffic and equipment.

D. Moisten aggregate base immediately before placing concrete to minimize absorption of water from fresh concrete.

E. Provide concrete surfaces that are clean and dry - free of oil, dirt or foreign materials immediately before application of compounds or painting.

3.03 COMPACTION:

A. Refer to Section 31 23 00 for additional compaction requirements.

B. Moisture: Maintain moisture content for Subgrade and Aggregate Base that is 3 percent of optimum moisture to attain required compaction density.

C. Subgrade: Compact top 12 inches to 95 percent of maximum dry density, unless noted otherwise.

D. Aggregate Base: Compact to 95 percent of maximum dry density, unless noted otherwise.

3.04 FORMWORK:

A. Set, align, and brace forms so that the pavement will meet the tolerances specified.

B. Apply form release agent to inside face of forms before placing concrete greater than 5 inches thick.

C. The edge of previously placed concrete may be used as a form. Do not apply form release agent to previously placed concrete, unless prevention of bond between the new and the old concrete is desired.

3.05 PLACING CONCRETE:

A. Place concrete on uniform subgrade.

B. Consolidate and strike off to proper elevation.

C. Place concrete continuously to prevent formation of “cold joints”.

D. Where placing operations stop, install bulkhead to form straight joint.

E. Texture pavement surface with broom.

F. Follow recommendations in ACI 305R when concreting during hot weather.

G. Follow recommendations in ACI 306R when concreting during cold weather.

3.06 JOINTS:

A. Joint pavement with full depth expansion joints as indicated on the drawings. Provide evenly spaced contraction joints between expansion joints per the requirements below.

B. Joint Spacing: 20 feet, maximum

C. Make contraction joints by sawing, tooling or installing insert with no exceptions noted to depth of 2 inches.

D. Cut saw joints as soon as possible without raveling concrete edges.

E. Install full depth expansion joints using 1/2-inch thick joint material around castings and where pavement abuts structures and where indicated on the Drawings.

3.07 REPAIR/RESTORATION:

A. Repair damaged work by replacing with new pavement to the nearest construction isolation joint.

3.08 FINISHING:

A. Float: Use magnesium or aluminum hand floats or power floats with slip on float shoes after concrete has stiffened to point where 1/4-inch maximum indentation can be imparted by normal foot pressure. Do not use combination blades for floating.

B. Float finish shall result in uniform smooth granular texture.

C. After floating, check slab tolerances with 10-foot straightedge. Fill low spots with fresh concrete.

D. Do not sprinkle with dry cement or add water.

E. Broom Finish:

1. Heavy Broom Finish: Use steel wire or stiff coarse fiber broom while concrete is still soft enough to produce deep scouring.

2. Texture parallel to travel direction of pavement

3. Texture shall be reviewed by Engineer

3.09 TOLERANCES:

A. Construct pavement to comply with the following tolerances:

1. Elevation: 3/4 inch

2. Thickness: plus 3/8 inch, minus 1/4-inch

3. Surface: In any direction, the gap below a 10-foot unleveled straightedge resting on high spots shall not exceed 1/2-inch.

B. Joint reinforcement: Tie bars-alignment of tie bar end relative to line perpendicular to edge of pavement: 1/2-inch per foot of tie bars.

C. Dowels:

1. Lateral alignment and spacing: 1 inch

2. Vertical alignment: 1/4-inch

3. Alignment of dowel bar end relative to line perpendicular to edge of pavement: 1/4-inch per foot of dowel

D. Joint Spacing:

1. Contraction joint depth (slab thickness): plus 1/4-inch, minus 0 inch

2. Joint width: plus 1/8-inch, minus 0 inch

3.10 FIELD QUALITY CONTROL:

A. Refer to Section 31 23 00 for compaction and testing requirements.

B. Submit compaction test results to Engineer for review.

C. Concrete Testing: Section 03 30 00. Maintain records of placed concrete including: record date, location of pour, quantity, air temperature, and test samples taken. Submit test results to Engineer for acceptance.

D. Defective Concrete: As defined in Section 03 30 00.

3.11 PAINTING AND STRIPING:

A. Paint pavement markings and striping after concrete or asphalt has cured for at least 14 days.

B. Protect markings from traffic until completely dry to prevent tracking.

3.12 PROTECTION:

A. Protect concrete from damage and replace if damage occurs.

B. Protect pavement from traffic for a minimum of 1 week of ambient temperatures above 40 degrees F.

C. Do not open the pavement to vehicular traffic until the in-place compressive strength is at least 3000 psi or until the pavement is accepted by the Engineer for opening to traffic.

D. Anti-Spall Compound:

1. Apply compound no sooner than 28 days after placement of concrete.

2. Spray two coats, allowing for first coat to completely dry.

3. Minimum spray rates shall be: 40 square yards per gallon (first application) and 60 square yards per gallon (second application)

3.13 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 32 17 23

PAVEMENT MARKING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide pavement marking as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. Military and Government Specs & Standards (Naval Publications and Form Center (NPFC):

1. TT-P-1952F: Paint, Traffic and Airfield Marking, Waterborne

2. FS 595B: Colors Used in Government Procurement

B. American Standards for Testing of Materials (ASTM):

1. D562: Standard Test Method for Consistency of Paints

2. D1644: Standard Test Methods for Nonvolatile Content of Varnishes

3. D2805: Standard Test Method for Hiding Power of Paints by Reflectometry

4. D3723: Standard Test Method for Measuring Neutron Fluence and Average Energy from 3H(d,n) 4He Neutron Generators by Radioactivation Techniques

5. D3960: Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings

6. D5381: Standard Guide for X-Ray Fluorescence (XRF) Spectroscopy of Pigments and Extenders

7. E1347: Standard Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Test Results:

1. Provide test reports of material supplied.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Furnish paint in sealed containers that legibly indicate at time of use designated name, formula or specification number, batch number, color, date of manufacturer, manufacturer's name, formulation number, and directions.

PART 2 - PRODUCTS

2.01 PAINT:

A. FS TT-P-1952F, Type II.

B. Paint shall be homogeneous, easily stirred to smooth consistency, and show no hard settlement or other objectionable characteristics during storage period of 6 months.

C. Paint shall meet the requirements for Acrylic Water Based Paint as specified in Table 32 17 23-1 below.

Table 32 17 23-1

Property	White	Yellow	Blue	Red	Test
Pigment – Percent by weight, minimum	60 - 62	60 - 62	60 - 62	60 - 62	ASTM D3723
Total Solids – Percent by weight, minimum	77 +/-2	77 +/-2	77 +/-2	77 +/-2	ASTM D1644
Nonvolatile Vehicle – Percent by weight vehicle, minimum	42 +/-2	42 +/-2	42 +/-2	42 +/-2	ASTM D3723 ASTM D1644
Viscosity, KU at 77 degrees F	80-110	80-110	80-100	80-110	ASTM D562
Volatile Organic Content (VOC) – g/L, maximum	<100	<100	<100	<100	ASTM D3960
Color Definition	#37925	#33538	#35180	#31136	FS 595B
Directional Reflectance, minimum	85 percent	NA	NA	NA	ASTM E1347
Dry Opacity – minimum (5 mils wet)	0.92	0.92	0.92	0.92	ASTM D2805

D. Traffic Pickup Time: Paint may not smear or track 10 minutes after application using standard application equipment, at the mil thickness required, and with an ambient shaded temperature of at least 50 degrees F.

E. Additional Requirements

1. Free of lead, chromium, and other related heavy metals. Refer to ASTM D5381.

2. Refer to ASTM D5381 for tests used to verify paint samples meet ASTM requirements.

F. Manufacturers:

1. Allstates Coatings Co.

2. Swarco Colorado Paint Company II, LLC

3. SealMaster

PART 3 - EXECUTION

3.01 APPLICATION EQUIPMENT:

A. Machines, tools, and equipment used in performance of work shall be capable of applying stripe widths indicated, at paint coverage rate specified, and of even uniform thickness with clear-cut edges.

B. Paint Applicator:

1. Traffic Line Paint Applicator:

a. Self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain specified results.

b. Speed during application of not less than 5 mph.

c. Spray mechanism tanks with air-driven mechanical agitators.

d. Equip with quick-action valves conveniently located, and include necessary pressure regulator and gauges in full view and reach of operator.

e. Provide paint strainers in supply lines to ensure freedom from residue and foreign matter that may cause malfunction of spray guns.

2. Provide pneumatic spray guns for application of paint for letters, handicapped symbols, and hand application of paint in areas where mobile paint applicator cannot be used.

C. Provide stencils for handicapped symbols and letters.

D. Sandblasting Equipment:

1. Includes air compressor, hoses, and nozzles of size and capacity as required for cleaning surfaces to be painted.

2. Compressor shall be capable of furnishing not less than 150 cfm of air at pressure of not less than 90 psi at nozzle for each nozzle used.

3.02 PREPARATION:

A. Cure pavement surfaces for period of not less than 30 days before application of marking materials.

B. Clean surfaces to be marked before application of paint.

C. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or combination of these methods as required.

D. Remove rubber deposits and other coatings adhering to pavement with scrapers, wire brushed, sandblasting, approved chemicals or mechanical abrasion.

3.03 APPLICATION:

A. Apply paint pneumatically.

B. Apply evenly to clean, dry surfaces of pavement at rate producing initial (wet) thickness of 15 mils, and only when air and pavement temperatures are above 50 degrees F and less than 90 degrees F. Do not apply when the relative humidity exceeds 85 percent or when the temperature falls below the dew point. Maintain paint temperature within these same limits.

C. Provide guidelines and templates as necessary to control paint application. Special precautions shall be taken in marking letters and handicapped symbols. Edges of markings shall be sharply outlined.

D. Maximum drying time requirements of paint will be enforced to prevent undue softening of bitumen and pickup, displacement or discoloration by tires of traffic. If there is deficiency in drying of markings, discontinue painting operations until cause of slow drying is determined and corrected.

E. Protect markings from traffic until dry to prevent tracking.

3.04 CLEANING:

A. At completion of work, remove rubbish, debris, equipment, and excess material from site. Clean adjoining surfaces soiled by and during this work.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Section includes:

1. Chain link fence framework, fabric, and accessories.

2. Excavation for post bases.

3. Manual gates and related hardware.

4. Electric Gate Operators. All new electric gate operators shall be from a single manufacturer for all vehicular swing and slide gates on the project.

1.02 REFERENCES:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. M181: Standard Specification for Chain-Link Fence.

B. ASTM International (ASTM):

1. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

2. A121: Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.

3. A392: Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.

4. A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

5. A817: Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire

6. A824: Specification for Metallic-Coated Steel Marcelled Tension Wire

7. F552: Standard Terminology Relating to Chain link Fencing

8. F567: Standard Practice for Installation of Chain-Link Fence.

9. F626: Standard Specification for Fence Fittings

10. F817: Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire

11. F824: Specification for Metallic-Coated Steel Marcelled Tension Wire

12. F900: Standard Specification for Industrial and Commercial Swing Gates.

13. F1083: Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

14. F1184: Standard Specification for Industrial and Commercial Horizontal Slide Gates.

15. F1379: Standard Terminology Relating to Barbed Tape

16. F2200: Specification for Automated Vehicular Gate Construction

17. F2611: Standard Guide for the Design and Construction of Chain Link Security Fencing

18. F3000: Standard Specification for Polymer Privacy Insert Slats for Chain Link Fabric and Privacy Chain Link Fabric Manufactured Containing Pre-Installed Privacy Slats

C. Underwriters Laboratories (UL):

1. UL325: Automatic Operators: Door, Gate, Louver and Window

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Submit Manufacturer's specifications, drawings, details and fence layout with appurtenances.

2. Submit two samples of fencing materials. Mark or tag each sample and submit 30 days prior to erection of fence.

3. Submit certified test reports with results of tests for fence finish.

4. Submit shop drawings, samples and certificates simultaneously as one complete package.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. Gate Hinges (4)

2. Tension Turn buckles (5)

3. Post Caps (5)

4. Tension Band (4)

5. Brace Band (4)

6. Privacy Slats (provide a minimum to cover 10 linear feet of fence)

C. Provide a list of recommended spare parts for the first year of operation and for the first five years of operation, including a price list and location of the nearest facility from which all spare parts can be obtained.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Provide chain link fence in accordance with AASHTO M181; Fabric: Type I Class D fabric coating (ASTM A392 Class 2); Posts: Grade 1; Tension wire: Type I, Class 3 coating (ASTM A 824 Type II, Class 5).

B. Provide framework, fabric, accessories and gates in accordance with ASTM F567.

C. Fence heights as indicated with top rail, bottom tension wire, and three strands of barbed wire projecting outward at top.

D. Gates:

1. Industrial and Commercial:

a. Provide swing gates in accordance with ASTM F900.

b. Provide horizontal cantilever slide gates in accordance with ASTM F1184.

2.02 FENCING MANUFACTURERS:

A. Framework, posts, rails, pipe for gates:

1. Wheatland Tube Co.

2. Master Halco, Inc.

3. Southwestern Wire, Inc.

2.03 FENCE FABRIC:

A. Galvanized steel chain-link fabric conforming to ASTM A392, with Class 2 zinc coating (2.0 ounces of zinc per square foot of uncoated wire surface); Fabric woven in 2-inch mesh from No. 9 gage wire in a 6 feet height with twisted top and barbed selvages bottom.

2.04 BARBED WIRE AND SUPPORT ARMS:

A. Galvanized-steel barbed wire consisting of three strands of twisted No. 12-1/2 gage wires with 4-point barbs spaced 5 inches apart and conforming to ASTM A121, with Type Z, Class 3 zinc coating (minimum of 0.8 ounces of zinc coating over each square foot of uncoated wire surface for No. 12-1/2 gage wire).

B. Barbed Wire Arms: In compliance with F626, pressed steel galvanized after fabrication, minimum zinc coating of 1.2 ounces per square foot. Type I support arms projecting outward, from top of posts, at 45 degrees and capable of withstanding 250 pounds downward pull on outermost end of arm, without failure. Arms with provision for attachment of three strands of evenly spaced barbed wire and integral with post top weather caps with holes for passage of top rail at intermediate posts.

2.05 TENSION WIRE:

A. Metallic Coated Steel Marcelled Tension Wire: 7-gauge marcelled wire complying with ASTM A824, Type II zinc coated, ASMT A817 Class 5 – 2.0 ounces per square foot.

2.06 TIE WIRES AND HOG RINGS:

A. Tie Wire and Hog Rings: Galvanized minimum zinc coating 1.2 ounces per square foot, 6-gauge steel wire in compliance with ASMT F626.

2.07 LINE POSTS:

A. Schedule 40 standard weight pipe in accordance with ASTM F1083, 2.0 ounce per square foot hot dip galvanized zinc exterior and 2.0 ounce per square foot hot dip

galvanized zinc interior coating, minimum 2-3/8-inch outside diameter, intermediate strength grade (minimum yield strength 50,000 psi).

2.08 END, CORNER, AND PULL POSTS:

A. Schedule 40 standard weight pipe in accordance with ASTM F1083, 2.0 ounce per square foot hot dip galvanized zinc exterior and 2.0 ounce per square foot hot dip galvanized zinc interior coating, minimum 2-7/8-inch outside diameter, intermediate strength grade (minimum yield strength 50,000 psi).

2.09 SWING GATES:

A. Swing Gates: Galvanized steel pipe welded fabrication in compliance with ASTM F900. Gate frame members 1.90-inch OD, ASTM F1083 schedule 40 galvanized steel pipes. Frame members spaced no greater than 8 feet apart vertically and horizontally. Welded joints protected by applying zinc-rich paint in accordance with ASTM Practice A780. Positive locking gate latch, pressed steel galvanized after fabrication. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges. Provide lockable drop bar and gate holdbacks with double gates. Match fabric to that of the fence system. Gateposts per ASTM F1083 schedule 40 galvanized steel pipe, minimum weight 3.65 pounds per foot for gates up to 4 feet wide, 5.79 pounds per foot for gates over 4 feet to 10 feet wide and 9.11 pounds per foot for gates over 10 feet to 18 feet wide. Gatepost diameter as indicated on the Drawings.

2.10 HORIZONTAL SLIDE GATES:

A. Cantilever Slide Gates: In compliance with ASTM F1184 Type II.

1. Class 1 – External Roller Design: Horizontal top and bottom steel pipe “track” members to be 2-3/8 inch OD. Vertical and internal members, 1,900-inch OD in compliance with ASTM F1083 schedule 40 galvanized steel pipes. Gate frame to be fabricated by welding, vertical and horizontal members installed no greater than 8 feet apart. Welded joints are to be protected by applying zinc-rich paint in accordance with ASTM Practice A780. Gates designed to open or close by applying an initial pull force no greater than 40 pounds. Match chain link fabric to that of the fence system. Positive locking pressed steel latch, galvanized after fabrication. Galvanized steel drop bars provided with double gates. Gateposts, 4-inch OD schedule 40 pipe per ASTM F1083. Provide safety protective guards for the top and bottom external rollers following ASTM F1184 guidelines.

B. Electrically operated horizontal slide gates must be manufactured and installed to comply with the safety requirements of ASTM F2200 and UL 325.

2.11 RAILINGS:

A. Schedule 40 standard weight pipe in accordance with ASTM F1083, 2.0 ounce per square foot hot dip galvanized zinc exterior and 2.0 ounce per square foot hot dip

galvanized zinc interior coating 1-5/8 inch outside diameter steel pipe with minimum weight of 2.27 lb/ft for top railing and railings for top middle and bottom braces between terminal posts and adjacent line posts.

2.12 TRUSS ROD:

A. In compliance with ASTM F626, 3/8 inch diameter steel rod, minimum zinc coating 1.2 ounces per square foot, capable of withstanding tension of 2,000 pounds, diagonal truss braces between terminal and adjacent line posts and for gate framework.

2.13 FITTINGS:

A. Heavy-duty malleable iron or pressed steel fittings of suitable size to produce strong construction.

2.14 STRETCHER BARS (TENSION BARS):

A. In compliance with ASTM F626. Galvanized steel one-piece full length of fabric height. Minimum zinc coating of 1.2 ounces per square foot. Flat bars with minimum cross section dimensions of 3/16-inch by 3/4 inch, secured with bar bands of minimum 11-gage sheet steel, spaced approximately 15 inches on centers and bolted with 3/8-inch diameter bolts, for attaching fabric to terminal posts.

2.15 ELECTRIC GATE OPERATOR:

A. Manufacturers:

1. Liftmaster SL595UL Elite Series

2. Linear OSCO GSLG-A Series

3. Doorking DKS 9200 Series

B. Contractor shall size the motor based on the width and weight of the gate to be operated. Gate operator shall be UL listed and meet all current safety requirements. Electric gate operator to consist of and/or meet the following minimum requirements:

1. Enclosed reversing, minimum 1 horsepower motor, 460 volts, 3-phase.

2. Heavy gauge steel frame for pad mounting.

3. All-weather hinged cover with provision for padlocking.

4. Adjustable safety friction clutch.

5. Adjustable limit switches, rotary type.

6. Magnetic solenoid locking brake.

7. Emergency disconnect for manual operation in case of power failure.

8. Magnetic reversing starter (size "1" contactor type) with overload and undervoltage protection.

9. Factory pre-wired electrical system.

10. Permanent lubricated heavy-duty bearings and heavy-duty roller chain.

C. Electric gate operator to be located as indicated. Operator to have parallel three-button illuminated control stations ("OPEN," "STOP," and "CLOSE").

D. Provide 24VDC power supply for access control panel, to derive power from unswitched electrical feed to gate operator. Provide fuses to protect both supply and load sides of the 24VDC power supply. Seal entries on both interior and exterior conduit between enclosures. A self-limiting transformer is an acceptable alternative to fusing where listed for the purpose. Size power supply for power requirement of access control panel provided.

E. Power Supply is to be in a UL 508 listed enclosure or integral to the UL/NRT listed gate actuator enclosure as a manufacturer provide feature.

F. Provide electrical conduit, switches, wiring, and connections specified under the applicable electrical sections of Division 26.

2.16 CONCRETE FOOTINGS:

A. Section 03 30 00, Class A concrete.

2.17 GROUT:

A. One-part Portland cement and three parts of clean, sharp, well-graded sand with minimum water for proper workability for posts set in solid rock.

2.18 ACCESSORIES:

A. Steel pipe dimensions and weights: ASTM A53, Schedule 40. Dimensions specified are nominal pipe sizes.

B. Dimensions and weight tolerances: Plus or minus 5 percent.

C. Zinc Coating: Minimum 2.0 ounces per square foot.

D. Provide posts with tops of same material, and designed to fit securely over post and carry top rail. Carry apron around outside of post at base of top fitting.

E. Ferrous metal fittings, posts, fence, gate framework, and accessories galvanized with heavy coating of 2.0 ounces/square foot pure zinc spelter per square foot or surface area

to be coated. Use hot-dip process. Thinner zinc coatings, electro-galvanizing, zinc paint or cold galvanizing compounds not used as substitute for hot-dipped galvanized finish not acceptable.

F. Fabricate and weld before hot-dip galvanizing. Weld conforming to American Welding Society standards.

G. Hot-dip galvanized gate frame, after welding, if bolted or riveted corner fittings not used.

H. Single and double leaf swing gates with center bolt, center stop, and automatic backstops.

I. Cantilever sliding (rolling type) gate complete with latch, stop, keeper, rollers, heavy duty roller track, and 3 strands of barbed wire installed vertically above fabric and electrically operated.

2.19 PRIVACY SLATS:

A. Privacy Slats: Slats to be manufactured from a combination of color pigments, quality high density virgin polyethylene and ultraviolet inhibitors, having a 25-year limited warranty against either color fading or breakage of slats and locking-channel used under normal climactic extremes experienced in Utah. Color shall be Forest Green. Slats shall be standard PDS self-locking type using horizontal bottom channel locking system. Privacy slats shall provide minimum 90% privacy and meet the requirements of ASTM F3000.

B. Manufacturers

1. Master Halco, Inc.

2. Pexco, LLC

3. SlatSource by Privacy Link

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine conditions under which fence and gates are to be installed. Notify Engineer, in writing, of improper conditions of work.

B. Do not proceed with work until unsatisfactory conditions have been corrected.

C. Verify measurements at site.

D. Check location of underground work to make sure fence footings clear utilities and drainage work.

E. Do not install fence until final grading is complete and finish elevations are established.

F. Do not drive equipment on areas to be landscaped, except as accepted by Engineer. Areas not accessible from roads shall be protected with heavy wood planking. Remove barricades and protection at completion of project. Repair damaged landscape surfaces.

3.02 INSTALLATION:

A. Footings:

1. Vertical sides to minimize up-lift. Dispose of excavated material in accordance with Section 01 74 23.

2. Rod and compact concrete around posts. Slope top of footings above level of adjacent grade, and trowel finish.

3. Size:

a. 10 inches minimum diameter, plus outside dimension of post.

b. Set corner, end, pull, and gate posts 42 inches into concrete.

c. Set line posts set 36 inches into concrete.

d. Total depth of concrete 6 inches greater than required for post embedment.

4. Time of Set: 48 hours before rails are erected or before fabric is applied or stretched.

B. Framing:

1. Install line posts not more than 10 feet apart.

2. Install pull posts not more than 500 feet apart where a straight run of fence exceeds 500 feet and where fence line changes direction by more than 15 degrees but less than 30 degrees.

3. Install corner posts where the fence line changes direction by more than 30 degrees.

4. Set posts in concrete footings, plumb and true to line.

5. Brace and truss end, pull, corner, and gate posts to adjacent line posts. Provide brace to match top rail spaced midway between top rail and tension wire and extending to adjacent line posts. Provide brace to match top rail spaced midway

between top rail and tension wire and extending to adjacent line post. Truss diagonally with 5/16-inch diameter tension rod with turnbuckle.

6. Fasten top rail to end, pull, gate and corner posts. Pass top rail through fittings of line posts.

7. Provide expansion and contraction joints in top rail for each 100 linear feet of fence.

8. Fasten bottom tension wire to end, pull, gate, corner, and line posts.

9. Maximum area of unbraced fence shall not exceed 1,500 square feet.

10. Install fencing on top of concrete structures with suitable galvanized flange casings and galvanized anchor bolts as accepted by Engineer.

C. Fabric:

1. Place fabric on outside of posts and stretch to avoid bulging or buckling.

2. Fasten at line posts, top rail, and bottom tension wire with aluminum or zinc PVC coated ties. Space ties not more than 15 inches apart on line posts and not more than 24 inches apart on rail and tension wire.

3. Fasten at terminal posts at intervals not exceeding 15 inches using flat or beveled galvanized steel bands with 5/16-inch x 1-1/4 inch galvanized carriage bolts and nuts.

4. Make tie connections on interior side of fence.

5. Provide steel angle metal closures where finished ground surface is more than two inches below bottom tension wire. Bolt steel angle to fence posts, and install reinforcing rods and bracing members as accepted. Install rods of accepted length vertically. Where drainage ditches cross fence line, provide concrete ditch lining and steel reinforcing bar grill.

6. Install three strands of barbed wire on each extension arm of line fence and at top of each gate. Pull wires taut and fasten at each support.

7. Install barbed wire on extension arms as indicated. Pull each wire taut, and make entire assembly secure Attach wire to end, corner, pull, and gate posts with wire stretching bands.

8. Install gates plumb, level, and secure for full width of opening and hardware adjusted for smooth operation.

9. Electrical Ground where a power line carrying more than 600 volts passes over fence, install ground rod at nearest point directly below each point of crossing.

10. Privacy slats: Install and lock in privacy slats in the fabric in accordance with manufacturer’s instructions.

3.03 ELECTRIC GATE OPERATOR INSTALLATION:

A. The Electric Gate Operator shall be installed in accordance with the manufacturer's written instructions.

3.04 ACCESS CONTROL PANEL POWER SUPPLY

A. Field test voltage of power supply and assure power supply does not switch nor reverse polarity in normal operation before connecting to Access Control Panel.

B. Provide bonding and 10-foot x 3/4-inch (nominal) copper-clad ground rod at gate operator and use bare #4 copper (minimum) conductors to bond to:

1. Power supply load-side neutral.

2. Gate Operator Chassis.

3. Gate Operator Power Conduit's insulated ground wire.

3.05 REPAIR:

A. Remove and replace fencing which is improperly located or is not true to line, grade and plumb within tolerances as indicated.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 32 32 16

PRECAST MODULAR BLOCK RETAINING WALLS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This Section includes furnishing all materials and labor required for the design and construction of a precast concrete modular block (PMB) retaining wall with or without geosynthetic reinforcement. Precast modular block retaining wall blocks under this section shall be cast utilizing a wet-cast concrete mix and exhibit a final handling weight in excess of 1,000 pounds per unit.

B. Scope of Work: The work shall consist of furnishing materials, labor, equipment and supervision for the construction of a precast modular block (PMB) retaining wall structure in accordance with the requirements of this section and in acceptable conformity with the lines, grades, design and dimensions shown in the project site plans.

1.02 REFERENCES:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. M 145: Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

2. M 288: Geotextile Specification for Highway Applications

3. T104: Standard Method of Test for Soundess of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

4. T267: Standard Method of Test for Determination of Organic Content in Soils by Loss of Ignition

5. LRFD Bridge Design Specifications

B. American Concrete Institute (ACI)

1. 201.2: Guide to Durable Concrete

2. 318: Building Code Requirements for Structural Concrete and Commentary.

C. American Society of Civil Engineers (ASCE)

1. 7: Minimum Design Loads for Buildings and Structures

D. ASTM International (ASTM):

1. C33: Standard Specification for Concrete Aggregates

2. C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

3. C94: Standard Specification for Ready-Mixed Concrete

4. C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

5. C138: Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

6. C143: Standard Test Method for Slump of Hydraulic-Cement Concrete

7. C150: Standard Specification for Portland Cement

8. C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

9. C260: Standard Specification for Air-Entraining Admixtures for Concrete

10. C494: Standard Specification for Chemical Admixtures for Concrete

11. C595: Standard Specification for Blended Hydraulic Cements

12. C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

13. C666: Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing

14. C845: Standard Specification for Expansive Hydraulic Cement

15. C920: Standard Specification for Elastomeric Joint Sealants

16. C989: Standard Specification for Slag Cement for Use in Concrete and Mortars

17. C1116: Standard Specification for Fiber-Reinforced Concrete

18. C1157: Standard Performance Specification for Hydraulic Cement

19. C1218: Standard Test Method for Water-Soluble Chloride in Mortar and Concrete

20. C1240: Standard Specification for Silica Fume Used in Cementitious Mixtures

21. C1611: Standard Test Method for Slump Flow of Self-Consolidating Concrete

22. C1776: Standard Specification for Wet-Cast Precast Modular Retaining Wall Units

23. D448: Standard Classification for Sizes of Aggregate for Road and Bridge Construction

24. D698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

25. D1241: Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses

26. D1556: Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method

27. D1557: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

28. D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

29. D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)

30. D4254: Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

31. D3786: Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method

32. D4318: Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

33. D4354: Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing

34. D4355: Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus

35. D4491: Standard Test Methods for Water Permeability of Geotextiles by Permittivity

36. D4533: Standard Test Method for Trapezoid Tearing Strength of Geotextiles

37. D4595: Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method

38. D4767: Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils

39. D4972: Standard Test Methods for pH of Soils

40. D4632: Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

41. D4751: Standard Test Method for Determining Apparent Opening Size of a Geotextile

42. D4759: Standard Practice for Determining the Specification Conformance of Geosynthetics

43. D4833: Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products

44. D4873: Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples

45. D5262: Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

46. D5321: Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

47. D5818: Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics

48. D5970: Standard Test Method for Deterioration of Geotextiles from Outdoor Exposure

49. D6241: Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

50. D6637: Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method

51. D6638: Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units (Modular Concrete Blocks)

52. D6706: Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil

53. D6916: Standard Test Method for Determining the Shear Strength Between Segmental Concrete Units (Modular Concrete Blocks)

54. D6938: Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

55. D6992: Standard Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method

56. G51: Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing

57. G57: Standard Test Method for Measurement of Soil Resistivity Using the Wenner Four-Electrode Method

E. International Building Code (IBC)

F. Federal Highway Administration (FHWA)

1. FHWA-NHI-10-024: GEC-11 Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Vol. I

2. FHWA-NHI-10-025: GEC-11 Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Vol II

G. National Concrete Masonry Association (NCMA):

1. TR127B: Design Manual for Segmental Retaining Walls

2. TR146: Segmental Retaining Wall Installation Guide

3. TR146: Segmental Retaining Walls – Seismic Design Manual

1.03 DEFINITIONS:

A. Precast Modular Block (PMB) Unit: Concrete, modular facing block provided by an authorized manufacturer.

B. Geogrid: A geosynthetic material manufactured of high tensile materials specifically for the purpose of reinforcing and creating a structural soil mass.

C. Drainage Aggregate: Clean, crushed rock located within and immediately behind PMB units to facilitate drainage and avoid compaction in close proximity to PMB wall units.

D. Reinforced Soil: Soil zone extending from the Drainage aggregate zone to the back of the embedded geogrid.

E. Foundation Soil: Soil zone immediately beneath the retaining wall facing units, the wall leveling pad and the reinforced soil zone.

F. Retained Soil: Soil immediately behind retaining wall facing and drainage aggregate for modular gravity structures or behind the reinforced soil for wall that utilize geogrid.

G. Construction Drawings: Approved final plan for construction prepared and stamped by the wall design engineer licensed to practice in the state where the retaining wall is located.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data. At least 14 days prior to construction, the Contractor shall submit the retaining wall product submittal package to the Engineer for review and approval. The submittal package shall include technical specifications and product data from the manufacturer for the following:

1. Precast Modular Block System brochure, product data, and installation instructions.

2. Manufacturer's test reports certifying that the PMB units manufactured at their production facility meet the requirements of this specification and the requirements of the Construction Drawings.

C. Contractor shall submit two sets of the Construction Drawings for all retaining walls on the project.

1. The design shall be prepared by a Professional Engineer licensed to practice in the State of Utah.

2. The design shall be per NCMA Design Guidelines for Segmental Retaining Walls, or the AASHTO Standard Specifications for Highway Bridges, whichever is applicable as determined by the retaining wall design engineer.

3. Construction Drawings shall include:

a. The retaining wall layout and retaining wall heights.

b. Proper placement, lengths and types of geogrid reinforcement where necessary.

c. Typical wall sections.

d. Types, locations and properties of all drainage materials, appurtenances and special installation requirements not covered in this specification.

e. Retaining wall elevation views.

f. Any soils information or testing conducted in addition to that included within the project drawings and specifications.

g. Design assumptions.

4. If geogrid reinforcement is required in the final engineered construction drawings, submit manufacturer's product literature, product testing reports and a twelve inch or larger sample of each type to be used in wall construction.

5. Submit gradation reports for aggregates used for the wall leveling pad, unit / drainage fill and for select reinforced fill if required in the final engineered wall design.

6. All submittals must be provided and reviewed prior to the start of retaining wall construction.

7. Drainage Pipe, if required.

8. Geotextile

A. Installer Qualification Data. At least 14 days prior to construction, the Contractor shall submit the qualifications of the business entity responsible for installation of the retaining wall, the Retaining Wall Installation Contractor, per the requirements of this section.

1.05 ADMINISTRATIVE REQUIREMENTS:

A. Preconstruction Meeting. The General Contractor shall schedule a preconstruction meeting at the project site prior to commencement of retaining wall construction. Participation in the preconstruction meeting shall be required of the General Contractor, Retaining Wall Design Engineer, Retaining Wall Installation Contractor, Grading Contractor and Engineer. The General Contractor shall provide notification to all parties at least 10 calendar days prior to the meeting.

1. Preconstruction Meeting Agenda:

a. The Retaining Wall Design Engineer shall explain all aspects of the retaining wall construction drawings.

b. The Retaining Wall Design Engineer shall explain the required bearing capacity of soil below the retaining wall structure and the shear strength of in-situ soils assumed in the retaining wall design to the Engineer.

c. The Retaining Wall Design Engineer shall explain the required shear strength of fill soil in the reinforced, retained and foundation zones of the retaining wall to the Engineer.

d. The Retaining Wall Design Engineer shall explain any measures required for coordination of the installation of utilities or other obstructions in the reinforced or retained fill zones of the retaining wall.

e. The Retaining Wall Installation Contractor shall explain all excavation needs, site access and material staging area requirements to the General Contractor and Grading Contractor.

1.06 CONSTRUCTION SHOP DRAWINGS PREPARATION

A. The Retaining Wall Design Engineer shall coordinate the retaining wall construction shop drawing preparation with the project Civil Engineer and project Geotechnical Engineer. The General Contractor shall furnish the Retaining Wall Design Engineer the following project information required to prepare the construction shop drawings. This information shall include, but is not limited to, the following:

1. Current versions of the site, grading, drainage, utility, erosion control, landscape, and irrigation plans;

2. electronic CAD file of the civil site plans listed in (1);

3. report of geotechnical investigation and all addenda and supplemental reports;

4. recommendations of the project Geotechnical Engineer regarding effective stress shear strength and total stress shear strength (when applicable) parameters for in-situ soils in the vicinity of the proposed retaining wall(s) and for any fill soil that may potentially be used as backfill in retained and/or foundation zones of the retaining wall.

B. The Retaining Wall Design Engineer shall provide the Engineer with a certificate of professional liability insurance verifying the minimum coverage limits of $1 million per claim and $1 million aggregate.

C. Design of the precast modular block retaining wall shall satisfy the requirements of this section. Where local design or building code requirements exceed these specifications, the local requirements shall also be satisfied.

D. The Retaining Wall Design Engineer shall note any exceptions to the requirements of this section by listing them at the bottom right corner of the first page of the construction shop drawings.

E. Approval or rejection of the exceptions taken by the Retaining Wall Engineer will be made in writing as directed by the Engineer.

F. The precast modular block design, except as noted herein, shall be based upon AASHTO Load and Resistance Factor Design (LRFD) methodology.

G. In the event that a conflict is discovered between these specifications and a reasonable interpretation of the design specifications and methods referenced in paragraph F above, these specifications shall prevail.

H. Soil Shear Parameters. The Retaining Wall Design Engineer shall prepare the construction shop drawings based upon soil shear strength parameters from the available project data and the recommendations of the project Geotechnical Engineer. If insufficient data exists to develop the retaining wall design, the Retaining Wall Design Engineer shall communicate the specific deficiency of the project information or data to the Owner in writing.

I. Allowable bearing pressure requirements for each retaining wall shall be clearly shown on the construction drawings.

J. Global Stability. Overall (global) stability shall be evaluated in accordance with the principals of limit equilibrium analysis as set forth in FHWA-NHI-10-024 Volume I and FHWA-NHI-10-025 Volume II GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes. The minimum factors of safety shall be as follows:

1. Normal Service (Static): 1.4

2. Seismic: 1.1

3. Rapid Drawdown (if applicable): 1.2

K. Seismic Stability. Seismic loading shall be evaluated in accordance with AASHTO Load and Resistance Factor Design (LRFD).

1.07 PERFORMANCE REQUIREMENTS:

A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified and registered professional engineer in State of Utah, using performance requirements and design criteria indicated.

B. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified and registered professional engineer in State of Utah, using performance requirements and design criteria indicated.

C. Structural Performance: Engineering design shall be based on the following loads and be according to the current version of AASHTO LRFD Standard Specification for Highway Bridges.

1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.

2. Superimposed loads (surcharge) indicated on Drawings.

D. Seismic Performance: Engineering design shall be based on the following loads and factors and be according to the current version of AASHTO LRFD Standard Specification for Highway Bridges.

1. Gravity loads due to soil pressures resulting from grades indicated.

2. Superimposed loads (surcharge) indicated on Drawings.

3. Horizontal Peak Ground Acceleration (A) for Project: 0.62g.

1.08 PRECONSTRUCTION TESTING:

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:

1. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D6706.

2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D5321.

1.09 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.10 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Prepare design, including calculations and drawings, under the direction of a Professional Engineer registered in State of Utah and having the following qualifications:

1. Not less than ten (10) years' experience in the design of precast modular block retaining wall systems.

2. Completed not less than five (5) successful segmental retaining wall systems for projects of equal type.

C. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects.

1. Build mockup of segmental retaining wall approximately 72 inches long by not less than 36 inches high above finished grade at front of wall.

a. Include typical soil reinforcement.

b. Include typical base and cap or finished top construction.

c. Include backfill to typical finished grades at both sides of wall.

d. Include typical end construction at one end of mockup.

e. Include 36-inch return at 1 end of mockup, with typical corner construction.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to segmental retaining walls including, but not limited to, the following:

a. Structural load limitations.

b. Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

F. Retaining Wall Installation Contractor Qualifications. In order to demonstrate basic competence in the construction of precast modular block walls, the Retaining Wall Installation Contractor shall document compliance with the following:

1. Experience.

a. Construction experience with a minimum of 30,000 square feet of the proposed precast modular block retaining wall system.

b. Construction of at least ten (10) precast modular block (large block) retaining wall structures within the past three (3) years.

c. Construction of at least 50,000 square feet of precast modular block (large block) retaining walls within the past three (3) years.

2. Retaining Wall Installation Contractor experience documentation for each qualifying project shall include:

a. Name and location

b. Date (month and year) of construction completion

c. Contact information of Owner or General Contractor

d. Type (trade name) of precast modular block system built

e. Maximum height of the wall constructed

f. Face area of the wall

3. In lieu of the requirements set forth in items 1 and 2 above, the Retaining Wall Installation Contractor must be a certified Precast Modular Block Retaining Wall Installation Contractor as demonstrated by satisfactory completion of a certified precast modular block retaining wall installation training program administered by the precast modular block manufacturer.

G. Retaining Wall Design Engineer Qualifications and Statement of Experience. The Retaining Wall Design Engineer shall submit a written statement affirming that he or she has the following minimum qualifications and experience.

1. The Retaining Wall Design Engineer shall be licensed to practice in the State of Utah.

2. The Retaining Wall Design Engineer shall be independently capable of performing all internal and external stability analyses, including those for seismic loading, compound stability, rapid draw-down and deep-seated, global modes of failure.

3. The Retaining Wall Design Engineer shall affirm in writing that he or she has personally supervised the design of the retaining walls for the project, that the design considers all the requirements listed above and that he or she accepts responsibility as the design engineer of record for the retaining walls constructed on the project.

4. The Retaining Wall Design Engineer shall affirm in writing that he or she has personally designed in excess of 100,000 face square feet of modular block earth retaining walls within the previous three (3) years.

5. In lieu of these specific requirements, the engineer may submit alternate documentation demonstrating competency in Precast Modular Block retaining wall design.

H. The Owner reserves the right to reject the design services of any engineer or engineering firm who, in the sole opinion of the Owner, does not possess the requisite experience or qualifications.

1.11 QUALITY CONTROL:

A. Comply with the requirements specified in Section 01 45 00.

B. The Engineer shall review all submittals for materials, design, Retaining Wall Design Engineer qualifications and the Retaining Wall Installation Contractor qualifications.

C. The General Contractor shall retain the services of an Inspection Engineer who is experienced with the construction of precast modular block retaining wall structures to perform inspection and testing. The cost of inspection shall be the responsibility of the General Contractor. Inspection shall be continuous throughout the construction of the retaining walls.

D. The Inspection Engineer shall perform the following duties:

1. Inspect the construction of the precast modular block structure for conformance with construction shop drawings and the requirements of this specification.

2. Verify that soil or aggregate fill placed and compacted in the reinforced, retained and foundation zones of the retaining wall conforms with requirements of this section and exhibits the shear strength parameters specified by the Retaining Wall Design Engineer.

3. Verify that the shear strength of the in-situ soil assumed by the Retaining Wall Design Engineer is appropriate.

4. Inspect and document soil compaction in accordance with these specifications:

    a. Required dry unit weight

    b. Actual dry unit weight

    c. Allowable moisture content

    d. Actual moisture content

    e. Pass/fail assessment

    f. Test location – wall station number

    g. Test elevation

    h. Distance of test location behind the wall face

5. Verify that all excavated slopes in the vicinity of the retaining wall are bench-cut as directed by the project Geotechnical Engineer.

6. Notify the Retaining Wall Installation Contractor of any deficiencies in the retaining wall construction and provide the Retaining Wall Installation Contractor a reasonable opportunity to correct the deficiency.

7. Notify the General Contractor, Owner and Retaining Wall Design Engineer of any construction deficiencies that have not been corrected timely.

8. Document all inspection results.

9. Test compacted density and moisture content of the retained backfill with the following frequency:

   a. At least once every 1,000 square feet (in plan) per 9-inch vertical lift, and

   b. At least once per every 18 inches of vertical wall construction.

E. The General Contractor's engagement of the Inspection Engineer does not relieve the Retaining Wall Installation Contractor of responsibility to construct the proposed retaining wall in accordance with the approved construction shop drawings and these specifications.

F. The Retaining Wall Installation Contractor shall inspect the on-site grades and excavations prior to construction and notify the Retaining Wall Design Engineer and General Contractor if on-site conditions differ from the elevations and grading conditions depicted in the retaining wall construction shop drawings.

1.12 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. The Retaining Wall Installation Contractor shall inspect the materials upon delivery to ensure that the proper type, grade and color of materials have been delivered.

C. The Retaining Wall Installation Contractor shall store and handle all materials in accordance with the manufacturer's recommendations as specified herein and in a manner that prevents deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, UV exposure or other causes. Damaged materials shall not be incorporated into the work.

D. Retaining wall units shall be stored in a location and manner that protects against excessive weathering and damage.

E. Contractor shall prevent PMB units from excessive soiling and coming in contact with substances which may stain or adhere to the finished visual surfaces of the unit.

F. Store geosynthetics in manufacturer's original packaging with labels intact and in accordance with ASTM D4873. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 degrees F or below 32 degrees F, and other conditions that might damage them. Verify identification of geosynthetics before using and examine them for defects as material is placed.

G. Precast Modular Blocks

1. Precast modular blocks shall be stored in an area with positive drainage away from the blocks. Be careful to protect the block from mud and excessive chipping and breakage. Precast modular blocks shall not be stacked more than three (3) units high in the storage area.

H. Drainage Aggregate and Backfill Stockpiles

1. Drainage aggregate or backfill material shall not be piled over unstable slopes or areas of the project site with buried utilities.

2. Drainage aggregate and/or reinforced fill material shall not be staged where it may become mixed with or contaminated by poor draining fine-grained soils such as clay or silt.

PART 2 - PRODUCTS

2.02 PRECAST MODULAR BLOCK (PMB) RETAINING WALL UNITS:

A. Concrete Units: All units shall be wet-cast precast modular retaining wall units conforming to ASTM C1776.

B. All units for the project shall be obtained from the same manufacturer. The manufacturer shall be licensed and authorized to produce the retaining wall units by the precast modular block system patent holder/licensor and shall document compliance with the published quality control standards of the proprietary precast modular block system licensor for the previous three (3) years or the total time the manufacturer has been licensed, whichever is less.

C. Concrete used in the production of the precast modular block units shall be first-purpose, fresh concrete. It shall not consist of returned, reconstituted, surplus or waste concrete. It shall be an original production mix meeting the requirements of ASTM C94 and exhibit the properties as shown in the following table:

Table 32 32 16-1
Concrete Mix Properties

Freeze Thaw Exposure Class[1]	Minimum 28-Day Compressive Strength[2]	Maximum Water Cement Ratio	Nominal Maximum Aggregate Size	Aggregate Class Designation[3]	Air Content[4]
Moderate	4,000 psi (27.6 MPa)	0.45	1 inch (25 mm)	3M	4.5% +/- 1.5%
Severe	4,000 psi (27.6 MPa)	0.45	1 inch (25 mm)	3S	6.0% +/- 1.5%
Very Severe	4,500 psi (30.0 MPa)	0.40	1 inch (25 mm)	4S	6.0% +/- 1.5%
Maximum Water-Soluble Chloride Ion (Cl^-) Content in Concrete, Percent by Weight of Cement[5,6]					0.15
Maximum Chloride as Cl^- Concentration in Mixing Water, Parts Per Million					1000
Maximum Percentage of Total Cementitious Materials By Weight [7,9] (Very Severe Exposure Class Only):					
Fly Ash or Other Pozzolans Conforming to ASTM C618					25
Slag Conforming to ASTM C989					50
Silica Fume Conforming to ASTM C1240					10
Total of Fly Ash or Other Pozzolans, Slag, and Silica Fume[8]					50
Total of Fly Ash or Other Pozzolans and Silica Fume[8]					35
Alkali-Aggregate Reactivity Mitigation per ACI 201					
Slump (Conventional Concrete) per ASTM C143[10]				5 inches +/- 1½ inches (125 mm +/- 40 mm)	
Slump Flow (Self-Consolidating Concrete) per ASTM C1611				18 inches – 32 inches (450 mm – 800 mm)	

NOTES:

(1) Exposure class is as described in ACI 318. "Moderate" describes concrete that is exposed to freezing and thawing cycles and occasional exposure to moisture. "Severe" describes concrete that is exposed to freezing and thawing cycles and in continuous contact with moisture. "Very Severe" describes concrete that is exposed to freezing and thawing cycles and in continuous contact with moisture and exposed to deicing chemicals. Exposure class should be specified by owner/purchaser prior to order placement.
(2) Test method ASTM C39.
(3) Defined in ASTM C33 Table 3 *Limits for Deleterious Substances and Physical Property Requirements of Coarse Aggregates for Concrete*.
(4) Test method ASTM C231.
(5) Test method ASTM C1218 at age between 28 and 42 days.
(6) Where used in high sulfate environments or where alkali-silica reactivity is an issue, water soluble chloride shall be limited to no more than trace amounts (from impurities in concrete-making components, not intended constituents.)
(7) The total cementitious material also includes ASTM C150, C595, C845, C1157 cement. The maximum percentages shall include:
- (a) Fly ash or other pozzolans in type IP, blended cement, ASTM C595, or ASTM C1157.
- (b) Slag used in the manufacture of an IS blended cement, ASTM C595, or ASTM C1157.
- (c) Silica fume, ASTM C1240, present in a blended cement.

(8) Fly ash or other pozzolans and silica fume shall constitute no more than 25 and 10 percent, respectively, of the total weight of the cementitious materials.
(9) Prescriptive limits shown may be waived for concrete mixes that demonstrate excellent freeze/thaw durability in a detailed and current testing program.
(10) Slump may be increased by a high-range water-reducing admixture.

D. Each concrete block shall be cast in a single continuous pour without cold joints.

E. Depth of units should be as per the Construction Drawings and shall range from 24 inches to 84-inches.

F. Individual block units shall have a nominal height of between 16 to 18 inches.

G. Exterior dimensions of the face shall be 46-inch to 48-inch for full units.

H. Units shall maintain tolerances of +/- 3/16-inch of height and +/- 1/2-inch of width.

I. Special shape units should be obtained and used where indicated on the final engineered construction drawings.

J. PMB unit face texture shall be ReCon Limestone, ReCon Granite, RediRock Limestone, or RediRock Kingston.

1. Manufacturers:

a. Redi-Rock Retaining Wall Systems

b. ReCon Wall Systems, Inc.

2.03 GEOGRID REINFORCEMENT:

A. Geosynthetic reinforcement shall be high tensile geogrid or geotextile manufactured specifically for soil reinforcement applications.

1. Construction Drawings shall indicate the type, strength, location and lengths of reinforcement used.

2. The geosynthetic manufacturer shall provide all relevant testing to the wall design engineer for incorporation in the wall design and shall be included in the submittal for the Construction Drawings.

3. No substitutions of geosynthetic shall be allowed that was not evaluated in the Construction Drawings.

B. Constructability Requirements. Geogrid design embedment length shall be measured from the back of the precast modular block facing unit and shall be consistent for the entire height of a given retaining wall section.

C. Geogrid shall be positively connected to every precast modular block unit. Design coverage ratio, Rc, as calculated in accordance with AASHTO LRFD Bridge Design Specifications Figure 11.10.6.4.1-2 shall not exceed 0.50.

D. Preapproved Geogrid Reinforcement Products.

1. Miragrid XT Geogrids as manufactured by TenCate Geosynthetics.

2.04 GEOTEXTILE:

A. Nonwoven geotextile fabric shall be placed as indicated on the retaining wall construction shop drawings. Additionally, the nonwoven geotextile fabric shall be placed in the v-shaped joint between adjacent block units on the same course. The nonwoven geotextile fabric shall meet the requirements Class 3 construction survivability in accordance with AASHTO M 288.

B. Preapproved Nonwoven Geotextile Products:

1. Mirafi 140N

2. Propex Geotex 451

3. Skaps GT-142

4. Thrace-Linq 140EX

5. Carthage Mills FX-40HS

6. Stratatex ST 142

2.05 DRAINAGE AGGREGATE AND WALL INFILL:

A. Drainage aggregate (and wall infill for retaining walls designed as modular gravity structures) shall be a durable crushed stone conforming to No. 57 size per ASTM C33 with the following particle-size distribution requirements per ASTM D422:

U.S. Standard Sieve Size	Passing
1 – 1-1/2 inches	100
1 inch	95-100
1/2 inch	25-60
No. 4	0-10
No. 8	0-2

2.06 REINFORCED FILL:

A. Material used as reinforced backfill material in the reinforced zone (if applicable) shall be a granular fill material meeting the requirements of USCS soil type GW, GP, SW or SP per ASTM D2487 or alternatively by AASHTO Group Classification A-1-a or A-3 per AASHTO M 145. The backfill shall exhibit a minimum effective internal angle of friction, ϕ = 34 degrees at a maximum 2 percent shear strain and meet the following particle-size distribution requirements per ASTM D422.

U.S. Standard Sieve Size	Passing
3/4 inch	100
No. 4	0-100
No. 40	0-60
No. 200	0-15

B. The reinforced backfill material shall be free of sod, peat, roots or other organic or deleterious matter including, but not limited to, ice, snow or frozen soils. Materials passing the No. 40 sieve shall have a liquid limit less than 25 and plasticity index less than 6 per ASTM D4318. Organic content in the backfill material shall be less than 1 percent per AASHTO T-267 and the pH of the backfill material shall be between 5 and 8.

C. Soundness. The reinforced backfill material shall exhibit a magnesium sulfate soundness loss of less than 30 percent after four (4) cycles, or sodium sulfate soundness loss of less than 15 percent after five (5) cycles as measured in accordance with AASHTO T-104.

D. Reinforced backfill shall not be comprised of crushed or recycled concrete, recycled asphalt, bottom ash, shale or any other material that may degrade, creep or experience a loss in shear strength or a change in pH over time.

2.07 LEVELING PAD:

A. The precast modular block units shall be placed on a leveling pad constructed from crushed stone or unreinforced concrete. The leveling pad shall be constructed to the dimensions and limits shown on the retaining wall design drawings prepared by the Retaining Wall Design Engineer.

B. Crushed stone used for construction of a granular leveling pad shall meet the requirements of the drainage aggregate and wall infill in Paragraph 2.04 or a preapproved alternate material.

C. Concrete used for construction of an unreinforced concrete leveling pad shall satisfy the criteria for AASHTO Class B. The concrete should be cured a minimum of 12 hours prior to placement of the precast modular block wall retaining units and exhibit a minimum 28-day compressive strength of 2,500 psi.

2.08 DRAINAGE:

A. Drainage Pipe:

1. Drainage collection pipe shall be a 4 inch diameter, 3-hole perforated, HDPE pipe with a minimum pipe stiffness of 22 psi per ASTM D2412.

2. The drainage pipe shall be manufactured in accordance with ASTM D1248 for HDPE pipe and fittings.

B. Preapproved Drainage Pipe Products:

1. ADS 3000 Triple Wall pipe as manufactured by Advanced Drainage Systems.

2.09 UNIT ADHESIVES:

A. Adhesive shall be a premium, construction grade suitable for concrete and exterior applications.

2.10 FINISHES:

A. Retaining wall color shall be left in natural (as-cast) concrete color.

PART 3 - EXECUTION

3.01 GENERAL:

A. All work shall be performed in accordance with OSHA safety standards, state and local building codes and manufacturer’s requirements.

B. The General Contractor is responsible for the location and protection of all existing underground utilities. Any new utilities proposed for installation in the vicinity of the retaining wall, shall be installed concurrent with retaining wall construction. The General Contractor shall coordinate the work of subcontractors affected by this requirement.

C. New utilities installed below the retaining wall shall be backfilled and compacted to a minimum of 98% maximum dry density per ASTM D698 standard proctor.

D. The General Contractor is responsible to ensure that safe excavations and embankments are maintained throughout the course of the project.

E. All work shall be inspected by the Inspection Engineer as directed by the Owner.

F. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

3.02 EXAMINATION:

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting short-term and long-term performance of segmental retaining walls.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION:

A. Fill Soil:

1. The Inspection Engineer shall verify that reinforced backfill placed in the reinforced soil zone satisfies the criteria of this section.

2. The Inspection Engineer shall verify that any fill soil installed in the foundation and retained soil zones of the retaining wall satisfies the specification of the Retaining Wall Design Engineer as shown on the Contract Drawings.

B. Excavation:

1. The Grading Contractor shall excavate to the lines and grades required for construction of the precast modular block retaining wall as shown on the construction drawings. The Grading Contractor shall minimize over-excavation. Excavation support, if required, shall be the responsibility of the Grading Contractor.

2. Over-excavated soil shall be replaced with compacted fill in conformance with the specifications of the Retaining Wall Design Engineer.

3. Embankment excavations shall be bench cut as directed by the project Geotechnical Engineer and inspected by the Inspection Engineer for compliance.

C. Foundation Preparation:

1. Prior to construction of the precast modular block retaining wall, the leveling pad area and undercut zone (if applicable) shall be cleared and grubbed. All topsoil, brush, frozen soil and organic material shall be removed. Additional foundation soils found to be unsatisfactory beyond the specified undercut limits shall be undercut and replaced with approved fill as directed by the project Geotechnical Engineer. The Inspection Engineer shall ensure that the undercut limits are consistent with the requirements of the project Geotechnical Engineer and that all soil fill material is properly compacted according project specifications. The Inspection Engineer shall document the volume of undercut and replacement.

2. Following excavation for the leveling pad and undercut zone (if applicable), the Inspection Engineer shall evaluate the in-situ soil in the foundation and retained soil zones.

a. The Inspection Engineer shall verify that the shear strength of the in-situ soil assumed by the Retaining Wall Design Engineer is appropriate. The Inspection Engineer shall immediately stop work and notify the Owner if the in-situ shear strength is found to be inconsistent with the retaining wall design assumptions.

b. The Inspection Engineer shall verify that the foundation soil exhibits sufficient ultimate bearing capacity to satisfy the requirements indicated on the retaining wall construction shop drawings.

D. Leveling Pad:

1. The leveling pad shall be constructed to provide a level, hard surface on which to place the first course of precast modular block units. The leveling pad shall be placed in the dimensions shown on the retaining wall construction drawings and extend to the limits indicated.

2. Crushed Stone Leveling Pad. Crushed stone shall be placed in uniform maximum lifts of 6-inches. The crushed stone shall be compacted by a minimum of 3 passes of a vibratory compactor capable of exerting 2,000 pounds of centrifugal force and to the satisfaction of the Inspection Engineer.

3. Unreinforced Concrete Leveling Pad. The concrete shall be placed in the same dimensions as those required for the crushed stone leveling pad. The Retaining Wall Installation Contractor shall erect proper forms as required to ensure the accurate placement of the concrete leveling pad according to the retaining wall construction drawings.

3.04 PRECAST MODULAR BLOCK WALL SYSTEM INSTALLATION:

A. The precast modular block structure shall be constructed in accordance with the construction drawings, these specifications and the recommendations of the retaining wall system component manufacturers. Where conflicts exist between the manufacturer's recommendations and these specifications, these specifications shall prevail.

B. Drainage components. Pipe, geotextile and drainage aggregate shall be installed as shown on the construction shop drawings.

C. Precast Modular Block Installation:

1. The first course of block units shall be placed with the front face edges tightly abutted together on the prepared leveling pad at the locations and elevations shown on the construction drawings. The Retaining Wall Installation Contractor shall take special care to ensure that the bottom course of block units are in full contact with the leveling pad, are set level and true and are properly aligned according to the locations shown on the construction drawings.

2. Backfill shall be placed in front of the bottom course of blocks prior to placement of subsequent block courses. Nonwoven geotextile fabric shall be placed in the V-shaped joints between adjacent blocks. Drainage aggregate shall be placed in the V-shaped joints between adjacent blocks to a minimum distance of 12 inches behind the block unit.

3. Drainage aggregate shall be placed in 9 inch maximum lifts and compacted by a minimum of three (3) passes of a vibratory plate compactor capable exerting a minimum of 2,000 pounds of centrifugal force.

4. Unit core fill shall be placed in the precast modular block unit vertical core slot. The core fill shall completely fill the slot to the level of the top of the block unit. The top of the block unit shall be broom-cleaned prior to placement of subsequent block courses. No additional courses of precast modular blocks may be stacked before the unit core fill is installed in the blocks on the course below.

5. Base course blocks for gravity wall designs (without geosynthetic soil reinforcement) may be furnished without vertical core slots. If so, disregard item 4 above, for the base course blocks in this application.

6. Nonwoven geotextile fabric shall be placed between the drainage aggregate and the retained soil (gravity wall design) or between the drainage aggregate and the reinforced fill (reinforced wall design) as required on the retaining wall construction drawings.

7. Subsequent courses of block units shall be installed with a running bond (half block horizontal course-to-course offset). With the exception of 90 degree corner units, the shear channel of the upper block shall be fully engaged with the shear knobs of the block course below. The upper block course shall be pushed forward to fully engage the interface shear key between the blocks and to ensure consistent face batter and wall alignment. Geogrid, drainage aggregate, unit core fill, geotextile and properly compacted backfill shall be complete and in-place for each course of block units before the next course of blocks is stacked.

8. The elevation of retained soil fill shall not be less than 1 block course below the elevation of the reinforced backfill throughout the construction of the retaining wall.

9. If included as part of the precast modular block wall design, cap units shall be secured with an adhesive in accordance with the precast modular block manufacturer's recommendation.

D. Geogrid Reinforcement Installation (if required):

1. Geogrid reinforcement shall be installed at the locations and elevations shown on the construction drawings on level fill compacted to the requirements of this specification.

2. Continuous 12 inches wide strips of geogrid reinforcement shall be passed completely through the vertical core slot of the precast modular block unit and extended to the embedment length shown on the construction plans. The strips shall be staked or anchored as necessary to maintain a taut condition.

3. Reinforcement length (L) of the geogrid reinforcement is measured from the back of the precast modular block unit. The cut length (Lc) is two times the reinforcement length plus additional length through the block facing unit. The cut length is calculated as follows:

   Lc = 2*L + 3 ft (2*L + 0.9 m) (28" (710 mm) block unit)

   Lc = 2*L + 5 ft (2*L + 1.5 m) (41" (1030 mm) block unit)

4. The geogrid strip shall be continuous throughout its entire length and may not be spliced. The geogrid shall be furnished in nominal, prefabricated roll widths of 12 inches, plus or minus 1/2 inch. No field modification of the geogrid roll width shall be permitted.

5. Neither rubber tire nor track vehicles may operate directly on the geogrid. Construction vehicle traffic in the reinforced zone shall be limited to speeds of less than 5 mph once a minimum of 9 inches of compacted fill has been placed over the geogrid reinforcement. Sudden braking and turning of construction vehicles in the reinforced zone shall be avoided.

E. Construction Tolerance. Allowable construction tolerance of the retaining wall shall be as follows:

1. Deviation from the design batter and horizontal alignment, when measured along a 10-feet straight wall section, shall not exceed 3/4 inches.

2. Deviation from the overall design batter shall not exceed 1/2 inch per 10-feet of wall height.

3. The maximum allowable offset (horizontal bulge) of the face in any precast modular block joint shall be 1/2 inch.

4. The base of the precast modular block wall excavation shall be within 2 inches of the staked elevations, unless otherwise approved by the Inspection Engineer.

5. Differential vertical settlement of the face shall not exceed 1-foot along any 200-feet of wall length.

6. The maximum allowable vertical displacement of the face in any precast modular block joint shall be 1/2 inch.

7. The wall face shall be placed within 2 inches of the horizontal location staked.

3.05 WALL INFILL AND REINFORCED BACKFILL PLACEMENT:

A. Backfill material placed immediately behind the drainage aggregate shall be compacted as follows:

1. 98 percent of maximum dry density at plus or minus 2 percent optimum moisture content per ASTM D698 standard proctor or 85 percent relative density per ASTM D4254.

B. Compactive effort within 3-feet of the back of the precast modular blocks should be accomplished with walk-behind compactors. Compaction in this zone shall be within 95 percent of maximum dry density as measured in accordance with ASTM D698 standard proctor or 80 percent relative density per ASTM D 4254. Heavy equipment should not be operated within 3-feet of the back of the precast modular blocks.

C. Backfill material shall be installed in lifts that do not exceed a compacted thickness of 9-inches.

D. At the end of each work day, the Retaining Wall Installation Contractor shall grade the surface of the last lift of the granular wall infill to a 3 percent, plus or minus 1 percent slope away from the precast modular block wall face and compact it.

E. The General Contractor shall direct the Grading Contractor to protect the precast modular block wall structure against surface water runoff at all times through the use of berms, diversion ditches, silt fence, temporary drains and/or any other necessary measures to prevent soil staining of the wall face, scour of the retaining wall foundation or erosion of the reinforced backfill or wall infill.

3.06 OBSTRUCTIONS IN THE INFILL AND REINFORCED FILL ZONE:

A. The Retaining Wall Installation Contractor shall make all required allowances for obstructions behind and through the wall face in accordance with the approved construction shop drawings.

B. Should unplanned obstructions become apparent for which the approved construction shop drawings do not account, the affected portion of the wall shall not be constructed until the Retaining Wall Design Engineer can appropriately address the required procedures for construction of the wall section in question.

3.07 COMPLETION:

A. For walls supporting unpaved areas, a minimum of 12-inch of compacted, low-permeability fill shall be placed over the granular wall infill zone of the precast modular block retaining wall structure. The adjacent retained soil shall be graded to prevent ponding of water behind the completed retaining wall.

B. For retaining walls with crest slopes of 5H:1V or steeper, silt fence shall be installed along the wall crest immediately following construction. The silt fence shall be located 3-feet to 4-feet behind the uppermost precast modular block unit. The crest slope above the wall shall be immediately seeded to establish vegetation. The General Contractor shall ensure that the seeded slope receives adequate irrigation and erosion protection to support germination and growth.

C. The General Contractor shall confirm that the as-built precast modular block wall geometries conform to the requirements of this section. The General Contractor shall notify the Owner of any deviations.

3.08 CONSTRUCTION TOLERANCES:

A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet, 3 inches maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet.

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet.

3.09 FIELD QUALITY CONTROL:

A. Comply with requirements in Section 31 22 00 for field quality control.

1. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 100 feet or less of segmental retaining wall length.

2. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 24 inches of fill depth and each 50 feet or less of segmental retaining wall length.

3.10 ADJUSTING:

A. Remove and replace retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Engineer approves methods and results.

2. Segmental retaining walls that do not match approved Samples and mockups.

3. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

3.11 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 32 90 10

PLANTING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide for establishment of permanent vegetation.

B. Provide topsoiling, fertilizing, seeding, sodding, planting and related work as indicated and specified to reestablish grass within the golf course fairways and tee boxes.

C. Repairing existing areas damaged by Work.

1.02 REFERENCES:

A. Comply with American National Standards Institute (ANSI) Z60.1-2004 American Standard for Nursery Stock.

B. ASTM International (ASTM):

1. D5268: Standard Specification for Topsoil Used for Landscaping Purposes.

2. D5435: Standard Test Method for Plant Growth and Food Chain Protection.

1.03 SUBMITTALS:

A. Product Data:

1. List indicating source of sod material to be provided, at least 4 weeks prior to installation. Include list naming seeds, coverage, and supplier's name, address and phone number.

2. Product Data, rates of application, and anticipated uses of pesticides, herbicides, fertilizers and fumigants.

3. Certificates concerning seed mixture, purity, germinating value, and crop year identification.

4. Maintenance and installation instructions, including top soil preparation, watering intervals, and maintenance instructions.

5. Planting plan.

B. Certify invoice or order plants for each shipment free of disease, mold, and insect pests. Submit certificates to Engineer.

C. Miscellaneous:

1. Prior to end of maintenance period, furnish 2 copies of typed maintenance instructions recommending procedures to be established by Owner for maintenance of landscape Work for one year.

2. Inspection certificates required by federal, state or other governing agency shall accompany each shipment.

3. Shop drawings showing locations and depths of agronomic soil samples collected.

D. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE:

A. Planting Plan

1. Contractor shall develop and submit a planting plan which includes areas which sod installation will take place, proposed thickness of topsoil under sod, time of year of installation, maintenance requirements, installation methods and growing requirements.

2. Plan shall clearly show limits of sod installation including all disturbed fairways, and tee boxes.

B. Inspection:

1. Engineer may inspect sod material at nursery/farm. Such inspection shall be in addition to inspection at Site.

2. Upon delivery and before planting, Engineer will inspect sod. Sod must not be dried out and must be free of mold, fungus, and other pests.

3. Inspection and approval is for quality, size, and variety only, and in no way impairs right of rejection for failure to meet other requirements during progress of Work.

4. Contractor shall be present during required inspections or as may be required by Engineer.

C. Source Quality Control:

1. Certification: Landscape materials shall be from stock inspected and certified by authorized governmental agencies. Material shall comply with governmental regulations prevailing at supply source and project. Investigate sources of supply and make assurances that plants will be supplied as indicated in the Planting Plan in sizes, variety and quality noted and specified before submitting bid. Substitution of species must be approved in writing prior to bidding. Ensure that materials can be procured depending on the time of year. Failure to take this precaution will not

relieve responsibility for furnishing and installing plant material in accordance with Contract requirements and without additional expense to Owner.

2. Plant material shall comply with State of Utah and federal laws with respect to inspection for plant diseases and insect infestation.

3. Contractor will furnish two copies of written maintenance, instructions for maintenance and care of installed plants and lawn areas.

4. Notify Engineer at least 48 hours in advance of all planned planting operations and identify specific material and its location. Plant material must not be dried out and must free of mold, fungus, or other pests.

5. Furnish suitable quantities of water, hose and appurtenances.

6. Provide topsoil that complies with ASTM 5268 – Standard Specification for Topsoil Used for Landscaping Purposes.

7. Begin maintenance immediately after planting.

8. Repair or replace sodded areas, which in judgment of Engineer, have not survived and grown in a satisfactory manner, for a period of 1 year after date of acceptance.

9. Provide as specified seedings or plantings replacements of the same type and size as specified.

1.05 DELIVERY STORAGE AND HANDLING:

A. Delivery:

1. Schedule shipping to minimize on-site storage of materials.

2. Plant Material: Take precautions in accordance with best trade practices to ensure arrival of plant material at Site in good condition and without injury. Cover plants to prevent freezing, drying, transit injury, or other exposure that may be harmful. During shipment, plants shall not be bent, stacked, or bound in manner that damages bark, breaks branches, deforms root balls, or destroys natural shape.

3. Fertilizer: Deliver fertilizer to site in original, unopened containers bearing weight, manufacturer's guaranteed chemical analysis, name, trade name, trademark, and conformance to state law.

4. Notify Engineer 48 hrs before delivery of plant material.

5. Each shipment shall be accompanied by invoice showing sizes and varieties included.

a. Provide copy of invoice to Engineer upon delivery of plant material.

6. Deliver topsoil in an unfrozen and non-muddy condition

1.06 PROJECT/SITE CONDITIONS:

A. Inspection:

1. Prior to beginning Work, Contractor shall examine and verify acceptability of Site for conditions under which Work will be performed. Do not proceed with Work until unsatisfactory conditions have been corrected.

2. Starting Work constitutes acceptance of conditions under which Work is to be performed. After such acceptances, Contractor shall be responsible for correcting unsatisfactory and defective Work resulting from such unsatisfactory conditions.

3. Remove invasive species, if applicable, in accordance with scope of work, water permits, and/or wetland/stream restoration plans

B. Utilities:

1. On-site sources of water will be provided by Owner.

C. Plant when weather and soil conditions are suitable in accordance with industry practices.

D. Protection:

1. Replace, repair, re-stake or replant lawn or plantings which are damaged.

2. If planting after lawn installation, protect lawn areas, and repair damage resulting from planting operations.

3. Where planting occurs in close proximity to other site improvements, protect features prior to commencing Work. Any items damaged due to planting operations shall be repaired to their original condition.

1.07 WARRANTY:

A. During 1 year correction period, replace sod which has died, or are in dying condition, or which has failed to flourish so its usefulness or appearance has been impaired.

1. Replacement and Damages:

a. Decisions of Engineer and Owner for required replacements are final and binding upon Contractor.

b. Contractor is responsible for repairing damage to property caused by defective workmanship and materials.

2. Exclusions:

a. Contractor is not liable for replacement cost of plants damaged by deicing compounds, fertilizers, pesticides or other materials not specified in Contract Documents or not applied by Contractor, by relocating or removal by others, by acts of God, or by vandalism, and losses due to curtailment of water by local authorities.

3. Inspection of Maintenance:

a. During correction period, Contractor shall, once per month**,** inspect watering, cultivation, and other maintenance operations by Owner, and notify Owner of methods, practices or operations considered unsatisfactory and not in accordance with good horticultural practices.

b. Failure of Contractor to inspect or report shall be construed as acceptance of Owner's maintenance operations, and Contractor shall not claim or assert defects which may later develop are result of such methods or practices or operations.

c. Owner will notify Contractor when maintenance is to be performed so Contractor may observe maintenance procedures.

PART 2 - PRODUCTS

2.01 PLANTS:

A. General:

1. Provide plants in accordance with ANSI Standard for Nursery Stock, Designation Z60.1-2004.

2. Plant material shall be nursery grown unless otherwise specified or approved in writing by Engineer. Plants shall have been grown within same hardiness zone as Project site or acclimated to conditions of same hardiness zone for minimum of 2 growing seasons. Hardiness zones shall conform to "Zones of Plant Hardiness" as provided by U.S. Department of Agriculture.

3. Unless specifically noted otherwise, plants shall be of selected specimen quality; have normal habit of growth; and be sound, healthy, vigorous plants with well developed root systems. Plants shall be free of disease, insect pests, their eggs or larvae, and injuries.

2.02 SOD:

A. Established, nursery grown Kentucky Bluegrass sod, vigorous, well rooted, healthy turf, free from disease, insect pests, weeds, other grasses, stones, and any other harmful or deleterious matter.

B. Sod harvested by machine at uniform soil thickness of approximately 1 inch but not less than 3/4-inch. Measurement for thickness excludes top growth and thatch. Prevent tearing, breaking, drying or any other damage.

C. Sod shall be provided in large rolls to eliminate dead edges versus smaller pallet sod.

D. Products:

1. Barefoot Blue Sod, by Raft River Sod.

E. Installers:

1. Wagner Golf Works (435-503-5763)

2. Eagle Golf (810-240-7961)

3. GPS As-Built (801-557-9021)

2.03 PLANTING MATERIALS

A. Topsoil:

1. Obtained from natural well drained areas, and be fertile, friable soil, clean of undesirable materials such as plants, weeds, roots, stalks, stones, and other debris.

2. Existing topsoil may be used if Engineer determines soil is suitable and of sufficient quantity. Topsoil must meet ASTM standard 5268 Standard Specification for Topsoil Used for Landscaping Purposes.

3. Acidity range of pH 5.0 and pH 7.0 and shall contain no less than 4 percent organic matter as determined by loss on ignition of moisture free samples dried at 212 degrees F.

B. Water

1. Obtain from golf course existing system.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Do not install plantings where depth of soil over underground construction, obstructions or rock is insufficient to accommodate roots or where pockets in rock or impervious soil require drainage.

1. Where such conditions are encountered in excavation planting areas and where stone, boulders or other obstruction cannot be broken or removed by hand methods and where trees to be planted are under overhead wires, alternate locations for planting may be designated by Engineer.

2. Dispose of excavated material not suitable for backfilling off-site.

3. If drainage problems are encountered detrimental to growth of specified plant material, notify Engineer of conditions before proceeding with Work.

3.02 INSTALLATION:

Topsoil/Finish Grading:

1. Do not place or work topsoil in frozen or muddy condition.

2. Finish grade is established final grade. Grades not otherwise indicated are uniform levels or slopes between points where elevations given or between such points and existing finished grades.

3. Where Drawings show existing grades of landscaped areas are not to be changed or if new grade is less than 4 inches above existing grades, remove enough material to allow placement of 4 inches new topsoil, unless existing topsoil to required depth is undisturbed and of equal or better quality than topsoil specified. In latter case, existing topsoil may be left in-place, using enough new topsoil to bring these areas up to grade.

B. Preparation:

1. Planting Season: Conform to planting seasons.

2. Preparation of Planting Areas: Cover surrounding turf (if existing) to protect turfed areas that are to be trucked or hauled over and upon which soil is to be temporarily stocked.

3. Stake or paint locations of plants and outlines of bed. Engineer will approve locations before excavation starts. Make adjustments in locations and outlines as required. If pits or areas for planting are prepared and backfilled with topsoil to grade prior to commencement of lawn operations, mark so they can be readily located when planting proceeds.

3.03 CLEAN UP AND PROTECTION

A. Remove excess and waste material daily.

B. Remove soil or similar material brought onto paved areas, keeping areas broom clean.

C. Upon completion of planting, remove excess soil, stones, and debris and dispose of off-site.

D. Damage to existing landscape, pavements, or other site features as result of Work shall be repaired to its original condition.

E. Protect landscape Work and materials from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods.

3.04 MAINTENANCE:

A. Temporary Maintenance:

1. Maintain sod material until substantial completion as defined in Paragraph 3.06. Acceptance of this specification.

2. Temporary maintenance begins immediately after each plant is installed and shall include watering, necessary cultivation, weeding, pruning, disease and insect pest control, protective spraying, resetting of plants to proper grades or upright position, restoration of damaged planting saucers, and other procedures consistent with good horticultural practice necessary to ensure normal, vigorous, and healthy growth of plantings.

3. Remove and replace dead and unacceptable plants as their condition becomes apparent.

4. Upon substantial completion, Owner assumes responsibility for sod maintenance.

3.05 REPLACEMENTS:

A. Replace sod which have died prior to substantial completion.

B. Procedure:

1. Dispose of removed sod off-site.

2. Replacements shall be supplied and installed in accordance with Specifications.

3. Restore areas damaged by replacement operations to original condition.

4. Notify Engineer at conclusion of replacement program.

5. Engineer will conduct inspection of replacements for determining final acceptance.

3.06 ACCEPTANCE:

A. Preliminary Planting Acceptance:

1. Notify Engineer at conclusion of planting operations so Engineer can determine substantial completion by field inspection.

2. Substantial completion requires:

a. Sod material conforms to Contract Documents with respect to quantity, quality, size, species, and location, except those items accepted or revised in field by Engineer.

b. Plant material shall be in healthy condition as defined under warranty.

B. Final Planting Acceptance:

1. Final planting acceptance shall be granted after completion of replacement operations required to fulfill guarantee.

2. On or about expiration of 1 yr correction period, follow-up inspection will be made to determine replacements required to be made by Contractor in accordance with provisions of these Specifications. Engineer will document findings in field report, and forward copies to Owner and Contractor. Items identified for replacement will be tagged during inspection with plastic flagging.

3. Upon completion of replacement program, Engineer will inspect to determine acceptability of required replacements. If acceptable, Engineer shall notify Contractor and Owner, in writing, of final acceptance of Work.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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DIVISION 33

UTILITIES

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SECTION 33 01 12

PRE- AND POST-CONSTRUCTION INSPECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide pre- and post-construction inspections on structures, buildings, utilities, roadways, and other facilities as indicated and in compliance with Contract Documents.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit qualifications and experience of proposed Claims Specialist conforming to the requirements of Article 3.01.F of this Section for Owner's approval within 30 days of Notice to Proceed.

C. Submit qualifications and experience of proposed qualified specialist to perform pre and post-construction inspections conforming to the requirements of Article 3.01 of this Section for Owner's approval within 30 days of Notice to Proceed.

D. Pre-construction and post-construction inspection reports as described in Part 3.01 of this Section.

E. All pre-construction inspection reports shall be submitted to Engineer at least 30 days prior to commencement of excavation.

1.03 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.05 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 INSPECTIONS:

A. Prior to the start of construction, Contractor shall conduct pre-construction inspections. These inspections shall be done initially, and later repeated as follows:

1. Open-cut:

a. Perform pre-construction inspection for all structures, buildings, and other observable facilities located above open cut centerline.

2. Pre-construction inspections shall be undertaken by qualified specialists having at least five years of documented experience. The specialists must also be approved by the Owner's and Contractor's insurance carrier. The pre-construction inspections shall thoroughly document all existing damage or defects to both the interior and exterior of all structures, buildings, houses or facilities. The interior conditions of all portions of all structures, including all walls, partitions, floors and ceilings shall be thoroughly documented by diagrams, transcribed notes, digital video, and photographs to show the location and extent of existing damage, deterioration, and cracks, including their dimensions, extent, and other relevant features.

3. A minimum of 10 interior and 30 exterior photographs shall be taken for each structure or facility. Close-up, detailed color photographs shall be taken of all cracks, deterioration and other observable defects in the exterior or interior portions of all buildings and other property improvements including, but not limited to, retaining walls, driveways and sidewalks. All color photographic prints shall be sized at least 4 inches by 6 inches and printed on Kodak or Fuji Film Paper in glossy format. If necessary, macro lenses and flash illumination shall be used to ensure cracks and other defects are shown clearly in the photographs. Photos shall contain a scale reference and an accurate date stamp.

4. In addition to type-written reports with photographs, inspections shall also include a walk-through digital video with audio commentary for each inspected structure or improvement within the specified inspection boundaries. Audio comments shall include name(s) of inspection staff, property type, name of Owner, date and time of inspection, and comments about the condition of the observed structure. Video-audio recordings shall be made and submitted electronically with the digital report.

5. Contractor shall prepare and deliver to the Owner and Engineer prior to the start of construction at each site, three bound copies of each of the pre-construction inspections containing all field notes taken, sketches and diagrams prepared, color prints of all photographs obtained, electronic files, descriptions and reports, all signed and witnessed by those taking part in the inspection. The Owner will, upon

request, present one of these copies to the property owner or responsible party for each property or utility affected.

6. Document the locations of existing cracks in all existing structures. Install crack monitors where crack width exceeds 1/16-inch. A minimum of three (3) photographs shall be taken of each crack monitor installation.

7. As construction progresses, Contractor shall re-inspect as often as necessary in the opinion of Engineer or Owner to verify the adequacy of Contractor's construction methods for prevention of damage and to obtain sufficient evidence for use in defense against possible claims for damage from third parties.

8. Contractor shall also re-inspect all homes where homeowners claim that damage is occurring as a result of Contractor's construction operations.

9. Three copies of all data and all electronic files obtained by Contractor, from each re-inspection outlined above shall be delivered to Owner within three (3) days of the inspection. The Owner will, upon request, present one of the submitted copies to the property owner or responsible party for each property or utility affected.

B. Upon completion of all excavation work, the Contractor shall make a similar examination of properties and structures where complaints of damage have been received or damage claims have been filed. Give notice to interested parties so that they may be present during the final examinations. Records of the final examination shall be signed and distributed as the original pre-construction inspection report.

C. Any damage noted after completion of construction operations which cannot be determined from the pre-construction inspection to be a pre-existing condition (PEC) shall be presumed to have been caused by construction operations. Such damage shall be repaired promptly and completely to the property Owner's satisfaction to restore the condition of the property to that existing prior to construction.

D. Maintain pre- and post-construction inspection records for a period of not less than 3 years following final completion and acceptance of the Work. In the event of damage claims, a report shall be prepared by the Contractor on the particular structures as requested by the Engineer from those notes and photographs and submitted to the Owner.

E. Nothing contained herein shall relieve Contractor of responsibility for claims arising from his construction operations whether within or outside of the limits of the required inspection. Failure to inspect any structure, whether or not required by these Contract Documents or inadequacy of the inspections, shall not relieve Contractor of its responsibility. Contractor shall indemnify the Owner and Engineer from such claims.

F. Contractor shall engage the services of an independent Claims Specialist, being a licensed engineer and having appropriate claims experience, to evaluate any claims that may arise as a result of construction activities.

G. The Claims Specialist shall prepare a written response to the claimant within two weeks of the date of the complaint. The response letter or report shall include all supporting data that were used to evaluate the claim. Copies of all correspondence with the claimant shall be submitted to the Owner and Engineer upon responding.

H. In the event any property owner denies access for the inspection of structures and facilities within the specified limits, Contractor shall notify such property owner, by certified mail, on the intent of the inspection. If after two weeks, access is still denied, Contractor shall notify the property owner once again by certified mail, stating this is their final notification. Contractor shall submit to the Owner copies of all correspondence between Contractor and the property owner(s). The Owner, upon review of the submitted correspondence, may waive requirements set forth in Paragraph A above. However, Contractor is fully responsible for claims and damage arising from its construction operation regardless of property location and the ability to conduct Pre-Construction Inspections.

I. Engineer or the Owner may reject the Claims Specialist if there is reason to believe material ownership interests exist between the Claims Specialist and Contractor and/or the vibration specialist, and/or there exists relationships other than Contractor/ Subcontractor among the aforementioned entities, or for other reasons.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 10 00

WATER UTILITIES

PART 1 - GENERAL

1.01 SUMMARY:

A. Excluded from this section are:

1. Yard process piping between structures for water or wastewater treatment plants. Refer to Division 46 for yard process piping.

2. Water utilities within 5 feet from buildings. Refer to Division 22 for plumbing piping.

1.02 DESCRIPTION:

A. Provide water utilities beyond 5 feet from buildings as indicated and in compliance with Contract Documents.

B. Section includes:

1. Pipe and fittings for site water line including domestic water line and fire water line.

2. Water line valves, fire hydrants, accessories, and appurtenances.

1.03 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B16.1: Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

2. B16.18: Cast Copper Alloy Solder Joint Pressure Fittings.

3. B16.22: Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

4. B18.2.1: Square and Hex Bolts and Screws (Inch Series).

5. B18.2.2: Square and Hex Nuts (Inch Series).

B. ASTM International (ASTM):

1. A126: Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. A307: Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

3. B88: Standard Specification for Seamless Copper Water Tube.

4. C890: Standard Specification for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

5. C913: Standard Specification for Precast Concrete Water and Wastewater Structures.

6. D1784: Standard Specification for Rigid Poly (Vinyl Chloride) Compounds (PVC) and Chlorinated Poly (Vinyl Chloride) Compounds.

7. D1785: Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

8. D2441: Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

9. D2466: Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

10. D2467: Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

11. D2564: Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.

12. D2657: Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings

13. D3139: Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.

14. F1290: Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings

C. American Welding Society (AWS):

1. A5.8: Specification for Filler Metals for Brazing and Braze Welding.

D. American Water Works Association (AWWA):

1. C104/A21.4: Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

2. C105/A21.5: Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. C110/A21.10: Ductile Iron and gray Iron Fittings, 3 Inch Through 48 Inch for Water and Other Liquids.

4. C111/A21.11: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

5. C115/A21.15: Flanged Ductile Iron Pipe with Threaded Flanges.

6. C116/A21.16: Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron fittings for Water Supply Service.

7. C150/A21.50: Thickness Design of Ductile Iron Pipe.

8. C151/A21.51: Ductile-Iron Pipe, Centrifugally Cast, for Water.

9. C153/A21.53: Ductile Iron Compact Fittings, k 3 inch through 24 Inch and 54 Inch Through 64 Inch for Water Service.

10. C502/502a: Dry Barrel Fire Hydrants.

11. C509: Resilient-Seated Gate Valves for Water Supply Service.

12. C511: Reduced - Pressure Principle Backflow Prevention Assembly.

13. C515: Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Services.

14. C550: Protective Interior Coatings for Valves and Hydrants.

15. C600: Installation of Ductile-Iron Water Mains and Their Appurtenances.

16. C700: Cold Water Meters - Displacement Type, Bronze Main Case.

17. C701: Cold Water Meters - Turbine Type, for Customer Service.

18. C702: Cold Water Meters - Compound Type.

19. C707: Encoder-Type Remote-Registration Systems for Cold-Water Meters

20. C800: Underground Service Line Valves and Fittings.

21. C900: Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 60 In. (100 mm Through 1,500 mm), for Water Distribution.

22. C901: Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.

23. M23: PVC Pipe - Design and Installation.

E. Factory Mutual (FM):

1. FM Approved: Factory Mutual Approval Guide.

F. National Fire Protection Association (NFPA):

1. 24: Installation of Private Fire Service Mains and Their Appurtenances.

G. Underwriters Laboratories (UL):

1. 246: Hydrants for Fire-Protection Service.

H. American Public Work Association (APWA) Utah Chapter

1. APWA 2017 Manual of Standard Plans and Specifications

I. Salt Lake City Department of Public Utilities (SLCDPU)

1. SLCDPU Standard Practices for Salt Lake City Public Utilities

1.04 DEFINITIONS:

A. Appurtenances: Additional piping items as required to provide a complete piping system suitable to convey water as specified and intended. These items may or may not be specified, but are necessary to complete the piping system.

1.05 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Pipe materials.

2. Pipe fittings.

3. Pipe couplings.

4. Pipe thrust restraint.

5. Valves.

6. Fire Hydrants.

7. Accessories.

8. Appurtenances.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Instructions: Provide manufacturer's installation instructions for pipe, hydrants, valves and joint restraints.

D. Field Test Reports: Provide results for hydrostatic and bacteriological tests.

E. Project Record Documents: Provide actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Perform Work in accordance with APWA Standard Plans and Specifications as modified by the Salt Lake City Department of Public Utilities' standards

C. Valves: Manufacturer's name, UL/FM and pressure rating marked on valve body.

D. Materials used for private fire lines shall be UL listed and approved by Factory Mutual.

E. NSF Approval: Material used in the manufacture of PVC pipe and fittings shall be approved by the National Sanitation Foundation (NSF) for conveying potable water. Pipe and fittings shall bear the NSF label.

F. Pipe and appurtenance Materials shall meet the requirements of SLCDPU Standard Practice #5.

G. Pipe bedding, trench zone, and stabilization materials shall meet the requirements of SLCDPU Standard Practice #1, Section 31 23 33, and APWA Section 32 11 23.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver and store valves in shipping containers with labeling in place.

1.08 WARRANTY:

A. Provide standard product warranties for piping materials and as required by Salt Lake City Department of Public Utilities' standards.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Water Pipe (PVC C-900):

1. JM Eagle

2. Diamond Plastics

3. Vinyl Tech

B. Water Pipe (Copper):

1. Mueller Streamline

2. Cerro Flow Products

3. Great Lakes Copper

C. Water Pipe (PE C-901)

1. JM Eagle

2. WL Plastics

3. IPEX

D. Valves – Provide valves manufactured by the following:

1. Gate Valves:

a. Mueller Co. (special order required for AIS compliant valves)

b. American Flow Control. (special order required for AIS compliant valves)

c. Kennedy Valve Co.

2. Corporation Stops: Mueller H-15000 (special order required for AIS compliant valves), Ford F600

E. Fire Hydrants – Provide fire hydrants manufactured by the following:

1. Mueller. (special order required for AIS compliant hydrants)

2. M&H.

3. American AVK Co.

4. Waterous. (special order required for AIS compliant hydrants)

F. Structures – Provide structures manufactured by the following:

1. Valve Boxes: Tyler 6850, D&L M-9042. (special order required for AIS compliant boxes)

2. Meter Boxes: Tyler 6150, Ford X32.

3. Mechanical Joint Restraint: EBAA Iron Megalug, Ford Meter Company, Inc.

2.02 WATER PIPE:

A. Copper Tubing: ASTM B 88, Type K, annealed.

1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.

2. Joints: Compression connection or AWS A5.8, BCuP silver braze.

3. Only lead-free solder shall be used.

4. Working Pressure: Minimum of 100 psi.

B. PVC Pipe:

1. PVC Material: ASTM D1784, Type 1, Grade 1.

a. PVC: ASTM D1784, Cell classification 12454-B.

2. PVC Pipe smaller than 3 inches in diameter:

a. Pipe: ASTM D1785, Schedule 40/80 or ASTM D2441, SDR 17 (unless noted otherwise

b. Fittings: ASTM D2467 for solvent welded joints; ASTMD 2464 for threaded joints. Match schedule and pressure rating of adjacent pipe.

c. Joints: Solvent welded or Push-on in accordance with ASTM D3139.

d. Tracer Wire: See Section 31 23 23-2.03.A for additional requirements.

e. Marking Tape: See Section 31 23 23-2.03.B for additional requirements. Magnetic detectable conductor, clear plastic covering, imprinted with “Water Service” in large letters.

3. PVC Pipe 4 through 48 inches in diameter:

a. Pipe: AWWA C900, Pressure Class 235 (DR 18).

b. Fittings: AWWA C110 or AWWA C153, ductile iron, pressure class to match adjacent pipe.

c. Bolts: MJ fitting T-bolts shall be corrosion resistant, high-strength, low-alloy steel in accordance with ANSI/AWWA C111/A21.11, manufactured by Romac (R-Blue), Birmingham Fastener, Trumbull Manufacturing (Cor-Blue) or EJ Prescott (CorTen). Buried flange bolts shall be carbon steel standard flange nuts and bolts in accordance with ASTM A307, Grade B and made to the standards of ANSI B18.2.1 manufactured by EJ Prescott, Tripac, or McMaster-Carr. Type 304 Stainless-Steel (Not Used in Contract).

d. Joints: ASTM D 3139 compression gasket ring.

e. Joint Restraints: Internal grip locking ring type, Eagle Loc900, or EBAA Iron Series 1900 for external type.

f. Tracer Wire: See Section 31 23 23-2.03.A for additional requirements.

g. Marking Tape: See Section 31 23 23-2.03.B for additional requirements. Magnetic detectable conductor, clear plastic covering, imprinted with “Water Service” in large letters.

4. Thread Lubricant:

a. Liquid: Teflon base liquid in plastic squeeze bottles. Use liquid lubricant on permanent joints.

b. Tape: Teflon base tape. Use tape on joints for valves or joints that may be disconnected often.

5. Bolting: Machine bolts and standard hexagon nuts with N.C. threads, 304 SS, unless noted otherwise.

C. Polyethylene Pipe and Tubing: For service lines only, 3 inches or less in diameter. AWWA C901 Pressure Class 200, copper tube sizes (CTS).

1. Fittings: AWWA C901, molded or fabricated, pressure class to match adjacent pipe.

2. Joints: Electrofusion joining conforming to ASTM F1290.

3. Tracer Wire: See Section 31 23 23-2.03.A for additional requirements.

4. Marking Tape: See Section 31 23 23-2.03.B for additional requirements. Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters.

2.03 VALVES:

A. Gate Valves:

1. Up to 3 Inches: 150 psi working pressure. Brass or bronze body, union bonnet, non-rising stem, inside screw, single solid wedge or disc, compression or IPS ends as noted on the drawings, extension box (for buried valves).

2. 3 Inches and Over: 150 psi working pressure. AWWA C509 or C515, Iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged or mechanical joint ends as required or noted on the drawings, control rod, extension box. Protective interior coating per AWWA C550. Gate valves

16 inches and larger to be equipped with spur or beveled gears enclosed in a seal grease case, in the horizontal position to be equipped with rollers, tracks, and scrappers.

3. UL Listed/FM Approved. Provide bonnet to accept indicator posts as indicated.

4. Provide one operating wrench of length to operate deepest valve.

5. Valves shall be counterclockwise opening.

2.04 MANUAL OPERATORS:

A. General:

1. Operator force not to exceed 40 lbf under any operating condition, including initial breakaway. Gear reduction operator when force exceeds 40 lbf.

2. Operator to be self-locking type or be equipped with self-locking device.

3. Provide position indicator on quarter-turn valves.

4. Worm and gear operators to be one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators to have threaded steel reach rods with internally threaded bronze or ductile iron nut.

B. Exposed Operator:

1. Galvanized and painted handwheels.

2. Lever operators allowed on quarter-turn valves, 8 inches and smaller.

3. Cranks on gear type operators.

4. Chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level.

5. Valve handles to take a padlock, and wheels a chain and padlock.

C. Buried Operator:

1. Buried Operator:

2. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2-inch and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.

3. Design buried service operators for quarter-turn valves to withstand 450 lbf-ft of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 10 psi.

4. Buried valves shall have extension stems, bonnets, and valve boxes.

2.05 VALVE BOXES:

A. General: Provide cast-iron valve boxes, rated for vehicular traffic.

B. Cast-Iron Boxes: Extension type with screw-type adjustment, flared base and 3/16-inch minimum thickness of metal.

C. Cast the word "WATER" in cover. Adapt box length, without full extension, to depth of cover required over pipe at valve location.

D. Manufacturers:

1. Tyler Union 6850

2. D&L Supply M-9042 (special order required for AIS compliant boxes)

3. Olympic VBU-8310 (special order required for AIS compliant boxes)

2.06 FIRE HYDRANTS:

A. AWWA C502, UL 246, dry barrel type compression hydrant with double O-ring seals; counter-clockwise rotation to open. Protective interior coating per AWWA C550.

B. Equip with a 5-1/4 inch valve opening, 6-inch mechanical joint shoe, two 2-1/2 inch hose nozzles, and one 4-1/2 inch nozzle breakaway flange and stem coupling.

C. Provide threads on nozzles in conformance with National Standard fire-hose coupling screw-thread dimensions. Nozzles shall be replaceable.

D. Fabricate extensions in multiples of 6 inches with rod and coupling to increase barrel length.

E. Working Pressure: 150 psi.

F. Provide 1 safety flange repair kit.

G. UL Listed/FM Approved.

H. Manufacturers:

1. Waterous WB-67 (special order required for AIS compliant hydrants)

2. Mueller Centurion A-423 (special order required for AIS compliant hydrants)

3. American AVK Series 2700

2.07 BEDDING AND COVER MATERIALS:

A. As specified in Section 31 23 33 and APWA Section 31 11 23 (3/4" Untreated Base Course).

2.08 THRUST RESTRAINT:

A. Mechanical Joint Restraint: Wedge action restrained joint retainer gland devices. Mechanical joint restraint incorporated into the design of the follower gland.

B. Pipe Clamps and Tie Rods: ANSI/NFPA 24.

C. Push-On Restrained Joint Pipe: Provide joint restraint and conforming joint to AWWA C111/21.11, fabricated to be easily disassembled. Provide assembly and disassembly kits. Tie bolts shall be carbon steel and wax-tape wrap.

D. Wall Pipes: Cast or ductile iron with an intermediate wall collar, unless noted otherwise. End connections as indicated.

2.09 COUPLINGS:

A. Mechanical Couplings: Dresser Style 38, long sleeve unless shown otherwise; equivalent by Smith-Blair (special order required for AIS compliant coupling) or Baker (special order required for AIS compliant coupling). Harness when required for thrust restraint.

B. Flanged Coupling Adapters (FCA): Dresser Style 127 (2-12 inches), Dresser Style 128 (14-96 inches), equivalent by Smith Blair (special order required for all named FCAs).

C. Tapping Sleeves: Ductile- or cast-iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of sleeve suitable for maximum working pressure of 150 psi. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets shall be as recommended by manufacturer of sleeve.

D. Tapping Valves: Provide tapping valves that conform to gate valves, specified herein. Provide tapping valves suitable for installation with tapping sleeves and pipe used, designed for minimum water working pressure of 150 psi, and have clear waterway equal to full nominal diameter of valve.

E. Corporation Stop: Standard corporation stop thread conforming to AWWA C800 on the inlet end, with compression pattern flared tube coupling.

F. Service Stops: Water-works inverted-ground-key type, oval or round flow way, tee handle, without drain. Parts shall be bronze with female compression-pattern flared tube coupling design for hydrostatic test pressure at least 200 psi.

G. Service Clamp (Saddle):

1. Pressure rating not less than connecting pipe; double flattened strap type conforming to AWWA C800. Clamps shall have rubber gasket cemented to the body. Straps and nuts shall be stainless steel. Manufacturers for PVC pipe shall be Romac 202-NS and Ford Meter Box 202BSD. Manufacturers for HDPE pipe shall be Romac 202N-H.

H. Service Boxes: Cast iron or concrete and shall be extension service boxes of length required for depth of line, with either screw or slide-type adjustment. Boxes shall have housings of sufficient size to completely cover service stop or valve and shall be complete with identifying covers.

I. HDPE and PVC Pipe Restrained Couplings: Restrained coupling shall have end rings, center ring, bolt guides, and grippers constructed of ductile iron meeting ASTM A536, Grade 65-45-12. Grippers shall be Xylan coated for corrosion resistance. Gaskets shall be provided for sewer service and meet the requirements of ASTM D2000. Bolts and nuts shall be Type 316 stainless steel. Draw hooks shall be stainless steel and ramp runners shall be glass filled nylon. Center ring shall be fusion bonded epoxy coated. Coupling shall be rated for a working pressure of 350 psi. Restrained joint shall accommodate up to 4 degrees deflection per end.

2.10 DISINFECTION CHEMICALS:

A. Refer to Section 33 13 00.

2.11 APPURTENANCES:

A. Provide appurtenances for a complete piping system suitable for operation, and in conformance with Project Documents.

2.12 SHOP PAINTING/COATINGS:

A. Unless noted otherwise, provide standard manufacturer paint and coatings for piping, valves, hydrants, and accessories to prevent corrosion for the life of the component.

2.13 SHOP TESTING:

A. Test pipes, valves, hydrants, and applicable accessories per manufacturer requirements, and as required by referenced Standards.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify existing conditions.

B. Verify building service connections and municipal utility water main sizes, locations and inverts are as indicated.

3.02 PREPARATION:

A. Ream pipe and tube ends and remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

D. Excavate pipe trench in accordance with Section 31 23 23 for work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.

3.03 WATER PIPE INSTALLATION:

A. Maintain separation of water main from sewer as follows:

1. Parallel Installation:

a. Under normal conditions water mains shall be laid at least 10 feet horizontally from a sewer or sewer manhole. The distance shall be measured edge-to-edge.

b. Under unusual conditions when local conditions prevent a horizontal separation of 10 feet the water main may be laid closer to a sewer or sewer manhole provided that:

(1) The bottom (invert) of the water main shall be at least 24 inches above the top (crown) of the sewer;

(2) Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA approved water pipe, pressure tested in place without leakage prior to backfilling; and

(3) The sewer manhole shall be of watertight construction and tested in place.

2. Crossing:

a. Under normal conditions water lines crossing sewers shall be laid to provide a separation of at least 24 inches between the bottom of the water line and the top of the sewer whenever possible.

b. Under unusual conditions when local conditions prevent a vertical separation described, the following construction shall be used:

(1) Sewers passing over or under water mains shall be constructed of AWWA approved water pipe, pressure tested in place without leakage prior to backfilling;

(2) Water lines passing under sewers shall, in addition, be protected by providing:

(a) A vertical separation of at least 24 inches between the bottom of the sewer and the top of the water line;

(b) Adequate structural support for the sewers to prevent excessive deflection of the joints and the settling on and breaking of the waterline; and

(c) That the length of the water line be centered at the point of the crossing so that joints shall equidistant and as far as possible from the sewer.

(3) No water pipes shall pass through or come in contact with any part of a sewer manhole.

B. Install pipes and structures to within tolerance of 1/2-inch of indicated elevations.

C. Install ductile iron piping and fittings to AWWA C600.

D. Install PVC piping according to AWWA M23.

E. Install fire service piping according to NFPA 24.

F. Install joint restraints on all fittings and valves. Pipe joints shall be restrained for the distances shown on the Contract Drawings and the following requirements.

1. If the distance between fittings or valves is less than 20 feet, a full pipe length shall be used, i.e., no joints between the fitting or valve.

2. A minimum of 10 feet of pipe (no joints) shall be provided on each side of the through section of all Tees.

3. Restrain all joints from a mainline branch Tee to all fire hydrants.

4. Restrain fittings and couplings and all pipe joints for 25 feet minimum from all building or structure connections or for the length indicated on the Contract Drawings.

G. Establish elevations of buried piping to ensure not less than 4 feet of cover.

H. Install trace wire continuous over top of pipe; coordinate with Section 31 23 33. Extend wire into valve boxes and adjacent to hydrants for connection to location equipment.

I. Backfill trench in accordance with Section 31 23 33.

J. Pipe bedding shall be Grade 1 - 1" UTBC per APWA Section 32 11 23 unless noted otherwise in Section 31 23 23.

3.04 VALVES AND HYDRANTS INSTALLATION:

A. Set valves on solid bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Set hydrants plumb and locate pumper nozzle perpendicular to roadway.

D. Provide drainage pit 36 inches square by 24 inches deep filled with No. 57 aggregate for fire hydrants. Encase elbow of fire hydrant in gravel to 6 inches above drain opening. Wrap drainage pit and gravel with filter fabric. Do not connect drain opening to sewer.

E. Paint fire hydrants in accordance with AWWA and NFPA 24; also comply with Salt Lake City Department of Public Utilities Standard.

F. Install tapping sleeves and tapping valves in accordance with manufacturer's recommendations.

G. Install valves and hydrants according to applicable AWWA Standards and NFPA 24.

3.05 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM:

A. Refer to Section 33 13 00.

3.06 SERVICE CONNECTIONS:

A. Provide water service including corporation stop, copper pipe, curb stop, meter setter, and water meter and back flow preventer and sand strainer.

3.07 REPAIR/RESTORATION:

A. Repair any existing utilities/structures, or features damaged during installation of water utilities to Owner's satisfaction, and at no cost to Owner.

3.08 FIELD TESTING:

A. Perform field-testing under provisions of Section 01 45 00.

B. Hydrostatically test newly laid pipeline and valved section thereof in accordance with AWWA C600, Salt Lake City Department of Public Utilities' Standard, and NFPA 24.

C. Bacteriological testing shall be in accordance with Utah State Standard, and Salt Lake City Department of Public Utilities' Standard. One series of test shall be performed for every 2,000 feet of line. Each series shall be two samples taken at least 24 hours apart and analyzed by a Utah certified lab. The results must indicate no coliform contamination before being used. If coliform is detected, the disinfection and testing procedure shall be repeated until no coliform is detected.

3.09 FIELD PAINTING/COATINGS:

A. Repair any shop painting/coatings damaged during storage or installation to Owner's satisfaction.

B. Wax-Tape wrap all ductile iron fittings and push-on joint restraints. Install primer, void filler, and wrap per manufacturer's instructions. Manufacturer shall be Trenton or Denso. Outer wrap wax-tape with 8-mil polyethylene wrap and seal ends with 12-mil Polyken #900 tape.

3.10 ADJUSTING:

A. Coordinate with Engineer for any field adjustments. The Engineer reserves the right to reject any field adjustments.

3.11 PROTECTION:

A. Protect installed water utilities from damage throughout storage, installation, testing, and final approval.

3.12 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 12 13

TEMPORARY CONNECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide temporary connections as indicated and in compliance with Contract Documents.

1. Scope:

a. Provide, disinfect, and maintain temporary potable water bypass pipe, connections, and services as indicated or required and as specified and later remove temporary facilities.

b. Have readily available sufficient additional quantity of bypass pipe, connections of suitable sizes to replace or supplement the temporary facilities in event these prove inadequate in any way.

c. Perform all appurtenant work including but not limited to excavation and backfilling, constructing ramps at driveways and other access ways, replacement of temporary and permanent pavement, restoration of public and private property.

1.02 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Before commencing work, submit for Engineer's review and acceptance, proposed layout plan and operations schedule for installing and removing temporary bypasses, connections and services.

2. Submit for Engineer's review and acceptance, a list of materials with sizes for temporary bypass, connections and services.

3. Submit documents indicating compliance with applicable traffic control and safety requirements and indicated Maintenance of Traffic Plan for the Project.

1.03 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00 and as specified.

B. Use only materials that are suitable for potable water transmission and distribution.

C. Provide temporary connections capable of withstanding service pressure of 150 psi.

D. Take water for temporary connections from Owner's nearest available hydrants remaining in service.

1.04 SAFETY REQUIREMENTS:

A. Prevent contamination of contiguous potable water distribution system and services.

B. Coordinate and cooperate with Owner's water utility and fire department to maintain water distribution and fire protection capability.

C. Take all necessary precautions for public safety.

D. Comply with Section 01 50 00, Paragraph 1.03.C for water supply for Contractor's operations.

E. Conform to all applicable traffic control and safety requirements during temporary connections and operations. Comply with indicated Maintenance of Traffic Plan for the Project.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Provide pipe, fittings, hoses, connections, backflow preventers, and valves suitable for potable water service at 150 psi and as accepted by Engineer.

PART 3 - EXECUTION

3.01 GENERAL:

A. Furnish, install, maintain and later remove devices necessary to ensure public safety as required and as approved by the Owner. Provide backflow preventers as required by Utah Department of Environmental Quality Division of Drinking Water and Utah Administrative Code R309-105.

B. Install, operate, maintain, test, disinfect and remove temporary facilities including bypass, connections, laterals, customer services and customer connections and temporary fire hydrants as indicated on drawings, as specified and as accepted by Engineer.

C. Make installation suitable for temporary potable water service pressures to 150 psi without leakage.

D. Do not operate Owner's or user's valves, stops and hydrants without Engineer's permission for specific valves, stops and hydrants.

E. Test temporary facilities in presence of Engineer before taking Owner's water main out of service.

F. Disinfect temporary facilities to meet Engineer's acceptance and in accordance with Section 33 13 00, Paragraph 3.06 Final Flushing and Test prior to placing such temporary facilities in service.

G. Make attachments and connections to fire hydrants and fire protection systems in a manner which can be easily and quickly removed to permit use of fire hydrants and fire protection systems for firefighting purposes.

H. Notify in writing the Owner and the Owner's water utility and fire department 48 hours in advance of connecting and disconnecting temporary and permanent facilities so that representatives of Salt Lake City water department and fire department may be present at installation or removal of permanent and temporary connections and to permit Owner to inform customers and users as Owner deems necessary.

I. Do not install temporary bypass, connections and customer services across streets except as permitted by Engineer.

J. Connect to the temporary bypass water mains that are to remain in service as indicated and accepted by Engineer.

K. After water mains are returned to service, remove temporary facilities not required for remaining work and restore and clean up affected areas to the acceptance of the Engineer.

3.02 TEMPORARY BYPASS:

A. Provide bypass not less than sizes indicated on drawings and in any case not less than 2 inch diameter.

B. Lay bypass out of traveled way in manner to protect the bypass from damage.

C. Where bypass is accepted to cross streets and street intersections, lay in trench and place temporary pavement over bypass except as permitted otherwise in writing by the Engineer.

D. Where bypass crosses driveways and similar access ways to properties, construct suitable ramp to allow driving and passing over pipe except where Engineer requires bypass be laid in trench with temporary pavement over bypass.

E. Keep existing fire hydrants in service by making appropriate connections to bypass or by installing and maintaining temporary fire hydrants adjacent to each existing fire hydrant affected by work until restored to service.

F. Provide each temporary fire hydrant with individual valve control.

G. Provide temporary fire hydrants with fire hose connections compatible with existing fire hydrant hose connections as accepted by the Engineer.

H. Satisfactorily flush existing hydrants, to which bypass is connected for water supply, prior to making connections to prevent stagnant or discolored water from entering bypass.

I. If bypass proves inadequate for temporary service, replace or supplement bypass as appropriate to provide adequate temporary service, including replacement with larger diameter bypass, as accepted by the Engineer.

3.03 TEMPORARY SERVICE CONNECTIONS:

A. Furnish, install, maintain and later remove temporary service connections from the bypass to each building and service supplied by water main to be removed from service.

B. Lay temporary connections out of traveled and access ways where possible.

C. Temporary service connections ramped or in trench where directed and accepted by the Engineer.

D. Provide temporary service connections equal to or larger size than permanent service connections.

E. Install and maintain pressure regulators for temporary services where necessary.

F. Install and remove temporary service connections and back clean permanent services at times when work can be observed by the Engineer and other representatives of the Owner.

G. Coordinate and cooperate with service user, Salt Lake City water department and fire department, to assure minimum disturbance to fire protection system and other special and automated uses.

H. Make temporary service connections to user service line, sill cock, or other convenient and reasonable points and acceptable to the Engineer.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 13 00

DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide disinfecting of water utility distribution systems as indicated and in compliance with Contract Documents.

B. Section Includes:

1. Disinfection of water mains in accordance with AWWA C651; except as modified below.

1.02 REFERENCES:

A. American Water Works Association (AWWA):

1. C651: Disinfecting Water Mains.

B. Standard Practices for Salt Lake City Public Utilities:

1. Standard Practice #4 – Flushing and De-Chlorination

2. Standard Practice #12 – Commissioning Waterlines

1.03 SEQUENCING:

A. Basic procedure for disinfecting water mains:

1. Inspecting materials to be used to ensure their integrity.

2. Preventing contaminating materials from entering the water main during storage, construction, or repair and noting potential contamination at the construction site.

3. Removing, by flushing or other means, those materials that may have entered the water main.

4. Chlorinating any residual contamination that may remain, and flushing the chlorinated water from the main.

5. Protecting the existing distribution system from backflow caused by hydrostatic pressure test and disinfection procedures.

6. Documenting that an adequate level of chlorine contacted each pipe to provide disinfection.

7. Determining the bacteriological quality by laboratory test after disinfection.

8. Final connection of the accepted new water main to the active distribution system.

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Supervisor qualifications.

2. Equipment list.

3. De-chlorination Procedure Documentation Form (SLC Standard Practice #4), if required for pipeline flushing water disposal.

4. Disinfection Procedure Plan

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Regulatory Requirements:

1. Disinfection work shall be acceptable to Utah Department of Drinking Water. If requirements of this section are in conflict with requirements of regulatory agencies, the latter shall govern.

C. Source Quality Assurance:

1. Perform Work in connection with disinfection under direction of experienced supervisor.

2. Use equipment in proper working condition and adequate for specified Work.

D. Prior to starting disinfection work, furnish detailed outline of proposed sequence of operation, manner of filling and flushing units, source and quality of water to be used, and disposal of wasted water.

E. Perform work in connection with disinfection under direction of experienced supervisor.

F. Use equipment in proper working condition and adequate for specified work. Equipment shall be specifically designed for injection of liquid and/or gas chlorine into the system.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.07 PROJECT CONDITIONS:

A. Discharge of chlorinated water into watercourses or surface waters is regulated by the National Pollutant Discharge Elimination System (NPDES). Disposal of the chlorinated disinfection water and the flushing water is the Contractor's responsibility. Dechlorinate the disinfection water such that the chlorine residual is non-detectable.

PART 2 - PRODUCTS

2.01 OWNER-SUPPLIED PRODUCTS:

A. The Owner will provide potable water for the first disinfection effort. Submit request for use of water from waterlines of Owner 48 hours in advance. If bacteriological testing shows that the first disinfection effort was not successful, the Contractor will be charged, at the Owner's current rates, the cost of additional water for subsequent disinfection efforts. Contractor will be responsible for conveying the water from the source to the test site.

2.02 MATERIALS:

A. Water: Use potable water for cleaning and disinfection.

B. Chlorine: Provide in accordance with AWWA C651.

1. Liquid Chlorine: Inject with a solution feed chlorinator and a water booster pump. Follow the instructions of the chlorinator manufacturer.

2. Calcium Hypochlorite (Dry): Dissolve in water to a known concentration in a drum and pump into the pipeline at a metered rate. Tablet form calcium hypochlorite may be used only for water mains up to 12 inches in diameter and less than 2,500 feet in length.

3. Sodium Hypochlorite (Solution): Further dilute in water to desired concentration and pump into the pipeline at a metered rate.

2.03 EQUIPMENT:

A. Submit list of equipment used for disinfecting work. Equipment shall be designed specifically for chlorine injection and shall be capable of properly controlling and measuring required flow rates and dosage rates.

2.04 ACCESSORIES:

A. Chlorine Residual Test Kit: For measuring chlorine concentration, supply and use a medium range, drop count, DPD drop dilution method kit per AWWA C651, Appendix A.1. Maintain kits in good working order available for immediate test of residuals at point of sampling.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Isolate new work being disinfected from system to avoid possibility of contaminating materials entering distribution system.

B. Method of disinfection for water containment devices and piping systems shall conform to AWWA C651 and SLC Standard Practice #12.

3.02 CHLORINE PREPARATION:

A. Liquid Chlorine:

1. Apply chlorine gas-water solution by means of solution feed chlorinating device or, if accepted by Engineer, dry gas may be fed directly through proper devices for regulating rate of flow and providing effective diffusion of gas into water within unit being treated.

2. Provide chlorinating devices for feeding solutions of chlorine gas that prevent backflow of water into chlorine cylinder.

B. Calcium Hypochlorite:

1. Prepare granular calcium hypochlorite as water mixture before introduction into unit. Make dry powder into paste and thin to approximately 1 percent chlorine solution.

2. To prepare chlorine solution, add 1 pound of calcium hypochlorite (65 to 70 percent available chlorine to 7-1/2 gallons of water.

3.03 PIPELINE PREPARATION:

A. After pressure and leakage tests complete, flush units thoroughly to remove foreign material.

B. Release entrapped air at high points and fill units with disinfecting agent and water to allow disinfecting agent to come in contact with interior surfaces.

C. If complete venting cannot be accomplished through available outlets, provide necessary corporation cocks and vent piping.

3.04 APPLICATION OF DISINFECTANT:

A. Point of Application:

1. Apply chlorinating agent at supply end of unit being disinfected.

2. For pipes, apply disinfectant through corporation cock installed in top of pipe.

3. Place tablets in accordance with AWWA C651.

B. Rate of Application:

1. Introduce water at controlled rate in order to regulate chlorine dosage.

2. Proportion rate of chlorine mixture flow to rate of water entering unit so chlorine dose applied produces at least 25 mg/L chlorine residual after period of 24 hours.

3. Method of determining rate of flow of water into unit being disinfected shall be accepted by Engineer.

C. Isolating Systems:

1. Keep chlorine gas-water disinfecting solution and contaminated water from flowing into units previously chlorinated and flushed.

D. Quality:

1. Retain chlorinated water in unit long enough to destroy non-spore forming bacteria.

2. Minimum retention period shall be 24 hours with chlorine residual at end of this period of not less than 25 mg/L (ppm).

E. Disinfecting Valves:

1. Operate valves and appurtenances while line or unit is being disinfected to ensure surfaces of valves are disinfected.

F. Swabbing:

1. Flush and swab pipe, fittings or valves that must be placed in service immediately with 5 percent solution of calcium hypochlorite immediately prior to assembly.

2. Secure acceptance from Engineer before using this method of disinfection.

G. Valve Operation: Performed by Owner.

3.05 DISINFECTING METHODS:

A. Continuous Feed Method:

1. Introduce potable water into the pipeline at a constant measured rate. Feed the chlorine solution into the same water at a measured rate. Proportion the two rates so that the chlorine concentration in the pipeline is maintained at a minimum concentration of 25 mg/L. Check the concentration at points downstream during the filling to ascertain that sufficient chlorine is being added.

B. Disinfection of Valves, Blind Flanges, and Appurtenances:

1. During the period that the chlorine solution is in the section of pipeline, open and close valves to obtain a chlorine residual at hydrants and other pipeline appurtenances. Swab exposed faces of valves and blind flanges prior to bolting flanges in place with a 1 percent sodium hypochlorite solution.

C. Disinfection of Connections to Existing Pipelines

1. Disinfect isolation valves, pipe, and appurtenances in accordance with AWWA C651, Section 4.7. Flush with potable water until discolored water, mud, and debris are eliminated. Swab interior of pipe and fittings with a 1 percent sodium hypochlorite solution. After disinfection, flush with potable water again until water is free of chlorine odor.

D. Disinfection of Tapping Sleeves and Line Stopping:

1. Flush exterior of pipe with potable water after removal of existing coating. Swab exterior of pipe with a 1 percent sodium hypochlorite solution. Disinfect per AWWA C651, Section 4.8. After completion of tapping and line stopping, swab interior of pipe, valves, and faces of flanges to be connected to bypass piping with a 1 percent sodium hypochlorite solution.

E. Confirmation of Residual:

1. After the chlorine solution applied by the continuous feed method has been retained in the pipeline for 24 hours, confirm that a chlorine residual of 25 mg/L minimum exists along the pipeline by sampling at air valves and other points of access, such as tapping valves.

3.06 FINAL FLUSHING AND TEST:

A. Following chlorination, flush unit or system until replacement water in system is proven to be comparable in quality to water which will enter unit or system. Follow procedures outlined in SLC Standard Practice #4.

B. Above acceptable condition of water delivered by each unit or system shall continue for at least 2 days, as demonstrated by laboratory examination of samples. Laboratory tests shall show chlorine residual, after final flushing, of less than 1 mg/L (ppm).

C. Repetition of Flushing and Testing:

1. If initial treatment results in unsatisfactory bacterial test, repeat disinfection until satisfactory results obtained.

D. Prevent entry of contaminated water into previously disinfected units or systems.

3.07 BACTERIOLOGIC TESTS:

A. Collect two sets of samples per AWWA C651, Section 5.1, from the new main at least 24-hours apart and deliver to a certified laboratory within six hours of obtaining the samples, and obtain a bacteriologic quality test to demonstrate the absence of coliform organisms in each separate section of the pipeline after chlorination and refilling. Collect at least one set of samples from every 1,200 feet of the new water main, plus one set from the end of the line and at least one set from each branch. At each connection to an existing pipeline, take two additional samples.

B. A standard heterotrophic plate count (HPC) test shall be conducted with the coliform samples. If sample results show HPC greater than 50 CFU/mL, flushing should resume and another set of HPC and coliform samples collected until no coliform are present and the HPC is less than 50 CFU/mL.

C. Repetition of Procedure: If the initial chlorination fails to produce required residuals and bacteriologic tests as outlined in SLC Standard Practice #12, repeat the chlorination and retesting until satisfactory results are obtained.

D. Test Facility Removal: After satisfactory disinfection, disinfect and replace air valves, restore the pipe coating, and complete the pipeline where temporary disinfection or test facilities were installed.

3.08 FIELD QUALITY CONTROL:

A. Owner will obtain samples for and submit to laboratory for analysis before reservoir placed in service.

B. If safe samples not obtained using above procedure, Contractor shall add additional chlorine in amounts necessary to obtain safe samples.

3.09 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 33 30 00

SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.01 SUMMARY:

A. Excluded from this section are:

1. Yard process piping between structures for water or wastewater treatment plants. Refer to Division 46 for yard process piping.

2. Water utilities within 5 feet from buildings. Refer to Division 22 for plumbing piping.

3. Force main (pressure) sanitary sewer piping. Refer to Section 40 05 33.

1.02 DESCRIPTION:

A. Provide gravity sanitary sewers and sanitary force mains beyond 5 feet from buildings to municipal sewers or other discharge system as indicated and in compliance with Contract Documents.

B. Section includes: Precast concrete maintenance holes, and cast-iron frames and covers.

1.03 REFERENCES:

A. American Railway Engineering and Maintenance-of-Way Association (AREMA):

1. Manual for Railway Engineering

B. ASTM International (ASTM):

1. C14: Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe

2. C76: Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

3. C443: Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

4. C478: Precast Reinforced Concrete Manhole Sections

5. C564: Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

6. C858: Underground Precast Concrete Utility Structures

7. C923: Resilient Connectors Between Reinforced Concrete Manhole Structures

8. C924: Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method; American Society For Testing And Materials

9. D638: Standard Test Method for Tensile Properties of Plastics

10. D648: Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

11. D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

12. D1785: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

13. D2241: Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

14. D2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

15. D2583: Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

16. D2729: Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

17. D2751: Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings

18. D3034: Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

19. D3139: Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals

20. D3212: Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

21. F477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C. American Water Works Association (AWWA):

1. C901: Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service

D. Occupational Safety and Health Administration (OSHA) Standards and Regulations:

1. 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations

E. UNI-BELL (UNI):

1. B3: Recommended Practice for Installation of Polyvinyl Chloride (PVC) Pressure Pipe (Nominal Diameters 4-36 Inch (100-900 mm))

2. B6: Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe; UNI-Bell PVC Pipe Association

F. Salt Lake City Department of Public Utilities (SLCDPU)

1. SLCDPU Standard Practices for Salt Lake City Public Utilities

1.04 DEFINITIONS:

A. Appurtenances: Additional piping items to provide a complete piping system suitable to convey wastewater as specified and intended. These items may or may not be specified, but are necessary to complete the piping system.

B. Standard Specifications: “Manual of Standard Plans and Specification – APWA Utah Chapter .

1.05 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Pipe materials

2. Precast maintenance holes materials, dimensions, and stack drawings including pipe penetration sizes and elevations

3. Maintenance hole frame and covers

4. Pipe fittings

5. Pipe couplings

6. Pipe thrust restraint

7. Accessories

8. Appurtenances

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Instructions: Provide manufacturer's installation instructions for pipe, valves, appurtenances, and maintenance holes.

D. Field Test Reports: Provide results for all testing performed as indicated in Subparagraph – Field Testing.

E. Project Record Documents: Provide marked-up set of drawings showing actual locations of piping, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide a list of recommended spare parts for the first year of operation and for the first five years of operation, including a price list and location of the nearest facility from which all spare parts can be obtained.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Perform Work in accordance with Salt Lake City Department of Public Utilities Standard Practices, APWA Utah Chapter Standard Plans and Specifications, and state and federal requirements.

C. Valves: Manufacturer’s name UL/FM**,** and pressure rating marked on valve body.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Deliver and store valves in shipping containers with labeling in place.

1.09 WARRANTY:

A. Comply with the requirements specified in Section 01 78 36.

B. Provide standard product warranties for all sanitary sewerage utility materials and as required by Salt Lake City Department of Public Utilities.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Reinforced Concrete Pipe:

1. Geneva Pipe and Precast

2. Oldcastle Infrastructure

B. Plastic Pipe (PVC):

1. JM Eagle

2. Vinyltech

3. Diamond Plastics Corporation

C. Glass-Fiber Reinforced Polymer (GFRP) Pipe:

1. HOBAS

2. Flowtite

D. Precast Concrete Maintenance Hole Structures:

1. Geneva Pipe and Precast

2. Oldcastle Infrastructure

E. Precast Concrete Maintenance Hole:

1. Geneva Pipe and Precast

2. Oldcastle Infrastructure

F. Frames and Covers:

1. D&L Supply

2. East Jordan

3. Neenah Foundry

2.02 GRAVITY SANITARY SEWER PIPE:

A. Acrylonitrile-butadiene-styrene (ABS) Pipe: ASTM D2751, SDR 23.5, acrylonitrile-butadiene-styrene (ABS) material; inside nominal diameter as indicated, bell and spigot style solvent sealed joint end.

B. Polyvinyl Chloride (PVC) Pipe:

1. Pipe (4-inch through 15-inch diameter): ASTM D3034, Type PSM PVC material; minimum SDR35, nominal inside diameter as indicated.

2. Pipe (18-inch through 48-inch diameter): ASTM F679, Type PSM PVC material; minimum pipe stiffness 46 psi, nominal inside diameter as indicated.

3. End Joints: Bell and spigot per ASTM D3212.

4. Joint Device: Gasket Flexible elastomeric locked-in gasket per ASTM F477.

C. Glass-Fiber Reinforced Polymer (GFRP) Pipe:

1. Provide GFRP pipe in accordance with Section 33 30 05.

2.03 FORCE MAIN (PRESSURE) SANITARY SEWER PIPE MATERIALS:

A. Force Main (Pressure) Sewer Pipe shall be high-density polyethylene (HDPE) pressure pipe and fittings per Section 40 05 33. .

2.04 PRECAST CONCRETE MAINTENANCE HOLES:

A. Maintenance Holes shall be in accordance with section 33 95 15.

B. Maintenance Hole Steps: Steps within maintenance hole structure shall not be allowed.

2.05 MAINTENANCE HOLE FRAME AND COVERS:

A. Frame and Cover: In accordance with section 33 95 15. Lid provided with embossed lettering saying “SANITARY SEWER” or “PROCESS DRAIN” cast into cover.

2.06 BEDDING AND COVER MATERIALS:

A. As specified in Section 31 23 00.

2.07 THRUST RESTRAINT:

A. See Section 40 05 33 – High-Density Polyethylene HDPE Pressure Pipe and Fittings.

2.08 ACCESSORIES:

A. Flexible Couplings: Sleeve type elastomeric polyvinyl chloride held firmly to pipe ends by screw-tightened bands. Bands and screws Type 304 stainless steel.

2.09 APPURTENANCES:

A. Provide all necessary appurtenances for a full and complete piping system suitable for operation, and in conformance with Project Documents.

2.10 SHOP PAINTING/COATINGS:

A. Unless otherwise specified or indicated, provide standard manufacturer paint and coatings for all piping and valves to prevent corrosion for the life of the component.

2.11 SHOP TESTING:

A. Test all pipes and valves per manufacturer requirements, and as required by pertinent Standards.

B. Provide notice to the Engineer and Owner in advance of the proposed test and requirements for the test including measurements to be taken, submittal requirements, etc.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated for sanitary sewer pipe. Verify excavation for maintenance holes to proper depth and proper placement of bedding material.

3.02 PREPARATION:

A. Sanitary sewer pipe: Hand trim excavations to required elevations. Correct over excavation with stabilization material. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

B. Maintenance Holes: Coordinate placement of inlet and outlet pipe sleeves. Seal exterior surface of sanitary sewer maintenance holes with minimum 14-mil-thick coal tar coating.

3.03 SANITARY SEWER PIPE INSTALLATION:

A. Maintain separation of sanitary sewers pipe and water mains as indicated in Specification Section 33 10 00.

B. Install pipe, fittings, and accessories in accordance with ASTM D2321 and manufacturer's instructions. Seal joints watertight.

C. Lay pipe to slope indicated; with maximum variation from true slope of 1/8-inch in 10 feet. Lay pipe upgrade, with spigot ends pointing in direction of flow. Lay pipe to form a close concentric joint with adjoining section and to prevent sudden offsets in flow line.

D. Install bedding to depths and dimensions as indicated.

E. Backfill each section of pipe as it is laid, as specified in Section 31 23 00 and as indicated at least up to centerline, before next joint is made. Do not completely conceal or bury pipe prior to being tested for water tightness and prior to being accepted by the Engineer. Do not displace or damage pipe when compacting.

F. Clear the interior of the pipe of dirt and superfluous materials as the work progresses. Keep a suitable swab or drag in the pipe and pull it forward past each joint immediately after the jointing has been completed.

G. Keep trenches and other excavations free of water until final inspection. Do not lay pipe or construct masonry work in water. Do not allow water to rise over the work until concrete or mortar has had ample time to set.

H. Close open ends of pipe and fittings in a manner acceptable to the Engineer when the work is not in progress so that trench water, earth and other substances will not enter the pipe or fittings.

I. Handle pipe and fittings to avoid damage. Carefully inspect pipe and fittings for defects before lowering into the trench.

J. Where necessary deflect pipelines to avoid obstructions or where long-radius curves are indicated. Do not exceed the maximum deflection recommended by pipe manufacturer. Provide short sections of pipe as necessary to maintain required line.

K. Provide compatible pipe connections to each valve and to equipment. Provide unions on pipelines with welded soldered or threaded joints to allow removal of each valve and equipment without disturbing connecting pipelines. Connect different types of pipe and accessories with flexible couplings or pipe and accessories with flexible couplings or accepted transition fittings. Provide insulation fittings where ferrous pipe connects to nonferrous metallic pipe.

L. Verify invert of each existing maintenance hole prior to commencing work. Connect to each existing maintenance hole where indicated or directed. Prevent debris from entering the pipelines. The work includes all necessary concrete work, cutting and shaping of invert.

M. Repair linings, coatings and coverings damaged during construction with accepted materials equal to and compatible with original lining, coating or covering. Repair damaged galvanizing with zinc-rich paint.

N. Connect to building sanitary sewer outlet as indicated.

3.04 PRECAST CONCRETE MAINTENANCE HOLE INSTALLATION:

A. Maintain separation of sanitary sewer precast concrete maintenance holes and water mains as indicated in Specification Section 33 10 00.

B. Place precast maintenance hole sections plumb and level, adjust to correct elevation. Provide bedding material as indicated and to APWA Utah Chapter standard .

C. After maintenance hole assembly, plug lift holes with non-shrink grout.

D. Cut and fit for pipe connections.

E. Invert Channels:

1. Built up with concrete, grout, or brick and mortar covered by not less than 2 inches of mortar.

2. Smooth and semicircular, conforming to inside of adjacent sewer section.

3. Changes in direction of flow made with a smooth curve radius as large as maintenance hole size will permit.

4. Slope floor of maintenance hole outside channels, smooth and not less than 1 inch per foot nor more than 2 inches per foot.

F. Set maintenance hole frames and covers level to correct elevations.

G. Sanitary sewer drop connections: Provide where indicated. Construct drop connection as indicated and according to APWA Utah Chapter Standard.

3.05 REPAIR/RESTORATION:

A. Repair any existing utilities/structures, or features damaged during installation of sanitary sewerage utilities to Owner's satisfaction, and at no cost to Owner.

3.06 FIELD TESTING:

A. General:

1. Perform field-testing under provisions of Section 01 43 00.

2. Request inspection by Owner's Representative prior to and immediately after placing bedding.

B. Cleaning and Testing:

1. Test for Displacement of Buried Sanitary Sewers: After trench has been backfilled and compacted, after cover over pipeline has been brought to finished grade, and after debris and silt has been removed, pipelines will be tested by the Engineer, as follows: Light will be flashed between maintenance holes, or, if maintenance holes have not yet been constructed, between locations of maintenance holes, by means of flashlight or by reflecting sunlight with mirror. Correct poor alignment, displaced pipe, and other defects indicated by the Engineer.

2. Test for Deflection of PVC Sanitary Sewers

3. Measure pipelines for vertical ring deflection within 15 days after completion of backfill and at least 4 months after installation, but no later than 30 days before substantial completion of the project. Limit maximum ring deflection of pipeline under load to 5 percent of vertical internal pipe diameter. Relay or replace pipe exceeding this deflection and retest.

4. Use deflectometer that produces continuous record of pipe deflection or pull mandrel, sphere, or pin-type go/no-go device through the pipeline. Make diameter of the go/no-go device 95 percent of undeflected inside diameter of pipe.

5. Cleaning: Flush out and clean sanitary force mains of foreign matter before placing systems into operation. Use flushing velocity of 10 feet per second, minimum. Take care to prevent scale and other objectionable matter from entering piping. Properly dispose of water used for flushing.

6. Force Main Pressure Test: Per Section 40 05 33.

7. Testing of Sanitary Sewers: At such times as Engineer may direct, prove watertightness of buried sanitary sewer or portions thereof by one of the following tests. Conduct tests under supervision of the Engineer. Furnish materials, labor, and equipment required for tests and repair system until test results are satisfactory.

8. Infiltration: When, in opinion of the Engineer, trench or excavation is sufficiently saturated by groundwater or rain, tests may be made on basis of infiltration. Infiltration tests will only be allowed when hydrostatic head outside pipe is minimum of 4 feet above crown of pipe for entire length of pipe being tested. Measure flow of water at nearest downgrade maintenance hole. Make three series of measurements at intervals of not less than 1 hour, and average results. Using this average, calculate infiltration rate for 24-hour period. Infiltration rate: Not greater than 100 gallons per inch of pipe diameter per mile per day in any section of system including maintenance holes.

9. Exfiltration: When conditions are not suitable for infiltration test, subject pipe to hydrostatic head of at least 4 feet above pipe crown. Fill line until appropriate water level is obtained at selected upstream maintenance hole. Observe rate of drop at this maintenance hole for 1 hour. Leakage rate: Not to exceed maximum rate allowed for infiltration.

10. Air Test: At Contractor's option, low-pressure air test may be used instead of exfiltration test for vitrified clay, PVC, and concrete pipelines 12 inches and smaller. Perform tests in accordance with ASTM C828 for vitrified clay pipelines, UNI B6 for PVC pipelines, and ASTM C924 for concrete and ductile iron pipelines.

11. Vacuum test: For precast concrete maintenance holes 25 feet deep and less, a vacuum test may be used instead of exfiltration test. Conduct tests prior to backfilling and include joint between maintenance hole cover and frame. Plug and brace pipe openings. Draw vacuum of 10 inches of mercury. Minimum time to drop to 9 inches of mercury follows:

Table 33 30 00-1			
	Maintenance Hole Diameter in Inches		
Depth in Feet	48	60	72
Up to 10	60 sec.	75 sec.	90 sec.
10.01-15	75 sec.	90 sec.	105 sec.
15.01-25	90 sec.	105 sec.	120 sec.

12. If maintenance hole fails the test, make necessary repairs and repeat the vacuum test and repairs until maintenance hole passes test. Submit test results.

3.07 STARTUP AND TESTING:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Comply with requirements for checkout, startup, and testing in Section 01 78 25.

3. Physical Checkout and Field Testing (Functional Completion Testing): Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connections; certify proper installation:

   a. 1 person-day

4. Startup: Calibrate, check alignment and perform a functional test with water or process fluid. Tests to include all items specified.

   a. 1 person-day

5. Commissioning: Field performance test equipment specified.

   a. 2 person-days

3.08 FIELD PAINTING/COATINGS:

A. Repair any shop painting/coatings damaged during storage or installation to Owner's satisfaction.

3.09 ADJUSTING:

A. Coordinate with Engineer for any field adjustments. The Engineer reserves the right to reject any field adjustments.

3.10 PROTECTION:

A. Protect sanitary sewerage utilities from damage throughout storage, installation, testing, and final acceptance.

3.11 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 30 05
GLASS-FIBER REINFORCED POLYMER (GFRP) PIPE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Glass-Fiber Reinforced Polymer (GFRP) Pipe for jacking installation and direct burial installation.

1.02 REFERENCES

A. ASTM International (ASTM):

1. D638: Test Method for Tensile Properties of Plastics

2. D2412: Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

3. D3262: Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe

4. D3681: Standard Test Method for Chemical Resistance of “Fiber glass” Pipe in a Deflected Condition

5. D4161: Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Pipe materials

2. Pipe fittings

3. Pipe couplings

4. Accessories

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Instructions: Provide manufacturer's installation instructions for pipe.

D. Field Test Reports: Provide results for all testing performed as indicated in Subparagraph – Field Testing.

E. Project Record Documents: Provide marked-up set of drawings showing actual locations of piping, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Perform Work in accordance with municipality standards.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.07 WARRANTY:

A. Comply with the requirements specified in Section 01 78 36.

B. Provide standard product warranties for all sanitary sewerage utility materials and as required by municipality standards.

PART 2 PRODUCTS

2.01 MATERIALS:

A. The Manning's n factor shall be a maximum of 0.009.

B. Resin Systems: The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.

C. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

D. Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally affect the performance of the product.

E. Elastomeric Gaskets: Gaskets shall meet ASTM F477 and be supplied by qualified gasket manufacturers and be suitable for the service intended.

2.02 MANUFACTURE AND CONSTRUCTION:

A. Installation: GFRP pipes shall conform to the requirements for jacking installation and direct burial installation based on pipe size.

1. Jacking: All 85-inch nominal diameter GFRP pipes as shown on the construction drawings shall meet the jacking pipe requirements outlined in this specification.

2. Burial: All GFRP pipes smaller than 85-inch nominal diameter as shown on the construction drawings shall meet the burial pipe requirements outlined in this specification.

B. Pipes: Manufacture pipe by a casting process to result in a dense, nonporous, corrosion-resistant, consistent composite structure. The interior surface of the pipes exposed to sewer flow shall provide crack resistance and abrasion resistance. The exterior surface of the pipes shall provide UV protection to the exterior. Pipes shall be Type 1, Liner 1 or 2, Grade 1 or 3 per ASTM D3262.

1. Jacking: Pipe shall be designed to withstand the microtunneling subcontractor's jacking loads and ground conditions as presented in the Project Geotechnical Baseline Report (GBR). Detailed calculations shall be submitted to the Engineer for approval prior to its procurement/manufacture. Jacking pipe will have a x 4 SF for allowable maximum jacking load v ultimate compression load

2. Burial: Pipe shall be designed to withstand the installation method and ground conditions as presented in the Project GBR. Detailed calculations shall be submitted to the Engineer for approval prior to its procurement/manufacture.

C. Joints:

1. Jacking: Unless otherwise specified, the pipe shall be field connected with fiberglass bell – spigot type couplings, the bell will be fixed permanently to the bell end of the pipe, joints will utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness. The joints must meet the performance requirements of ASTM D4161. The joint shall have approximately the same O.D. and ID of the pipe, so when the pipes are assembled, the joints are essentially flush with the pipe inside and outside surface. The joints will maintain their seal and meet all requirements outlined in this specification with a joint gap of 2 inches. Joints at tie-ins, when needed, may utilize gasket-sealed closure couplings.

2. Burial: Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness. The joints must meet the performance requirements of ASTM D4161. Joints at tie-ins, when needed, may utilize gasket-sealed closure couplings.

D. Fittings: Flanges, elbows, reducers, tees, wyes, laterals and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays.

2.03 DIMENSIONS

A. Diameters: The actual outside diameter of the pipes shall be in accordance with ASTM D3262. For other diameters, OD's shall be per manufacturer's literature.

B. Lengths:

1. Jacking: Pipe shall be supplied in nominal lengths of 10 feet. Actual laying length shall be nominal +1, -4 inches. At least 90 percent of the total footage of each size and class of pipe, excluding special order lengths, shall be furnished in nominal length sections.

2. Jacking pipe will be supplied with 3-inch x 2-inch NCP threaded lubrication/ grouting ports every 10 feet of pipe, ports will be equally spaced at 120 degrees around the pipe circumference

3. Direct bury pipe will be supplied and installed in 20' pipe lengths unless noted overwise on drawings.

C. Wall Thickness:

1. Jacking:

a. The minimum wall thickness, measured at the bottom of the spigot gasket groove where the wall cross-section has been reduced, is determined from the maximum jacking load. Minimum factor of safety (FoS) against jacking force shall be equal to 4 based on the straight drives for the ICST. The Contractor shall use inter-jacking stations as required to reduce the thrust needed to advance the jacking pipe through the ground to meet the minimum FoS equal to 3. In the case where pipe manufacturer's casting molds are Outside Diameter (OD) controlled, the pipe's wall thickness shall not be increased in order to increase the allowable jacking loads to meet the required FoS which would compromise the pipe's inside diameter (ID) tolerances as specified below in Provision 2.03.C.1.a.1:

(1) The ID of the jacking pipe shall have an 1/8-inch tolerance, resulting in an ID between 82.675-inches and 82.925-inches

D. End Squareness:

1. Jacking: Pipe ends shall be square to the pipe axis with a maximum tolerance of 1/16-inch.

2. Burial: Pipe ends shall be in accordance with ASTM D3262.

2.04 TESTING:

A. Pipes: Pipes shall be manufactured and tested in accordance with ASTM D3262.

B. Joints: Joints shall meet the requirements of ASTM D4161.

C. Stiffness:

1. Jacking: Minimum pipe stiffness per manufacturer design, when tested in accordance with ASTM D2412 shall normally be 140 psi minimum.

2. Direct Bury: Minimum pipe stiffness per manufacturer design when tested in accordance with ASTM D2412 shall normally be 72 psi minimum.

2.05 CUSTOMER INSPECTION:

A. The Owner or other designated representative shall be entitled to inspect pipes or witness the pipe manufacturing.

B. Manufacturer's Notification to Customer: Should the Owner request to see specific pipes during any phase of the manufacturing process, the manufacturer must provide the Owner with adequate advance notice of when and where the production of those pipes will take place.

2.06 PACKAGING, HANDLING, AND SHIPPING:

A. Packaging, handling, and shipping shall be done in accordance with the manufacturer's instructions.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Installation: The installation of pipe and fittings shall be in accordance with the project plans and specifications and the manufacturer's requirements.

B. Pipe Handling: Use textile slings, other suitable materials or a forklift. Use of chains or cables is not permitted.

C. Jointing:

1. Clean ends of pipe and joint components.

2. Apply joint lubricant to the bell interior surface and the elastomeric seals. Use only lubricants approved by the pipe manufacturer.

3. Use suitable equipment and end protection to push the pipes together.

4. Do not exceed forces recommended by the manufacturer for joining or pushing pipe.

3.02 REPAIR/RESTORATION:

A. Repair any existing utilities/structures or features damaged during installation of sanitary sewerage utilities to Owner's satisfaction, and at no cost to Owner. Restore roadway trenches and patches per APWA Plan 255 and APWA Plan 256.

3.03 FIELD TESTING:

A. General:

1. Request inspection by Owner's Representative prior to placing bedding.

B. Cleaning and Testing:

1. Test for Displacement of Buried Sanitary Sewers: After trench has been backfilled and compacted, after cover over pipeline has been brought to finished grade, and after debris and silt has been removed, pipelines will be tested by the Engineer, as follows: Light will be flashed between maintenance holes, or, if maintenance holes have not yet been constructed, between locations of maintenance holes, by means of flashlight or by reflecting sunlight with mirror. Correct poor alignment, displaced pipe, and other defects indicated by the Engineer.

2. Cleaning: Flush out and clean sanitary force mains of foreign matter before placing systems into operation. Use flushing velocity of 10 feet per second, minimum or power washing as approved by Engineer. Take care to prevent scale and other objectionable matter from entering piping. Properly dispose of water used for flushing.

3. Deflection:

a. Jacking: Maximum allowable long-term deflection is 3 percent of the initial diameter.

b. Burial: Maximum allowable long-term deflection is 5 percent of the initial diameter

4. Testing of Sanitary Sewers: At such times as Engineer may direct, prove water tightness of buried sanitary sewer or portions thereof by one of the following tests. Conduct tests under supervision of the Engineer. Furnish materials, labor, and equipment required for tests and repair system until test results are satisfactory.

5. Infiltration: When, in opinion of the Engineer, trench or excavation is sufficiently saturated by groundwater or rain, tests may be made on basis of infiltration. Infiltration tests will only be allowed when hydrostatic head outside pipe is minimum of 4 feet above crown of pipe for entire length of pipe being tested. Measure flow of water at nearest downgrade maintenance hole. Make three series of measurements at intervals of not less than 1 hour, and average results. Using this average, calculate infiltration rate for 24-hour period. Infiltration rate: Not greater than 100 gallons per inch of pipe diameter per mile per day in any section of system including maintenance holes.

6. Exfiltration: When conditions are not suitable for infiltration test, subject pipe to hydrostatic head of at least 4 feet above pipe crown. Fill line until appropriate water level is obtained at selected upstream maintenance hole. Observe rate of drop at this maintenance hole for 1 hour. Leakage rate: Not to exceed maximum rate allowed for infiltration.

7. Vacuum test: For precast concrete maintenance holes 25 feet deep and less, a vacuum test may be used instead of exfiltration test. Conduct tests prior to backfilling and include joint between maintenance hole cover and frame. Plug and brace pipe openings. Draw vacuum of 10 inches of mercury. Minimum time to drop to 9 inches of mercury follows:

Table 33 30 05-1

	Maintenance Hole Diameter in Inches		
Depth in Feet	48	60	72
Up to 10	60 sec.	75 sec.	90 sec.
10.01-15	75 sec.	90 sec.	105 sec.
15.01-25	90 sec.	105 sec.	120 sec.

8. If maintenance hole fails the test, make necessary repairs and repeat the vacuum test and repairs until maintenance hole passes test. Submit test results.

3.04 FIELD PAINTING/COATINGS:

A. Repair any shop painting/coatings damaged during storage or installation to Owner's satisfaction.

3.05 ADJUSTING:

A. Coordinate with Engineer for any field adjustments. The Engineer reserves the right to reject any field adjustments.

3.06 PROTECTION:

A. Protect sanitary sewerage utilities from damage throughout storage, installation, testing, and final acceptance.

3.07 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 39 15

MAINTENANCE HOLES AND STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide maintenance hole and structures as indicated and in compliance with Contract Documents.

B. Requirements for precast concrete vaults are provided in Section 03 48 18 – Precast Reinforced Concrete Vaults.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 318: Building Code Requirements for Structural Concrete

B. ASTM International (ASTM):

1. A48: Standard Specification for Gray Iron Castings

2. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

3. A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

4. C478: Standard Specification for Precast Reinforced Concrete Manhole Sections

5. C877: Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections

6. C913: Standard Specification for Precast Concrete Water and Wastewater Structures

7. C923: Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

8. C990: Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

1.03 DESIGN REQUIREMENTS:

A. Equivalent Strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Components: In accordance with ASTM C913.

C. Design of Joints for Precast Components: In accordance with ASTM C913; maximum leakage of 0.025 gallons per hour per foot of joint at 3 feet of head.

D. Design and install maintenance hole and structure to withstand hydrostatic uplift caused by a groundwater elevation at 3 feet below grade level. Use only the weight of the maintenance hole and structure and hold-down slab to resist hydrostatic uplift with a minimum safety factor of 1.15. Do not include side friction of soils on walls.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Shop Drawings: Indicate maintenance hole and structure locations, elevations, piping, and conduit, sizes and elevations of penetrations.

2. Product Data: Submit cover and frame construction, features, configuration, dimensions.

3. One copy of results of tests and certification reports with each shipment of materials.

4. If manufacturer's test data is inadequate or unavailable, Engineer reserves right to require cores drilled for compressive strength tests.

5. Reinforcing Steel: Certificate of compliance with specifications.

6. Cement: Certificate of compliance with specifications.

7. Aggregates: Certificate of compliance with specifications.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Perform work in accordance with American Public Works Association (APWA) standard.

C. Maintain one copy of each document on-site.

D. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

E. Inspection by Engineer:

1. At site of work after delivery.

2. Reject precast concrete maintenance holes and structures at any time if it fails to meet specified requirements, even if accepted at plant.

3. Immediately remove rejected precast concrete maintenance holes and structures from site.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Comply with precast concrete manufacturer's instructions for unloading, storing and moving precast maintenance holes and structures.

C. Store precast concrete maintenance holes and structures to prevent damage to Owner's property or other public or private property. Repair property damaged from materials storage.

D. Mark each precast maintenance hole and structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

1.08 PROJECT/SITE CONDITIONS:

A. Maintain materials and surrounding air temperatures to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

B. Cold Weather Requirements: ACI 530.

PART 2 - PRODUCTS

2.01 MAINTENANCE HOLES AND STRUCTURES:

A. Manufacturers:

1. Geneva Pipe and Precast, Inc.

2. Oldcastle Infrastructure, Inc.

3. Harper Precast

B. Maintenance Hole and Structure Sections: Reinforced precast concrete in accordance with ASTM C478 with butyl-rubber sealants, Conseal CS-102 or Ram-Nek RN101 in accordance with ASTM C990. Wrap exterior section joints with membrane waterproofing and exterior joint wrap meeting the requirements of ASTM C877, Type III, Marmac, Conseal CS212, or Press-Seal Corp EA-Wrap.

C. Pipe Connections: Barrel section to pipe connections shall be sealed with resilient connectors, Kor-N-Seal by Trelleborg, complying with ASTM C923. Mechanical devices shall be stainless steel.

2.02 FRAMES AND COVERS:

A. Manufacturers:

1. D&L Supply Company

2. East Jordan Iron Works (EJ)

3. Neenah Foundry

B. Product Description: Shall be non-rocking conforming to ASTM A48, Class 30B cast iron construction or ASTM A536, Grade 60-40-18 ductile iron construction. Machined flat bearing surface, removable lid; rated for AASHTO HS-20 loading, unless noted otherwise. Unless noted otherwise, covers and frames shall be 30-inches in diameter, non-vented, machined flat bearing surface, removable lid; with embossed lettering saying “STORM DRAIN” or “SANITARY SEWER” as applicable cast into cover.

C. Base Pad: Cast-in-place concrete of type specified in Section 03 30 00, leveled top surface or precast concrete base section.

2.03 CONFIGURATION:

A. Shaft Construction: Concentric with eccentric cone or flat top section; lipped male/female dry joints; sleeved to receive pipe and conduit sections.

B. Shape: Cylindrical, Square, or Rectangular, as indicated on the drawings.

C. Clear Inside Dimensions: As indicated on Drawings.

D. Design Depth: As indicated on Drawings.

E. Clear Cover Opening: 30 inches diameter minimum or as indicated on Drawings.

F. Pipe and/or Conduit Entry: Furnish openings as indicated on Drawings. Barrel section to pipe connections shall be sealed with resilient connectors, Kor-N-Seal by Trelleborg;

Press-Seal Corporation; or A-Lok Products, Inc., complying with ASTM C923. Mechanical devices shall be stainless steel.

G. Steps: 14 inches wide, 12 inches on center vertically, set into maintenance hole and structure wall.

2.04 BEDDING AND COVER MATERIALS:

A. Bedding: Fill Type as specified in Section 31 23 00.

B. Cover: Fill Type, as specified in Section 31 23 00.

C. Soil Backfill from Above Pipe to Finish Grade: Soil Type, as specified in Section 31 23 00. Subsoil with no rocks over 6 inches in diameter, frozen earth, or foreign matter.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verification of existing conditions before starting work.

B. Verify items provided by other sections of Work are properly sized and located.

C. Verify built-in items are in proper location, and ready for roughing into Work.

D. Verify correct size of maintenance hole and structure excavation.

3.02 PREPARATION:

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.03 INSTALLATION:

A. Excavation and Backfill:

1. Excavate for maintenance holes and structures in accordance with Section 31 23 00 in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.

2. When groundwater is encountered, prevent accumulation of water in excavations. Place maintenance holes and structures in dry trench.

3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.

B. Place base pad, trowel top surface level.

C. Place maintenance hole and structure sections plumb and level, trim to correct elevations, anchor to base pad.

D. Backfill excavations for maintenance holes and structures in accordance with Section 31 23 00.

E. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour to form continuous drainage channel as indicated on Drawings.

F. Set cover frames and covers level without tipping, to correct elevations.

G. Coordinate with other sections of Work to provide correct size, shape, and location.

3.04 PRECAST CONCRETE MAINTENANCE HOLE AND STRUCTURE INSTALLATION:

A. Lift precast components at lifting points designated by manufacturer.

B. When lowering maintenance hole and structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

C. Set precast structures bearing firmly and fully on crushed stone bedding, compacted in accordance with provisions of Section 31 23 00 or on other support system shown on Drawings.

D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.

E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.

F. Joint sealing materials may be installed on site or at manufacturer’s plant.

G. Verify maintenance holes and structures installed satisfy required alignment and grade.

H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.

I. Cut pipe to finish flush with interior of structure.

J. Install exterior joint wrap per manufacturer's written installation instructions. Wrap shall extend 12 inches above and 12 inches below the joint.

K. Shape inverts through maintenance hole and structures as shown on Drawings.

3.05 CAST-IN-PLACE CONCRETE MAINTENANCE HOLE AND STRUCTURE INSTALLATION:

A. Prepare crushed stone bedding or other support system shown on Drawings, to receive base slab as specified for precast structures.

B. Erect and brace forms against movement in accordance with Section 03 10 00.

C. Install reinforcing steel as indicated on Drawings and in accordance with Section 03 21 00.

D. Place and cure concrete in accordance with Section 03 30 00.

3.06 FRAME AND COVER INSTALLATION:

A. Set frames using precast concrete grade rings. Maximum height of grades rings shall be 12 inches.

B. Set frame and cover 2 inches above finished grade for maintenance holes and structures with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.

3.07 FIELD QUALITY CONTROL:

A. Section 01 45 00: Field inspecting, testing, adjusting, and balancing.

B. Test cast-in-place concrete in accordance with Section 03 30 00.

C. Vertical Adjustment of Existing Maintenance holes and Structures:

1. Where required, adjust top elevation of existing maintenance holes and structures to finished grades shown on Drawings.

2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.

3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated Drawings.

4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete in accordance with Section 03 30 00.

D. Precast Concrete Maintenance Hole Test:

1. Vacuum test: For precast concrete maintenance holes 25 feet deep and less, a vacuum test may be used instead of exfiltration test. Conduct tests prior to backfilling and include joint between maintenance hole cover and frame. Plug and brace pipe openings. Draw vacuum of 10 inches of mercury. Minimum time to drop to 9 inches of mercury follows:

Table 33 39 15-1

	Maintenance Hole Diameter in Inches		
Depth in Feet	48	60	72
Up to 10	60 sec.	75 sec.	90 sec.
10.01-15	75 sec.	90 sec.	105 sec.
15.01-25	90 sec.	105 sec.	120 sec.

2. If maintenance hole fails the test, make necessary repairs and repeat the vacuum test and repairs until maintenance hole passes test. Submit test results.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 40 00

STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide storm drainage utilities as indicated and in compliance with Contract Documents.

B. This section specifies storm drainage systems from 5 feet outside the building and excludes interceptors, storm separators, or sub-drainage.

C. Section includes:

1. Storm drainage piping, fittings, and accessories.

2. Storm drainage catch basins, inlets, area drains, maintenance holes or other structures.

1.02 REFERENCES:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. M198: Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

2. M294: Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter.

B. ASTM International (ASTM):

1. C76: Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

2. C150: Standard Specification for Portland Cement.

3. C443: Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

4. C478: Standard Specification for Precast Reinforced Concrete Manhole Sections.

5. C858: Standard Specification for Underground Precast Concrete Utility Structures

6. C890: Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

7. C913: Standard Specification for Precast Concrete Water and Wastewater Structures

8. C923: Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

9. C990: Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

10. C1103: Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

11. D1785: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

12. D2729: Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

13. D3034: Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

14. D3212: Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

15. F477: Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

16. F679: Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

17. F1417: Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air

1.03 DEFINITIONS:

A. Catch Basin or Catchbasin: A special type of inlet structure designed to retain sediment and debris transported by stormwater into the storm drainage system.

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Sustainable Design Submittals.

2. Shop Drawings:

a. Precast Concrete Structures: Indicate locations, dimensions, configuration, thicknesses, elevations, sizes, and penetration elevations.

3. Product Data:

   a. Pipe: Material, pipe accessories, and manufacturer's installation instructions.

4. Certificates: Manufacturer's certificate stating that product meets or exceeds specified requirements.

5. Project Record Documents: Provide record drawings of actual pipe run locations, connections, structures, and invert elevations.

6. Testing results.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Conform to Standard Practices for Salt Lake City Public Utilities for materials and installation of work specified in this section.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PIPE MATERIALS:

A. Reinforced Concrete Pipe (RCP):

1. Pipe: ASTM C76, minimum Class III, unless noted otherwise; nominal inside diameter as indicated.

2. End Joints: Bell and spigot for pipes 12-inch diameter through 48-inch diameter. Tongue and groove for pipes 60-inch diameter and larger.

3. Joint Device:

   a. Water Tight: ASTM C443, rubber compression gasket.

   b. Manufacturer:

      (1) Geneva Pipe and Precast

      (2) Oldcastle Infrastructure

B. Plastic Pipe (PVC):

1. Pipe (4-inch through 15-inch diameter): ASTM D3034, Type PSM PVC material; minimum SDR35, nominal inside diameter as indicated.

2. Pipe (18-inch through 48-inch diameter): ASTM F679, Type PSM PVC material; minimum pipe stiffness 46 psi, nominal inside diameter as indicated.

3. End Joints: Bell and spigot per ASTM D3212.

4. Joint Device: Gasket Flexible elastomeric locked-in gasket per ASTM F477.

5. Manufacturer:

a. JM Eagle

b. Vinyltech

c. Diamond Plastics Corporation

C. Plastic Pipe (HDPE): AASHTO M294, Type S; high density polyethylene (HDPE) material; smooth interior and annular-corrugated exterior; bell shall be an integral part of the pipe and shall be watertight in accordance with ASTM D3212. Pipe gaskets shall be meet the requirements of ASTM F477 and shall be manufacturer installed. Joints shall remain watertight when subjected to a 1.5-degree deflection for pipe 4-inch through 24-inch diameter and 1.0-degree deflection for pipe 30-inch through 60-inch diameter.

1. Manufacturer:

a. ADS, Inc N-12 WT IB

b. Springfield Plastics, Inc.

2.02 CATCH BASINS:

A. Cast-in-place drainage structure per APWA Plan 315.1.

B. Minimum sump depth is 12 inches, unless noted otherwise.

C. Steps: None.

D. Grating: Per APWA Plan 308. Bicycle friendly, gray iron ASTM A48 Class 35B grate for H-20 traffic loading with asphalt-based coating.

1. Manufacturer:

a. D&L Supply

b. East Jordan

c. Neenah Foundry

2.03 CLEANOUT BOXES:

A. Cast-in-place drainage structure per APWA Plan 331.2, Type B.

B. Minimum sump depth is 12 inches, unless noted otherwise.

C. Steps: Required in boxes greater than 6 feet deep.

D. Ring and Cover: 30-inch per APWA Plan 302.1.

2.04 AREA DRAINS:

A. Precast drainage structure per ASTM C858 or ASTM C913.

B. Loading: H-20 traffic loading.

C. Grating: Steel frame to be cast into concrete riser or base. Bicycle friendly, gray iron ASTM A48 Class 35B grate for H-20 traffic loading with asphalt-based coating.

1. Manufacturer:

a. D&L Supply

b. East Jordan

c. Neenah Foundry

D. Minimum sump depth is 12 inches, unless noted otherwise.

E. Steps: None.

F. Manufacturer:

1. Harper Precast, Inc.

2. Geneve Pipe and Precast, Inc.

3. Oldcastle Infrastructure, Inc.

2.05 PRECAST MAINTENANCE HOLES:

A. Maintenance Hole Sections: Circular reinforced precast concrete in accordance with ASTM C478. Maintenance Hole diameter shall be as indicated on the Drawings. Axial length of barrel sections shall be selected to provide the correct total height with the

fewest joints. Conical sections shall be designed to support cast iron frames and covers under H-20 loading, unless noted otherwise.

1. Manufacturer:

   a. Geneva Pipe and Precast, Inc.

   b. Oldcastle Infrastructure, Inc.

B. Pipe Connections: Barrel section to pipe connections shall be sealed with resilient connectors, Kor-N-Seal by Trelleborg, complying with ASTM C923. Mechanical devices shall be stainless steel.

C. Joints: Water-tight joints shall be sealed with butyl-rubber sealants, ConSeal CS-102 or Ram-Nek RN101 conforming to ASTM C990.

D. Per Section 33 39 15.

2.06 CAST-IN-PLACE STRUCTURES:

A. Materials:

1. Concrete: Section 03 30 00, minimum compressive strength of 4,000 psi.

2. Portland Cement: ASTM C150, Type II.

3. Hydrated Lime: ASTM C207, Type S.

4. Sand: ASTM C33, Fine Aggregate, except all passes No. 8 sieve.

5. Water: Potable, not detrimental to concrete.

2.07 MIXES:

A. Mortar for Plugging Lift Holes: Mix Portland cement and sand, 1 part cement to 1/2 part sand with sufficient water to make mortar damp without "balling".

2.08 COMPONENTS:

A. Frame and Cover: Shall be non-rocking conforming to ASTM A48, Class 30B cast iron construction or ASTM A536, Grade 60-40-18 ductile iron construction. Machined flat bearing surface, removable lid; rated for AASHTO HS-20 loading, unless noted otherwise. Unless noted otherwise, covers and frames shall be 30-inches in diameter, non-vented, machined flat bearing surface, removable lid; with embossed lettering saying "STORM DRAIN" cast into cover.

1. Manufacturer:

a. D&L Supply Company

b. East Jordan Company

c. Neenah Foundry

2. Castings shall be as follows:

a. Free from scale, lumps, blisters, and sandholes.

b. Machine contact surfaces to prevent rocking.

c. Thoroughly clean and hammer inspect.

B. Maintenance Hole Steps: ASTM C478. Maintenance hole steps shall have a 1/2-inch ASTM A615 grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have a tread width of 14-inches (nominal), contoured to fit the hand for comfort, and a sure grip sturdy tread design with side molded slip-resistant wings. Steps shall be manufactured by American Step Company, Inc. or M.A. Industries.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify items provided by other sections of Work are properly sized and located.

B. Verify built-in items are in proper location, and ready for roughing into Work.

C. Verify correct size of maintenance hole and structure excavation.

3.02 PREPARATION:

A. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

B. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.03 TRENCHING:

A. See Section 31 23 23 for additional requirements.

B. Hand trim excavation for accurate placement of pipe to indicated elevations.

3.04 CATCH BASINS AND CLEANOUTS:

A. Form bottom of excavation, clean and smooth and to correct elevation.

B. Provide bedding in accordance with Section 31 23 33.

C. Place structure plumb and level on prepared bedding.

D. Orient structure for pipe connections.

E. Form and place cast-in-place concrete base pad.

F. Level the top surface of base pad and sleeve concrete shaft sections to receive storm drainage pipe sections.

G. Establish elevations and pipe inverts as indicated.

H. Establish top elevation and mount frame and cover.

I. Mount frame level in grout, secured to top cone section.

3.05 PRECAST STRUCTURES:

A. Provide bedding according to Section 31 23 33.

B. Lift precast components at lifting points designated by the manufacturer.

C. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.

D. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.

E. Joint sealing materials may be installed on site or at manufacturer’s plant.

F. Verify maintenance holes installed plumb and level and satisfy required alignment and grade.

G. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe or flexible connector.

H. Steps shall not be installed in maintenance holes.

I. Prior to backfilling, fill all cracks and voids in the maintenance holes or vaults with non-shrink grout, polyurethane sealant, or both.

3.06 FIELD QUALITY CONTROL:

A. Remove work that does pass tests; replace and retest until successful installation is achieved.

B. General:

1. Perform field-testing under provisions of Section 01 45 33.

2. Request inspection by Engineer prior to placing bedding.

C. Displacement Test:

1. After trench has been backfilled and compacted, after cover over pipeline has been brought to finished grade, and after debris and silt has been removed Engineer will visually inspect pipe. Pipes that do not present a uniform bore due to displacement and misalignment shall be replaced.

D. Deflection Test:

1. Test pipes for vertical ring deflection within 15 days after completion of backfill and again at least 4 months after installation but not later than 30 days before estimated substantial completion.

2. Maximum allowable ring deflection is 5 percent of vertical internal pipe diameter.

3. Replace pipe exceeding this allowable deflection.

E. Make deflection tests with deflectometer which produces a continuous record of pipe deflection by pulling mandrel, sphere, or pin-type go/no-go device through pipe. Make the diameter of go/no-go device to be 95 percent of the undeflected inside pipe diameter.

F. Vertical Adjustment of Existing Maintenance Holes and Structures:

1. Where required, adjust top elevation of maintenance holes and structures to finished grades shown on Drawings.

2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.

G. Cleaning and Testing:

1. Testing of Storm Drainage Utilities: At such times as Engineer may direct, prove watertightness of buried storm drainage utilities or portions thereof by one of the following tests. Conduct tests under supervision of the Engineer. Furnish materials, labor, and equipment required for tests and repair system until test results are satisfactory.

2. Infiltration: When, in opinion of the Engineer, trench or excavation is sufficiently saturated by groundwater or rain, tests may be made on basis of infiltration. Infiltration tests will only be allowed when hydrostatic head outside pipe is minimum of 4 feet above crown of pipe for entire length of pipe being tested. Measure flow of water at nearest downgrade maintenance hole. Make three series of measurements at intervals of not less than 1 hour, and average results. Using this average, calculate infiltration rate for 24-hour period. Infiltration rate: Not greater than 100 gallons per inch of pipe diameter per mile of pipe per day in any section of system including maintenance holes.

3. Exfiltration: When conditions are not suitable for infiltration test, subject pipe to hydrostatic head of at least 4 feet above pipe crown. Fill line until appropriate water level is obtained at selected upstream maintenance hole. Observe rate of drop at this maintenance hole for 1 hour. Leakage rate: Not to exceed maximum rate allowed for infiltration.

4. Air Pressure Test:

   a. Air testing for sections of pipe shall be limited to lines less than 36-inch average inside diameter.

   b. Lines 36-inch average inside diameter and larger shall be “joint” tested at each joint. The minimum allowable for the pressure drop from 3.5 psig to 2.5 psig during a joint test shall be 10 seconds, regardless of pipe size. Joint test shall be conducted as follows:

      (1) Each joint shall be tested successfully.

      (2) Joint tester shall be set over joint to be tested so that the two inflation tubes straddle the joint.

      (3) Inflate tubes to 25 psig to seal off joint to be tested.

      (4) Apply air pressure into void between inflation tubes until pressure reaches 4 psig.

      (5) After pressure has stabilized, bleed air pressure back to 3.5 psig.

      (6) Record time required for pressure to drop from 3.5 psig to 2.5 psig.

(7) If the time in seconds for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than 10 seconds, the joint shall be presumed to be free from defect. When the time is less than 10 seconds pipe breakage, joint leakage, or leaking testing seals are indicated and an inspection must be made to determine the cause. The Contractor shall affect such repairs as may be required to accomplish a successful air joint test.

c. For pipe sections less than 36-inch average inside diameter:

(1) Determine the groundwater level.

(2) Plug both ends of the pipe. For concrete pipe, flood pipe and allow 2 hours to saturate concrete. Then drain and plug pipe.

(3) After a maintenance hole to maintenance hole section of pipe has been sliplined and prior to any services lines being connected to new liner, plug liner at each maintenance hole with pneumatic plugs.

(4) Pressurize pipe to 4.0 psig. Increase pressure 1.0 psi for each 2.3 feet of ground water over highest point in the system. Allow pressure to stabilize for 2 to 4 minutes. Adjust pressure to start at 3.5 psig (plus adjustment for ground water table). See Table 33 40 00-2 at the end of this Section.

(5) To determine air loss, measure the time interval for pressure to drop to 2.5 psig. The time must exceed that listed in the Table 33 40 00-2 at the end of this Section for pipe diameter and length. For sliplining, use diameter of carrier pipe.

d. The test of the pipe and service laterals shall be conducted in the presence of the Engineer. Testing of pipe, regardless of the pipe material, shall be performed in accordance with ASTM C828 or ASTM F1417, as applicable.

e. Any section of pipe which fails to meet requirements shall be repaired and retested.

5. Vacuum test: For precast concrete maintenance holes 25 feet deep and less, a vacuum test may be used instead of exfiltration test. Conduct tests prior to backfilling and include joint between maintenance hole cover and frame. Plug and brace pipe openings. Draw vacuum of 10 inches of mercury. Minimum time to drop to 9 inches of mercury follows:

Table 33 40 00-1			
	Maintenance Hole Diameter in Inches		
Depth in Feet	48	60	72
Up to 10	60 sec.	75 sec.	90 sec.
10.01-15	75 sec.	90 sec.	105 sec.
15.01-25	90 sec.	105 sec.	120 sec.

6. If maintenance hole fails the test, make necessary repairs and repeat the vacuum test and repairs until maintenance hole passes test. Submit test results.

3.07 VIDEO INSPECTION:

A. Immediately after cleaning and testing, video the storm drainage pipeline to document the condition of the line. Notify the Engineer 24 hours in advance of any video inspection so that the Engineer may observe inspection operations.

B. Survey video inspection DVDs shall be continuous for pipe segments between maintenance holes. Do not leave gaps in the videotaping of a segment between maintenance holes and do not show a single segment on more than one DVD.

C. Do not pull or propel the video camera through the line at a speed greater than 30 feet per minute.

3.08 ALIGNMENT AND GRADE TEST:

A. Line and grade of pipe may not vary more than 1/2 inch in 10 feet and not more than 1-inch variance from true line at any location.

B. Grade of pipe may not vary more than 1/4 inch in 10 feet for all design grades less than or equal to 1 percent and not more the 1/2-inch total variance from true grade at any location. Also, grade of pipe may not vary more than 1/2 inch in 10 feet for all design grades greater than 1 percent and not more than 1-inch total variance from true grade at any location. These tolerances shall be acceptable provided that such variation does not result in a level or reverse sloping invert.

C. The variation in the invert elevation between adjoining ends of pipe due to eccentricity of joining surface and pipe interior surfaces shall not exceed 1/64 inch per inch of pipe diameter, or 1/4 inch maximum.

3.09 PROTECTION:

A. Protect pipe and bedding from damage or displacement until backfilling operation is completed.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

TABLE 33 40 00-2												
Pipe Diameter (inch)	Minimum Time (min:sec)	Length for Minimum Time (ft)	Time for Longer Length (sec/ft)	Specification Time for Length (L) Shown (min:sec)								
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	500 ft
6	5:40	398	0.8548	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:25	7:07
8	7:33	298	1.5196	7:33	7:33	7:33	7:33	7:36	8:52	10:08	11:24	12:40
10	9:27	239	2.3743	9:27	9:27	9:27	9:54	11:52	13:51	15:50	17:48	19:47
12	11:20	199	3.4190	11:20	11:20	11:20	14:15	17:06	19:57	22:48	25:39	28:30
15	14:10	159	5.3423	14:10	14:10	17:48	22:16	26:43	31:10	35:37	40:04	44:31
18	17:00	133	7.6928	17:00	19:14	25:39	32:03	38:28	44:52	51:17	57:42	64:06
21	19:50	114	10.4708	19:50	26:11	34:54	43:38	52:21	61:05	69:48	78:32	87:15
24	22:40	99	13.6762	22:48	34:11	45:35	56:59	68:23	79:47	91:10	102:34	113:58
27	25:30	88	17.3089	28:51	43:16	57:42	72:07	86:33	100:58	115:24	129:49	144:14
30	28:20	80	21.3690	35:37	53:25	71:14	89:02	106:51	124:39	142:28	160:16	178:05
33	31:10	72	25.8565	43:06	64:38	86:11	107:44	129:17	150:50	172:23	193:55	215:28

END OF SECTION

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SECTION 33 42 16

REINFORCED CONCRETE CULVERT PIPE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide materials, fabrication, testing, and installation of circular reinforced concrete culvert pipe complying with ASTM C76 or C655 as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. C76: Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe

2. C150: Standard Specification for Portland Cement

3. C361: Standard Specification for Reinforced Concrete Low-Head Pressure Pipe

4. C443: Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

5. C655: Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

6. C1478: Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes, and Laterals

7. C1479: Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Piping Using Standard Installations

8. D507: General Methods of Testing and Tolerances for Spun Rayon Yarns and Threads

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Prior to delivery of pipe from each manufacturing lot or run, submit:

1. Test results for external load crushing strength test per Section 11 of ASTM C76 or 10 of ASTM C655.

2. Certification of compliance with cited ASTM specifications of cement, aggregate, and reinforcement.

3. Manufacturer's description of admixtures used.

4. Adsorption test results per Section 11 of ASTM C76.

5. Manufacturer's report of visual inspection.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - MATERIALS

2.01 CIRCULAR REINFORCED CONCRETE CULVERT PIPE:

A. Comply with ASTM C76 or C655. Method of manufacture shall be either cast or spun. Obtain class or D-load rating from drawings. If no class or D-load is shown, use D-2000 pipe.

B. Cement shall comply with ASTM C150, Type V.

C. Acceptance shall be on the basis of plant load-bearing tests, material tests, and inspection of manufactured pipe for visible defects and imperfections as defined in ASTM C76 or C655. Conduct three-edge bearing test for load to produce a 0.01-inch crack. Conduct tests on 2 percent of the number of each size of pipe furnished for the project. For extended delivery schedules, conduct tests on two pipe sections for each size preliminary to delivery of pipe. Conduct remainder of tests during extended delivery schedule.

2.02 JOINTS:

A. Use push-on rubber-gasketed watertight type.

B. Bells, spigots, and rubber gaskets shall conform to ASTM C361 or C443 and shall be compatible with ASTM C76 or C655 pipe barrel. Use flared or flush bell design.

2.03 BASE, BEDDING, AND BACKFILL MATERIAL:

A. Use the following materials as specified in Section 31 23 33:

Zone	Material
Bedding, Pipe Zone, Trench Zone	3/4-inch well grade material

PART 3 - EXECUTION

3.01 PRODUCT MARKING:

A. Letter on the interior of each section of pipe the following:

1. Class designation or corresponding D-load to produce a 0.01-inch crack.

2. Date of manufacture.

3. Name of manufacturer and plant.

4. For elliptical or quadrant reinforcement, the vertical axis in which the pipe is to be laid.

3.02 REJECTION:

A. Reject and replace pipe exhibiting any of the following:

1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

2. Defects that indicate imperfect proportioning, mixing, and molding.

3. Surface defects indicating honeycombed or open texture.

4. Damaged or cracked ends where such damage would prevent making a satisfactory joint.

5. Any continuous crack having surface width of 0.01 inch or more and extending for a length of 12 inches or more, regardless of position in the wall of the pipe.

6. Exposure of any reinforcement indicating incorrect placement.

7. Any tested pipe that fails to meet the specified D-load.

3.03 INSTALLING BURIED PIPE:

A. Install in accordance with Section 31 23 33 and as follows.

B. When installing pipe in trenches, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure elevation at the pipe invert.

C. Lay pipe upgrade from structure to structure, with the bell ends of the pipe upgrade.

D. After joint assembly, bring the pipe zone and bedding material up to 1 foot above the top of pipe. Place the material in even lifts on each side of the pipe.

3.04 LEAKAGE AND INFILTRATION TESTING OF RUBBER GASKET JOINTS:

A. See Section 33 40 00.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 71 10

OVERHEAD POWER DISTRIBUTION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide overhead power distribution system as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. C135.14: Staples with Rolled or Slash Points for Overhead Line Construction

B. ASTM International (ASTM):

1. A47: Standard Specification for Ferritic Malleable Iron Castings

2. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

3. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

4. A575: Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades

5. A576: Steel Bars, Carbon, Hot-Wrought, Special Quality

6. B1: Standard Specification for Hard-Drawn Copper Wire

7. B8: Standard Specification for Concentric Lay Stranded Copper Conductors, Hard, Medium Hard, or Soft.

8. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.

9. B232: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)

C. American Wood Protection Association (AWPA):

1. C25: Sawn Crossarms.

2. P1: Standard for Creosote Preservative.

3. P5: Waterborne Preservatives.

4. P8: Standard for Oil-Borne Preservatives.

5. P9: Standards for Solvents and Formulations for Organic Preservative Systems.

D. Insulated Cable Engineers Association (ICEA):

1. S-93-639: 5-46kV Shielded Power Cable for Use in The Transmission and Distribution of Electric Energy

E. Institute of Electrical and Electronics Engineers (IEEE):

1. 48: Standard for Test Procedures and Requirements for Alternating Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5kV through 765 kV or Extruded Insulation Rated 2.5kV through 500 kV.

2. 404: Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500 000 V

3. C62.11 Standard for Metal-Oxide Surge Arresters for AC Power Circuits

4. C2: National Electrical Safety Code

5. C135.1: Zinc-Coated Steel Bolts and Nuts for Overhead Line Construction

6. C135.2: Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction

F. National Electrical Manufactures Association (NEMA):

1. CC 3: Connectors for Use Between Aluminum or Aluminum-Copper Overhead Conductors

2. C62.11: Surge Arresters

3. WC 74: 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

G. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

H. USDA Rural Utilities Service (RUS):

1. DT-5B: Wood Crossarms

I. Underwriters' Laboratories Inc. (UL):

1. 467: Standard for Grounding and Bonding Equipment

2. 486A: Standard for Safety Wire Connectors and Soldering Lugs for Use with Copper Conductors

3. 486B: UL Standard for Safety for Wire Connectors

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data:

1. Conductors.

2. Crossarms.

3. Cable Terminations.

4. Surge arresters.

5. Guy anchors.

6. Guy wires.

C. Coordination Drawings:

1. Submit to supplement Drawings, manufacturer's data and Drawings, and Contractor's data to demonstrate compliance with Contract Documents. Dimension Drawings or scale to show relative arrangement and mounting details of equipment or equipment assemblies.

D. Operation and Maintenance Data:

1. Include assembly, installation, operation and maintenance manuals, spare parts data which provides supplier name, current cost, catalog order number, and recommended list of spare parts to be stocked and documents previously submitted and accepted.

2. Data shall also include data outlining step-by-step procedures for system startup and operation, and troubleshooting guide which lists possible operational problems and corrective action to be taken.

3. Include brief description of equipment and their basic operating features.

1.04 QUALITY CONTROL:

A. Items of same classification shall be identical including equipment, assemblies, parts, and components.

B. Code Compliance:

1. Installation shall comply with requirements and recommendations of NFPA 70 and IEEE C2 for medium loading district, Grade B construction. No reduction in clearance shall be made.

C. Standard Product:

1. Material and equipment shall be standard product of manufacturer regularly engaged in manufacture of product and essentially duplicate items in satisfactory use for at least 2 years prior to Bid opening.

D. Equipment Nameplates:

1. Each major component of equipment shall have, as minimum, manufacturer's name, address, and catalog or style number on nameplate securely attached to item of equipment.

2. Nameplates for individual items of electrical equipment shall be as specified in referenced publications and provided on each item of equipment.

E. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.

2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

F. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 - PRODUCTS

2.01 CORROSION PREVENTION:

A. Metallic Materials: Protect against corrosion as specified. Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, use fittings conforming to UL 486A-486B.

B. Ferrous Metal Hardware: Hot-dip galvanized in accordance with ASTM A123 and A153.

2.02 CONDUCTORS, CONNECTORS AND SPLICES:

A. Bare Conductors:

1. Aluminum-Composition Conductors (ACSR): Aluminum-conductor-steel-reinforced, ACSR; ASTM B232.

2. Copper Conductors (CU): ASTM B1 and B8 to conductor size, hard-drawn temper.

B. Conductor sizes indicated are based on electrical and physical properties provided by materials specified. Where conductor materials other than as specified are used, such conductors shall provide equivalent ampacity and adequate strength for specified loading conditions.

C. Connectors and Splices: Copper alloys for copper conductors, aluminum alloys for aluminum-composition conductors, designed to minimize galvanic corrosion for copper to aluminum composition conductors.

1. Bare Conductors: NEMA CC 3 for aluminum composition and aluminum composition to copper.

2. Insulated Aerial Low Voltage Cable: NEMA CC 3 and UL 486A-486B for aluminum composition, aluminum composition to copper, and UL 486A-486B for copper to copper.

2.03 CROSS ARM AND HARDWARE:

A. Cross-arm Assembly:

1. RUS DT-5B solid wood, distribution type, with pressure treatment conforming to AWPA C25, and 1/4-inch, 45 degree chamfer on top edges.

2. Straight and free of twists to within 1/10-inch/foot of length. Bend or twist shall be in one direction only.

3. Machine, chamfer, trim, and bore cross-arms for stud and bolt holes before pressure treatment.

B. Pole Line Hardware:

1. Zinc-coated; IEEE C135.1, IEEE C135.2, ANSI C135.4, ANSI C135.14, ANSI C135.17, IEEE C135.22, and IEEE C135.33.

2. Steel hardware material, ASTM A575 and A576. Hardware shall be hot-dip galvanized in accordance with ASTM A153.

3. Pole-line hardware shall be hot-dip galvanized steel.

4. Install washers under boltheads and nuts on wood surfaces and elsewhere as required.

5. Washers used on through-bolts and double-arming bolts shall be approximately 2-1/4 inch square and 3/16-inch thick.

6. Diameter of holes in washers shall be correct standard size for bolt on which washer used.

7. Washers for use under heads of carriage bolts shall be of proper size to fit over square shanks of bolts.

8. Provide eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises wherever required to adequately support and to protect poles, brackets, crossarms, guy wires, and insulators.

2.04 MATERIALS AND EQUIPMENT:

A. Grounding and Bonding:

1. Equipment: UL 467.

2. Wire: ASTM B8, soft drawn copper

B. Guy Strands:

1. Zinc-coated steel, ASTM A47.

2. Material shall be aluminum-clad-steel-strand, with minimum breaking strength not less than as shown, except where 2 or more guys are used to provide required strength.

C. Guy Rods: Not less than 8 feet long by 1-1/2 inch diameter.

D. Nameplates:

1. Nameplates shall be made of corrosion-resistant metal with not less than 1/4-inch raised or engraved characters. Mount nameplate on front of enclosure.

E. Surge Arresters: IEEE C62.11 of metal-oxide type suitable for outdoor installations.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Coordinate connection to utility lines with Owner and electric utility.

3.02 POLE LINES:

A. General:

1. Provide cross-arm mounted, three-phase surge arrester and cable termination installations.

B. Clearances:

1. Cross arm shall be of length and strength indicated.

C. Guy Assemblies:

1. Construction:

a. Guy assemblies, including insulators and attachments, shall provide strength exceeding required guy strength.

b. Provide thimbles or thimble eyes on anchor rods and eye-bolt guy attachments to protect strands.

c. Provide half-round, yellow polyvinyl, fiberglass or other suitable plastic guy marker, not less than 8 feet long, where shown or required at anchor end of each guy, securely clamp to guy or anchor at bottom and top of marker.

d. Holding capacities for down guys shall be based on lead angle as indicated.

e. When field conditions prevent indicated lead angles, place anchors in other locations as accepted and increase guy strengths by ratio of sine of lead angle indicated to sine of lead angle provided, except lead angles shall be not less than 15 degrees.

2. Installation:

a. Guys shall be provided where shown, with loads and strengths as indicated.

b. Where single guy will not provide required strength, provide 2 or more guys.

c. Provide steel band attachment of guy wires to poles as indicated.

d. Provide multiple-helix screw anchors in marshy ground; install rock anchors in rock at right angles to guys, elsewhere anchors shall be expanding type, except power-installed screw anchors of equivalent holding power are acceptable.

3.03 CROSS-ARM INSTALLATION:

A. Mounting:

Bolt cross-arms to poles using mounting brackets with 5/8-inch through-bolts with square washers at each end. Bolts shall extend not less than 1/8-inch nor more than 2 inch beyond nuts. On single cross-arm construction, install bolt head on cross-arm side of pole.

B. Equipment Arms:

Set parallel or at right angles to lines to provide climbing space. Locate below line construction to provide necessary wire and equipment clearances.

C. Mounting Bracket Installation:

1. Install pole mounting brackets for cable termination and surge-arrester cross-arm supports to provide not less than required climbing space.

2. Attach brackets to poles with minimum of 2 bolts.

3.04 CONDUCTOR INSTALLATION:

A. Install conductor jumper loops to cable termination to maintain required clearances.

1. Miscellaneous Installations:

a. In vertical risers on poles, protect cables by conduit secured at intervals not exceeding 10 feet and within 12 inch of each side of bend or termination.

2. Supports: Use connectors, supports, clamps, and ties designed for particular purpose. Use materials, size and install in accordance with standard practice.

3.05 APPARATUS:

A. General:

1. Ground apparatus as specified in Article 3.07.

B. Surge Arresters:

1. Surge arresters shall be provided for protection of aerial-to-underground transitions.

2. Arresters shall be distribution-valve class rated as shown.

3. Equip arresters with mounting brackets suitable for indicated installations.

3.06 CONNECTIONS BETWEEN MEDIUM VOLTAGE OVERHEAD AND UNDERGROUND SYSTEMS:

A. Where indicated, connections between medium voltage overhead and underground systems shall be made as shown.

3.07 GROUNDING:

A. General Requirements:

1. Install equipment, neutral, and surge arrester ground systems at poles where indicated.

2. Resistance of not greater than 25 ohms shall be provided, unless otherwise specified.

3. Measure ground resistances in normally dry conditions not less than 48 hours after rainfall.

4. Combined ground resistance of separate systems bonded together below grade may be used to meet specified ground resistance.

B. Ground Rods:

1. Additional ground rod to the existing poles shall be provided for equipment grounding to achieve the specified ground resistance. New ground rod shall be driven into ground until tops of rods are approximately 1 foot below finished grade.

2. Space ground rods as evenly as possible at least 6 feet apart and connected 2 feet below grade.

3. Copper-coil-type grounds may be used at wood poles in lieu of ground rods where required ground resistance can be obtained by this method. Copper-coil-type ground shall consist of coil of at least 12 feet of 6 AWG minimum bare copper wire stapled to butt of pole.

4. Connections:

a. Make connections above grade with bolted solderless connectors and below grade with fusion-welding process.

b. Where ground wires are connected to aluminum-composition conductors, use specially treated or lined copper-to-aluminum connectors suitable for this purpose.

C. Equipment Grounding:

1. Ground noncurrent-carrying metal parts of medium voltage cable terminations and guy wire attachments as shown.

2. Ground wire sizes, not otherwise indicated, shall be not smaller than 6 AWG.

D. Surge Arrester Grounding:

1. Ground surge arresters.

2. Ground resistance for distribution class arresters shall be not more than 25 ohms.

3. Ground wire connections shall be not be less than 4 AWG for distribution arresters.

4. Overhead portion of surge arrester, cable termination and neutral ground conductor shall be bonded together to a new pole ground at pole base. The new pole ground shall be bonded to the existing pole ground and neutral as shown.

3.08 TESTS:

A. Ground-Resistance Measurements:

1. Ground-resistance measurements of each ground rod shall be taken and certified by Contractor to Engineer.

2. No part of electrical distribution system shall be energized prior to resistance testing of that system's ground rods and grounding systems and submission of test results to Engineer.

3. Test reports shall indicate location of ground rod and grounding system and resistance and soil conditions at time test was performed.

4. When building water service is used as ground or part of grounding system, ground-resistance measurements shall also be made of this connection.

5. Ground-resistance measurements shall be made in normally dry weather, not less than 48 hrs after rainfall, and with ground under test isolated from other grounds.

6. Resistance to ground shall be measured using fall-of-potential method described in IEEE 142.

B. Medium Voltage Pre-assembled Cable Test:

1. Medium voltage riser cables shall be installed and tested in accordance with Section 26 05 13.

C. Operating Test:

1. After installation is complete, conduct operating test for acceptance.

2. Equipment shall be demonstrated to operate in accordance with Contract Documents.

3. Perform tests in presence of Engineer.

4. Furnish instruments and personnel required for test, and necessary electric power.

3.09 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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DIVISION 40

PROCESS INTEGRATION

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SECTION 40 05 33

HIGH-DENSITY POLYETHYLENE (HDPE) PRESSURE PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide materials testing and installation of high-density polyethylene (HDPE) pressure pipe and fittings as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B18.2.2: Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

B. ASTM International (ASTM):

1. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

2. A194: Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

3. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

4. D638: Standard Test Method for Tensile Properties of Plastics

5. D3261: Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

6. D3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

7. F714: Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

8. F1055: Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing

9. F2620: Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

10. F3190: Standard Practice for Heat Fusion Equipment (HFE) Operator Qualification on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings

C. American Water Works Association (AWWA):

1. C906: Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution and Transmission.

2. M55: PE Pipe-Design and Installation

D. Plastics Pipe Institute (PPI):

1. TN-38: Bolt Torque for Polyethylene Flanged Joints

2. TR-33: Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Sustainable Design Submittals.

2. Action Submittals:

a. Shop Drawings:

(1) Catalog information confirming pipe, fittings, and other materials conform to requirements of this Section.

(2) Drawings of specific connection details.

(3) Drawing of fabricated or manufactured fittings.

(4) A plan for pipe joining and installation. The plan must be reviewed and approved by Engineer prior to pipe installation.

b. Submit HDPE temperature control plan describing Contractor's approach to controlling movement of the pipe related to the thermal expansion and contraction of the pipeline during installation. Plan shall outline Contractor's approach to mitigate and control movement during installation, backfill, and connection to flanges or structures.

3. Informational Submittals:

a. Manufacturer's Certificate of Compliance.

b. Infrared temperature gun product data.

c. Certificates of qualification for persons to be fusing HDPE pipe. Experience and training record of persons to be fusing HDPE pipe of this diameter.

d. Hydrostatic Testing Plan as required per Section 01 45 00.

e. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.

f. Hydrostatic test report documentation.

g. Fusion parameters including recommended limits of criteria recorded by data logger.

h. Fusion report for each joint.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Sustainability Standards Certifications.

C. Qualifications:

1. Pipe Manufacturer: Listed with Plastic Pipe Institute.

2. Persons fusing HDPE pipe shall have minimum of 1 year of experience with fusing HDPE pipe and shall have received a minimum of 20 hours of training for fusing HDPE pipe from pipe supplier or fusing equipment supplier.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1. Shipping: Do not cut, kink, or otherwise damage pipe during transportation.

2. Storage:

a. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.

b. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.

c. Keep pipe shaded from direct sunlight prior to installation in trench.

1.08 CONNECTIONS TO EXISTING PIPE, NEW PIPE, AND STRUCTURES:

A. Fusing to Existing HDPE Pipe: Comply with manufacturer's or distributor's recommendations based on Site conditions and PPI TR-33.

B. Any connections from new HDPE pipe to existing or new pipelines shall be done using a flanged restrained joint. If plans do not specify the type of joint between HDPE and another pipe or structure, use a flanged welded steel pipe spool to connect the new HDPE pipe to another pipe or concrete structure.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. JM Eagle

B. WL Plastics

C. Performance Pipe

D. InfraPipe

E. AGRU America, Inc.

2.02 MATERIALS:

A. Pipe and Fittings:

1. Conform to requirements of ASTM F714.

2. Resin: Polyethylene resin shall meet or exceed requirements of ASTM D3350 for PE 4710 material Cell Classification 445574C. Pressure rating shall be based on hydrostatic design stress of 200 psi at 73.4 degrees F.

3. Outside Diameter Basis: Iron Pipe Size (IPS) unless noted otherwise on Drawings.

4. Pipe Wall:

a. Sizes 2 Inches to 102 Inches: Solid wall

b. Sizes over 60 Inches: Profile wall

c. Sizes in the overlap range may be solid wall or profile wall.

d. Minimum Wall Thickness:

(1) Solid Wall: DR 13.5, unless Drawing require otherwise, or depth of cover dictates thicker wall for buried pipe.

(2) Profile Wall: RSC250, unless depth of cover dictates a higher class.

5. For piping exposed as in buildings, galleries and pumping stations connect to equipment using flanged connections. Use butt fused pipe, unless otherwise indicated.

6. Buried Piping: Use butt fused joints except where flanged joints are called out.

7. Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of a compatible resin mix for the fusion process.

8. Fittings:

a. Sizes 6 Inches and Smaller: Molded or fabricated from polyethylene pipe.

b. Sizes 8 Inches and Larger: Use thermal butt-fusion.

c. Polyethylene fittings shall have same or higher pressure rating as pipe.

B. Backup Rings:

1. Convoluted for Flanged Connections:

a. ASTM A240, Type 316 stainless steel, unless noted otherwise on the drawings.

b. Complete with one-piece, molded polyethylene flange adapters.

c. Flanged Connections: Same or greater pressure rating as pipe and sized to be compatible with mating flange.

C. Gaskets: Material, size, and thickness shall be as recommended by pipe or flange manufacturer, and in accordance with PPI Technical Note 38.

D. Joints:

1. Buried Pipe: Provide thermal butt fusion joints except where flanges joints are called out on plans.

2. Buried Flanged Joints: Buried HDPE flanged joints shall have 316 stainless steel follower rings and bolting, all coated (after assembling) with wax tape coating per AWWA C217.

E. Bolts, Nuts, Washers:

1. Type 316 stainless steel, ASTM A193, Grade B8 hex head bolts; and ASTM A194, Grade 8 hex head nuts.

2. Bolts: Fabricated in accordance with ASME B18.2.2 and provided with washers of same material as bolts.

F. Wall Anchor (Anchor Ring):

1. Material: Same as HDPE pipe.

2. Internal Diameter: Equal to adjacent pipe.

3. Shear Strength: Equal to or greater than tensile strength of adjacent pipe.

4. Fabrication: Butt fusion. Extrusion bead welding is not allowed.

G. Electrofusion Flex Restraint: Electrofusion flex restraint is not allowed.

H. Products that restrain HDPE pipe with wedges, machined serrations, or clamps are not acceptable.

2.03 TRACER WIRE:

A. All direct bury piping (including service lines) shall be installed with 12 gauge solid copper THHN tracer wire for pipeline location purposes by means of an electronic line tracer.

1. The wires must be installed along the entire length of the pipe on the top of the pipe and be held in place with ties or hitches spaced not more than 12-feet apart.

2. Sections of wire shall be spliced together using approved splice caps and waterproof seals or solder. Twisting the wires together is not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:

1. Install buried polyethylene pipe in conformance with Section 31 23 33, AWWA M55, PPI TR-33, ASTM F2620, and pipe manufacturer's recommendations.

2. Joining:

    a. Buried Pipe:

        (1) Butt-fuse pipes and fittings in accordance with pipe manufacturer's recommendations. Depending on Site conditions, perform butt-fusion joining in or outside of excavation.

3. If HDPE pipe surface temperature is above 80 degrees F as measured with infrared temperature gun, allow pipe to cool prior to making any connections to flanges, existing pipeline systems, or structures.

4. Connect HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems with flanged connections as follows:

    a. Polyethylene flange adapter, thermally butt-fused to end of pipe. Flange "stub ends" are not allowed.

    b. Convoluted backing flange, as specified herein.

    c. Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard.

    d. Follow requirements of PPI Technical Note 38 including mandatory 4-hour bolt retorquing.

5. Special Precautions at Flanges: Support polyethylene pipe connected to heavy fittings, maintenance holes, and rigid structures in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

6. Minimum Long-Term Field Bending Radius: Restricted to limits recommended by AWWA M55, Table 8-2.

B. Placement in Trench:

1. Control water in trench per Section 31 23 33.

2. Handle joined pipeline in such a manner that pipe is not damaged by dragging it over sharp and cutting objects.

3. Position slings for handling pipeline away from butt-fused joints.

4. Remove sections of damaged pipe and replace it with undamaged pipe. Damaged pipe is defined as pipe with kinks or gouges exceeding 10 percent of pipe wall thickness.

5. Exercise care when lowering pipe into trench to prevent damage or twisting of pipe.

6. At flanges, valves, and connections, excavate out trench bottom sufficiently to provide clearance between undisturbed trench bottom and flange, valve, or connection.

3.02 FIELD TESTING:

A. Joint Fusion:

1. Measure and log each joint fusion by an electronic monitoring device (data logger) affixed to fusion machine, and shall be capable of being retrieved electronically. Fusion operators shall be certified according to ASTM F3190 or latest nationally recognized certification. Data to be logged shall include the following:

a. Pipe size and dimensions.

b. Machine model and size.

c. Operator identification.

d. Job identification number.

e. Weld number.

f. Fusion, heating, and drag pressure settings.

g. Heater plate temperature.

h. Time stamp showing when weld was performed.

i. Heating and curing time of weld.

j. Curing temperature readings and time stamps of readings.

k. Error messages and warnings for out of range temperature or pressure settings.

2. In addition to logged items above, the following shall be logged or annotated on report:

a. Location of joint being fused by pipeline station or by reference to pipe Shop Drawing.

b. Ambient temperature and humidity.

c. If internal bead was removed.

B. Joint Weld Testing:

1. Contractor shall perform joint testing in accordance with testing procedures specified in ASTM D638.

2. Specimens: Cut pipe 12 inches on each side of field made joint. Rejoin ends and proceed with Work.

3. Test Frequency:

a. First 500 Linear Feet: Two joints selected at random by Engineer.

b. Each Additional 2,000 Linear Feet: One joint selected at random by Engineer.

c. Each Test Failure: Two additional joints selected at random by Engineer.

3.03 PRESSURE AND LEAK TEST:

A. The system design pressure shall be 150 psi, unless noted otherwise on the drawings. Hydrotest DR 26 forcemains to the pressure rating of the pipe (ie 64 psi).

B. Testing in the trench: Fill the pipeline with water after it has been laid; bleed off any trapped air. Subject the lowest element in the system to a test pressure that is 1.5 times the design pressure, and check for any leakage. When, in the opinion of the Engineer, local conditions require that the trenches be backfilled immediately after the pipe has been laid, apply the pressure test after backfilling has been completed but not sooner than a time which will allow sufficient curing of any concrete that may have been used.

1. The test procedures consist of two steps: the initial expansion and the test phase. When test pressure is applied to a water-filled pipe, the pipe expands. During the initial expansion of the pipe under test, sufficient make-up water must be added to the system at hourly intervals for three hours to maintain the test pressure. After about four hours, initial expansion should be complete and the actual test can start.

2. When the test is to begin, the pipe is full of water and is subjected to a constant test pressure of 1.5 times the system design pressure. The test phase should not exceed three hours, after which time any water deficiency must be replaced and measured. Add and measure the amount of make-up water required to return the test pressure and compare this to the maximum allowance in Table 40 05 33-1 below.

Table 40 05 33-1 Allowance for Expansion Under Test Pressure							
Nominal Pipe Size	U.S. Gal/100 ft of Pipe			Nominal Pipe Size	U.S. Gal/100 ft of Pipe		
	1-Hour	2-Hour	3-Hour		1-Hour	2-Hour	3-Hour
2	0.08	0.12	0.15	22	3.50	7.00	10.50
3	0.10	0.15	0.25	24	4.50	8.90	13.30
4	0.13	0.25	0.40	28	5.50	11.10	16.80
5	0.21	0.41	0.63	30	6.20	12.60	19.10
6	0.30	0.60	0.90	32	7.00	14.30	21.50
8	0.50	1.00	1.50	36	9.00	18.00	27.00
10	0.75	1.30	2.10	42	12.00	24.00	36.00
12	1.10	2.30	3.40	48	15.00	27.00	43.00
14	1.40	2.80	4.20	54	18.00	30.00	50.00
16	1.70	3.30	5.00	60	21.00	33.00	57.00
18	2.20	4.30	6.50	72	27.00	39.00	71.00
20	2.80	5.50	8.00	78	30.00	42.00	78.00

From PPI Technical Report TR-31 by the Plastic Pipe Institute.

C. An alternate leakage test consists of maintaining the test pressure over a period of four hours, and then dropping the pressure by 10 psi. If the pressure then remains within 5 percent of the target value for one hour, this indicates there is no leakage in the system.

D. Under no circumstances shall the total time under test exceed eight hours at 1.5 times the system pressure rating. If the test is not complete within this time limit (due to leakage, equipment failure, etc.), the test section shall be permitted to "relax" for eight-hours prior to the next test sequence.

3.04 MANUFACTURER'S SERVICES:

A. Provide pipe manufacturer's representative at Site for assistance during pipe joining operations and pipe installation.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 40 05 90.02

STAINLESS STEEL SLIDE GATES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test stainless steel slide gates and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

2. A276: Standard Specifications for Stainless Steel Bars and Shapes.

3. B584: Standard Specification for Copper Alloy Sand Castings for General Applications.

4. D2000: Standard Classification System for Rubber Products in Automotive Applications.

5. D4020: Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials

B. American Welding Society Code.

C. American Water Works Association (AWWA):

1. C561: Fabricated Stainless Steel Slide Gates

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Certified shop and erection drawings. Contractor shall submit electronic files of the proposed equipment in the capacity, size, and arrangement as indicated and specified. Contractor shall confirm opening size prior to developing shop drawings for gates.

2. Data for gate and actuator characteristics and performance.

3. Complete description of all materials, material thicknesses of all components.

4. Maximum bending stress and deflection of the slide under design head specified and indicated.

5. Installation drawings showing the details required for installation, dimensions, clearances and anchor bolt locations, including for stem guides, stem guide supports and pedestal supports. Where indicated in the Gate Schedule, structural design of the stem guide supports and pedestal supports, including anchors, shall be signed and sealed by an engineer in the State of Utah.

6. Shop drawing data for accessory items.

7. Certified setting plans, with tolerances, for anchor bolts.

8. Manufacturer's literature as needed to supplement certified data.

9. Operating and maintenance instructions and parts lists.

10. Certified results of gate shop testing, including shop leakage test results of each gate at the design unseating head specified and indicated

11. Certified results of actuator shop testing from the actuator manufacturer.

12. List of recommended spare parts other than those specified.

13. Shop and field inspection reports.

14. Qualifications of field service engineer.

15. Recommendations for short and long-term storage.

16. Shop and field testing procedures and set up

17. Special tools.

18. Manufacturer’s product data, specifications and color charts for shop painting.

19. Motor shop test results.

20. The latest ISO 9001 series certification or quality system plan.

21. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an

installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process, structural, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1. One set of all special tools.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Gates shall be the product of one manufacturer.

C. Gates shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Welding: In accordance with latest applicable American Welding Society Code, ASME Welding Code, or equivalent.

E. Shop tests as specified, including shop leakage testing of each gate at the design unseating head to confirm compliance with the leakage rate specified and indicated.

F. The Contractor shall obtain the gates, actuators and appurtenances from the gate manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

G. Services of Manufacturer's Representative as stated in Section 01 45 00 and as specified herein.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Ship electric actuators separate from the gate assembly.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Gate sizes and operating data are indicated in the Slide Gate Schedule.

2.02 MANUFACTURERS:

A. Stainless Steel Slide Gates:

1. Whipps

2. RW Gate Co.

2.03 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were

performed and that all components have been sized for the seismic forces specified and indicated.

2.04 SLIDE GATE CONSTRUCTION:

A. Provide all gates produced by a single manufacturer and designed for installation in the channels and structures as specified and indicated.

B. Gate Configuration: As indicated in the Slide Gate Schedule.

C. Provide all gates in conformance with AWWA C561 and as specified.

D. Self-contained, non-self-contained, rising or non-rising stem, flush bottom type with self-adjusting seals.

E. Gates with adjustable wedges or wedging devices are not acceptable.

F. Provide all structural components 1/4-inch minimum thickness.

G. Gate assemblies shall be media blasted or passivated in accordance with ASTM A380 prior to shipment to remove all mill scale, weld splatter, discoloration, or other surface imperfections.

H. Leakage Rate:

1. Seating head and unseating head conditions: Leakage not to exceed half of the allowable leakage rate specified in AWWA C561.

I. Assembly to consist of the following:

1. Frame

2. Slide

3. Stem

4. Seals

5. Benchstand with operator type as indicated in the Slide Gate Schedule.

J. Materials:

1. Frame Assembly and Retainers: ASTM A240 Type 316L stainless steel.

2. Slides and Stiffeners: ASTM A240 Type 316L stainless steel.

a. 1/4-inch minimum thickness.

3. Seat, seals and facing: ASTM D4020 UHMW (Ultra-high Molecular Weight Polyethylene

4. Invert Seal for upward acting gates only: ASTM D2000 Neoprene or EPDM

5. Stems: ASTM A276 Type 316 stainless steel.

   a. Minimum diameter: 1-1/2-inch

6. Lift Nuts: ASTM B584 Bronze

7. Floorstand and Wall Brackets: ASTM A276 Type 316L stainless steel

8. Gear Operator Housing: Cast aluminum or ductile iron

9. Hardware, studs and nuts: ASTM A276 Type 316 stainless steel

10. Anchor bolts: Type 316L stainless steel. Minimum diameter of 1/2-inch.

K. Slide:

1. Slide and reinforcing stiffeners welded to the slide.

   a. Stainless steel plate, minimum 1/4-inch.

   b. Reinforcement: Provide a minimum of two horizontal stiffeners welded to the slide and two vertical stiffeners welded to outside of the horizontal stiffeners.

   c. Provide slide to engage the guide a minimum of 1 inch on each side and have a minimum material thickness of 1/2 inch where it engages the guide.

   d. Provide the stem connector constructed of two angles or plates welded to the slide. Provide a minimum of two bolts connecting the stem to the stem connector.

2. Deflection: Maximum as specified in AWWA C561.

L. Seals:

1. Provide a self-adjusting seal system suitable for the leakage, frequent cycling and velocities specified herein, and mounted such that there is no obstruction to the specified gate opening size.

2. Provide gates equipped with UHMW polyethylene seat/seals to restrict leakage and to prevent metal to metal contact between the frame and slide.

3. Extend the seat/seals to accommodate the 1.50 x the slide height with the gate in the fully open or fully closed position.

4. Provide all upward opening gates with a resilient flush bottom seal for sealing the invert of the gate.

5. Provide all downward opening weir gates with self-adjusting UHMW seat/seals across the invert member.

6. Provide all seals mechanically fastened to the frame or slide, force fit seals or seals attached with adhesive are not acceptable.

7. Provide all seats and seals to be field replaceable without the need to remove grout or concrete and without the need to remove the frame from the wall or wall thimble.

8. Gates using "J" or "P" seals are not acceptable.

M. Frames:

1. Provide frame assembly including guide members, invert members and yoke members constructed of formed stainless steel plate with a minimum thickness of 1/4-inch.

2. Provide gussets to support the guide members for unseating gates as required by the design head specified and indicated.

   a. Provide gussets extended to support the outer portion of the guide assembly and positioned to transfer the load to the anchor bolts or the wall thimble studs.

3. Provide frames for mounting type as indicated in the Slide Gate Schedule.

   a. Embedded

   b. Wall mounted with stainless steel anchor bolts and non-shrink, non-metallic grout or EPDM gasket

   c. Thimble mounted with stainless steel mounting studs and mastic gasket

4. Provide all wall mounted and thimble mounted gates with a flanged frame. Flat frame gates are not acceptable.

5. Provide all mounted and wall thimble mounted frames with a minimum guide weight of 11 lbs/ft and a minimum guide extension weight of 6.5 lbs/ft.

6. Provide guide extensions constructed of C-channel shape or similar. Angles are not acceptable guide extensions.

7. Frame Guides and Invert Members: Provide frames as a one-piece, fully welded assembly.

    a. Bolt-on yokes are acceptable when necessary to facilitate slide removal.

    b. Frames that require field assembly are not acceptable unless the overall frame size exceeds a size suitable for shipment on a standard flatbed truck.

8. Provide the frame guides extending to accommodate the entire height of the slide when the slide is in the fully opened position on upward opening slide gates or downward opening weir gates.

9. For self-contained gates, provide a yoke across the top of the frame guides with the yoke formed by two structural members fixed to the top of the guides to provide a one-piece rigid frame.

    a. Provide the yoke designed to allow removal of the slide.

10. Provide a rigid stainless steel invert member across the bottom of the opening.

    a. Invert member: Flush bottom type on upward opening gates with a minimum weight as specified

11. Provide a rigid stainless steel top seal member across the top of the opening on gates designed to cover submerged openings.

12. Provide a rigid stainless steel member across the invert of the opening on downward opening weir gates.

N. Stems:

1. Provide a threaded operating stem to connect the operating mechanism to the slide.

2. For rising stem gates provide the threaded portion engaging the operating nut in the manual operator or motor actuator.

3. For non-rising stem gates provide the threaded portion engaging the nut on the slide.

4. Minimum stem outside diameter of 1-1/2 inches.

5. Stem extension pipes are not acceptable.

6. Provide the stem constructed of solid stainless steel bar for the entire length

7. Tensile strength: Not less than 60,000 psi for stems.

8. Provide the stem threaded to allow full travel of the slide unless otherwise specified or indicated.

9. L/R: Not to exceed 200.

10. Provide the stem in accordance with AWWA C561, to withstand in tension the loads caused by an 80 pound effort on the manual crank or handwheel without exceeding 25 percent of the ultimate tensile strength of the stem material.

11. Motor Operators: Design stems to withstand in compression 1.30 x stalled output.

12. Provide the stem, in tension, designed to withstand a load caused by a 40 pound effort on the crank or handwheel without exceeding 1/5 of the ultimate tensile strength of the stem material.

13. Provide the threaded portion of the stem machined rolled or cut full depth ACME type threads with 16 micro-inch or better finish. Stub threads are not acceptable.

14. Provide stems of more than one piece joined by bronze or stainless steel couplings with the coupling bolted to the stem.

15. Provide dual stems for upward opening gates wider than 60-inch when the opening width is 2 x greater or more than the height of the slide. Provide dual stems for downward opening gates wider than 48 inch when the opening width is 2 x greater or more than the height of the slide.

16. Provide stems on manually operated gates with an adjustable stop collar to prevent over closing of the gate.

17. For rising stem gates, provide clear plastic covers with 1-inch graduations. Provide vent holes to prevent condensation.

2.05 STEM GUIDES:

A. Provide stem guides where required to maintain L/R of 200 or less for the unsupported length of the stem

B. Provide stem guides and brackets of Type 316L stainless steel.

1. Adjustable in two directions

2. Minimum Thickness: 1/4-inch

3. Bushings: UHMW or bronze

2.06 WALL THIMBLES:

A. Provide where indicated on the Slide Gate Schedule.

1. Provide “F” thimbles for all systems not connected to piping systems

2. Provide “E” thimbles for all gates connected to piping systems

B. Provide “E” thimble depth equal to the thickness of the concrete wall in which the thimble is to be mounted.

C. For “F” thimbles in walls 36 inch thick and smaller provide thimble depth equal to the thickness of the concrete wall in which the thimble is to be mounted. For walls 36 inches thick and larger provide a minimum of 36-inch deep “F” thimble.

D. Provide a water stop continuously welded or stitch welded and sealed on both sides around the periphery of the thimble.

E. Provide wall thimbles of fabricated Type 316L stainless steel construction of adequate section to withstand all operational and installation stresses.

1. Minimum thickness including front face: 3/8-inch

F. Provide the thimble square and plumb and the front face sufficiently flat to provide a mounting surface for the gate frame to achieve the specified leakage rate.

G. Provide the face of the wall thimble machined if recommended by the gate manufacturer. If the wall thimble is to be machined provide the front face with a minimum thickness of 3/8-inch after machining.

H. Provide a gasket or mastic to seal between the gate frame and the wall thimble.

2.07 MANUAL OPERATORS:

A. Provide a manual gate operator for each gate so specified.

1. Provide all gates with slides 24 inches tall or taller with a gearbox operator suitable for use with a portable operator.

B. Type of operator as indicated in the Slide Gate Schedule.

C. Manually operated floorstands and benchstands:

1. Handwheel or crank operated floorstand or benchstand as indicated in the Slide Gate Schedule.

a. Handwheel: No gear reduction.

b. Handwheel or Crank Gearbox Operator: Single or double gear reduction.

c. Material: Cast aluminum or ductile iron housing

2. Provide a threaded cast bronze lift nut to engage operating stem.

3. Provide roller bearings above and below a flange on the operating nut to support both opening and closing thrusts.

4. Operate gates under the operating head and design head, as specified and indicated, with no greater than a 40 pound effort on the crank or handwheel.

5. Gears, where required, steel with machined cut teeth designed for smooth operation.

6. Provide Type 304 or 400 Series stainless steel pinion shafts on crank operated benchstands and floorstands supported on tapered roller bearing or ball bearings with all components totally enclosed in a weatherproof housing with a removable cover.

a. Design bearing arrangement for use with portable operators specified herein.

7. Provide mechanical seals on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist mechanism.

8. Provide lubricating fittings for the lubrication of all gears and bearings.

9. Floorstands: Provide a Type 316L stainless steel pedestal, constructed of minimum Schedule 40 tube and 3/8-inch thick base plates, designed to position the input shaft or crank operator or handwheel approximately 36-inch above the operating level.

10. Benchstands: Provide with a rectangular cast aluminum or ductile iron base machined and drilled for mounting purposes. Provide all adaptor plates of Type 316L stainless steel.

11. Stamp or cast an arrow with the word "OPEN" on the floorstand, benchstand or handwheel indicating the direction of rotation to open the gate.

12. Handwheels: Minimum 15 inches, maximum 24 inches diameter and removable.

13. Cranks: Cast aluminum or stainless steel with revolving nylon grip and removable.

14. Provide two gearboxes for all upward opening gates 60 inch wide and larger and with opening widths greater than 2 x gate height. Provide two gearboxes for all downward-opening gates wider than 48 inch wide and larger and with opening widths greater than 2 x gate height.

    a. Provide Type 316 stainless steel interconnecting shaft.

    b. Provide flexible couplings at each end of the interconnecting shaft.

    c. Provide a handwheel or crank mounted on the pinion shaft of one of the gear boxes.

D. Extended Operators:

1. Provide an extended operator system to bring the pinion shaft to 36 inches above the operating level utilizing chain and sprockets when the centerline of the handwheel on a non-geared operator is located 48 inches or more above the operating level.

2. Chainwheels are not acceptable.

3. Provide a removable Type 316L stainless steel cover to enclose the chain and sprockets.

4. If the centerline of the pinion shaft is 60 inches or less above the operating level a handwheel may be used with a gearbox in lieu of the extended operator system specified above.

E. Operating Nut:

1. All gates shall be provided with a 2 inch square operating nut mounted to the manual or electric actuator.

    a. Nut Material: Bronze.

    b. Where indicated and specified provide a Type 316L stainless steel or cast iron floor box be set in the concrete floor above the gate as indicated.

    c. Provide one Type 316L stainless steel T-handle wrench for operation.

F. Floorstands and Wall Brackets:

1. Provide Type 316L stainless steel floorstands of a height such that the handwheel or crank operated pinion shaft is located 36 inches (915 mm) above the operating level.

2. Provide Type 316L stainless steel wall brackets to support floorstands.

a. Provide wall brackets reinforced to withstand in compression a minimum of 2 x rated output of the operator with an 80 pound effort on the crank or handwheel.

2.08 ELECTRIC MOTOR ACTUATORS:

A. Provide in accordance with Section 40 23 13.03.

2.09 PORTABLE OPERATORS:

A. Furnished and fabricated by slide gate manufacturer.

1. Provide 1 portable operator sized to operate all slide gates provided.

B. Electric Drill Operator:

1. Ensure all gates provided are compatible with the Owner's portable electric drill operator:

a. Milwaukee 1-1/4 inch Super Hole Shooter

(1) Cat. No. 2404-1, 250 RPM, 120V, 10A

2. Provide portable operator with reversing switch and safety hold-down, ON-OFF switch incorporated in handle.

a. Electrical Service: 120V, single-phase, 60 Hertz.

3. Drive through overload release clutch of positive spring-loaded pawl type releasing instantly at preset torque of 40 feet-pound.

4. Provide adapter to fit pinion shaft of floorstand.

5. Provide 25 feet long heavy duty cord with 3-prong plug with unit.

2.10 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10.

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.11 SHOP TESTING:

A. Provide motor actuator shop testing in accordance with Section 40 23 13.03.

B. Assemble each gate and inspect for proper seating.

1. Check clearance between frame and disc seating surfaces.

C. Fully open and close each gate in guide system to ensure gates operate freely as recommended by the gate manufacturer.

D. Conduct a shop leakage test at the design unseating head on each gate to confirm leakage as specified and indicated for Field Testing.

E. Operate floorstands and benchstands to insure proper assembly and operation.

F. Repeat tests until specified results are obtained.

G. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with shop drawings, manufacturer's printed instructions and as indicated.

B. Clean debris, dirt, and gravel, from inside of gates and channels before placing gates.

C. Install slide gates in completely assembled condition.

D. Erect and support slide gates in positions free from distortion and strain on appurtenances during handling and installation.

E. Inspect material for defects in workmanship and material.

F. Clean out debris and foreign material from gate opening and seats, test operating mechanisms to check proper functioning, and check nuts and bolts for tightness. Repair gates and other equipment which do not operate easily or are otherwise defective.

G. Set floorstand operators and stem guides so stems run smoothly in true alignment. Anchor guides firmly to walls. Check distances from centerlines of gates to operating level or base of floorstand and adjust if necessary to suit actual conditions of installation.

3.02 MANUFACTURERS SERVICES:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Comply with requirements for checkout, startup, and testing in Section 01 78 25.

3. Physical Checkout and Field Testing (Functional Completion Testing): Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connections; certify proper installation:

a. 1/2 person-day

4. Startup: Calibrate, check alignment and perform a functional test with water or process fluid. Tests to include all items specified.

a. 1/2 person-day

B. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of electrical connection:

a. 1 day

3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.

a. 1 day

4. Field Performance Testing: Field performance test equipment specified.

a. 1 day

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

   a. 1 trips, 1/2 day per trip

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

C. Manufacturer of gates shall have a minimum of five (5) operating installations with gates of the size specified and in the same service as specified operating for not less than five (5) years or manufacturer of gates shall utilize a Project Manager that is experienced in stainless steel gate design and construction. The Project Manager shall be an employee of the gate manufacturer and shall have designed a minimum of five (5) operating installations with gates of the size specified and in the same service as specified operating for not less than five (5) years.

3.03 FIELD TESTING:

A. Field testing will not be conducted without a procedure accepted by the Engineer, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Section 01 78 25.

B. After installation of gates, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct operating and leakage test for each gate in presence of the Engineer to determine its ability to operate as specified, and to operate smoothly without jamming under specified conditions.

C. Test all operators.

D. Leakage Test: Leakage not to exceed half of the allowable leakage rate specified in AWWA C561.

   1. Conduct tests at design heads shown in the slide gate schedule.

E. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

F. Repeat tests until specified results are obtained.

G. Contractor to provide all water labor, piping, testing equipment for conducting tests.

H. Make all adjustments necessary to place equipment in specified working order at time of above tests.

I. Remove and replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted.

3.04 FIELD TOUCH-UP PAINTING:

A. After installation and testing accepted by the Engineer, apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.05 TRAINING:

A. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions. See Section 01 78 24.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

Table 1: Gate Schedule

	Area	Commodity	Tag	Type	Size (WXH)	Seating Head (ft)	Unseating Head (ft)	Mount (Embedded/ Wall/ Thimble)	Self Contained/ Non Self Contained	Stem	Electric Actuator	Motor Enclosure Type	Notes
1	01 - IPS	RWW	01-FV-11101	SG	8-0"x 8'-0"	15	minimal	Embedded	Self Contained	Rising	Y	NEMA 7 FM	Provide removable hand crank actuator
2	01 - IPS	RWW	01-FV-11201	SG	8-0"x 8'-0"	15	minimal	Embedded	Self Contained	Rising	Y	NEMA 7 FM	Provide removable hand crank actuator

END OF SECTION

SECTION 40 05 90.07

STOP LOGS AND APPURTENANCES

1.01 DESCRIPTION:

A. Provide aluminum or stainless steel stop logs and stainless steel frames and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. Aluminum Association (AA):

1. ASM35: Aluminum Construction Manual.

2. H35.1: Aluminum Alloy and Temper Designation.

B. ASTM International (ASTM):

1. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

2. A276: Standard Specifications for Stainless Steel Bars and Shapes.

3. D2000: Standard Classification System for Rubber Products in Automotive Applications.

4. D4020: Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials

C. American Welding Society Code (AWS):

1. D1.2: Structural Welding Code - Aluminum

2. D1.6: Structural Welding Code – Stainless Steel

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Certified shop and erection drawings. Contractor shall submit electronic files of the proposed equipment in the capacity, size, and arrangement as indicated and specified. Contractor shall confirm opening size prior to developing shop drawings for stop logs.

2. Data for stop log characteristics and performance.

3. Complete description of all materials, material thicknesses of all components.

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4. Maximum bending stress and deflection of the stop logs under design head specified and indicated.

5. Installation drawings showing the details required for installation, dimensions, clearances and anchor bolt locations.

6. Recommended storage racks with dimensions and layout.

7. Shop drawing data for accessory items.

8. Certified setting plans, with tolerances, for anchor bolts.

9. Manufacturer's literature as needed to supplement certified data.

10. Operating and maintenance instructions and parts lists.

11. Shop and field inspection reports.

12. Qualifications of field service engineer.

13. Recommendations for short and long-term storage.

14. Field testing procedures and set up

15. Special tools.

16. The latest ISO 9001 series certification or quality system plan.

B. A copy of the contract mechanical process and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1. One set of all special tools is required.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Stop logs shall be the product of one manufacturer.

C. Stop logs shall be manufacturer’s standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Welding: In accordance with latest applicable American Welding Society Code, ASME Welding Code, or equivalent.

E. The Contractor shall obtain the stop logs, guide frames (groves) and appurtenances from the stop log manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

F. Services of Manufacturer's Representative as stated in Section 01 45 00 and as specified herein.

G. Manufacturer of stop logs shall have a minimum of ten (10) operating installations with stop logs of the size specified or larger and in the same service and head as specified operating for not less than five (5) years or manufacturer of stop logs shall utilize a Project Manager that is experienced in stop log design and construction. The Project Manager shall be an employee of the gate manufacturer and shall have designed a minimum of ten (10) operating installations with stop logs of the size specified or larger and in the same service and head as specified operating for not less than five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Stop log sizes and operating data are indicated in the Stop Log Schedule.

2.02 MANUFACTURERS:

A. Stop Logs:

1. Whipps

2. RW Gate Co.

2.03 STOP LOG CONSTRUCTION:

A. Provide all stop logs produced by a single manufacturer and designed for installation in the channels and structures as specified and indicated.

B. Stop log Configuration, Dimensions and Characteristics: As indicated in the Stop Log Schedule.

C. Leakage Rate: Not to exceed 0.05 gpm per foot of wetted seal perimeter.

D. Provide the stop logs with a continuous resilient seal along the bottom and both sides. Seals on or within the guide frames are not acceptable.

E. Stop Log Height: As indicated and designed to function as specified and indicated when stacked in any order.

F. Provide all structural components of the stop logs fabricated of aluminum or stainless steel and with strength to prevent distortion during normal handling, during installation and while in service as specified and indicated.

G. Provide all structural components of the guide frames fabricated of stainless steel with strength to prevent distortion during normal handling, during installation and while in service as specified and indicated.

H. Provide all welds performed by welders with AWS D1.2 certification for aluminum and AWS D1.6 or ASME Section IX certification for stainless steel.

I. Finish: Mill finish on aluminum and passivated mill finish on stainless steel.

1. Provide welds on aluminum cleaned to provide a uniform finish.

2. Provide weld on stainless steel passivated in accordance with ASTM A380 to remove weld burn and scale.

J. Materials:

1. Stop Logs: ASTM A240 Type 316L stainless steel or 6061-T6 Aluminum, as indicated

2. Frame Guides and Invert: ASTM A240 Type 316L stainless steel

3. Lip Seal: Urethane ASTM D4020, Neoprene ASTM D2000 or EPDM

4. Fasteners, Nuts and Bolts: ASTM A276 Type 316 stainless steel

a. Anchor Bolts: Minimum 1/2-inch diameter

2.04 STOP LOGS:

A. Provide stop logs constructed of extruded aluminum or stainless steel shapes with a minimum thickness as specified below or as required for the head as indicated in the Stop Log Schedule.

1. Aluminum: 1/4-inch

2. Stainless steel: 1/4-inch

B. Provide each stop log 12 inches tall unless otherwise indicated in the Stop Log Schedule

C. Maximum Bending Stress: Not to exceed 7600 psi at the maximum operating head.

D. Provide stop logs designed to prevent buoyancy and to allow drainage.

E. Provide two slots in the top of each stop log for removal and installation by means of the specified stop log lifter.

F. Provide each stop log with a welded identification tag indicating the following:

1. Manufacturer and model number

2. Width of the opening

3. Design head

4. Seal Material

G. Finish: All stainless steel shall be passivated.

2.05 SEALS:

A. Provide stop logs with a continuous resilient seal along the bottom and both sides to restrict the leakage to the rate specified.

B. Provide all seals of urethane or rubber, replaceable and mechanically retained to the stop logs.

C. Stop logs using rubber “J” or “P” seals are not acceptable.

2.06 FRAMES:

A. Provide frame guides or grooves and invert members constructed of stainless steel plate with a minimum thickness of 1/4-inch.

B. Provide frame design to allow for embedded mounting or mounting directly to a wall with stainless steel anchor bolts and grout.

C. Provide mounting style as indicated in the Stop Log Schedule

D. Provide a flush bottom invert member across the bottom of the guides.

E. Frame mounted seals are not acceptable.

F. Finish: All stainless steel shall be passivated.

2.07 STOP LOG LIFTER:

A. Provide one (1) stop log lifter for each different stop log (guide frame) width.

B. Provide the lifter constructed of aluminum or Type 304L stainless steel and fitted with UHMW guide bars and stainless steel fasteners.

C. Provide the lifter with lifting hooks designed to engage the slots in the top of the stop logs.

D. Provide a lanyard release.

E. Provide the lifter capable of installing and removing all stop logs of the same width whether they are installed or at the operating floor level.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with shop drawings, manufacturer's printed instructions and as indicated.

B. Clean debris, dirt, and gravel, from inside of stop logs, guide frames and channels before placing stop logs.

C. Install guide frames in a true vertical position and grout all voids between guide frames and walls.

D. Inspect material for defects in workmanship and material.

3.02 STARTUP AND TESTING:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Comply with requirements for checkout, startup, and testing in Section 01 78 25.

3. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment and field erection:

a. 1/4 person-days per stop log location identified on the Stop Log Schedule

4. Functional Testing: Check alignment and perform a functional test. Tests to include all items specified.

a. 1/4 person-days per stop log location identified on the Stop Log Schedule

5. Testing: Field performance test equipment specified.

a. 1/4 person-days per stop log location identified on the Stop Log Schedule

6. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions. See Section 01 78 24.

a. 1 trip, 1/2 day per trip

7. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

8. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

3.03 FIELD TESTING:

A. Field testing will not be conducted without a procedure accepted by the Engineer, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Section 01 78 25.

B. After installation of guide frames, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct operating and leakage test for each stop log in presence of the Engineer to determine its ability to operate as specified, and to operate smoothly without jamming under specified conditions.

C. Test installation and removal of each stop log location with the number of stop logs as indicated.

D. Leakage Test: Leakage not to exceed 0.05 gpm per foot of seal perimeter.

1. Conduct tests at 7 feet of head.

E. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

F. Repeat tests until specified results are obtained.

G. Contractor to provide all water, labor, piping, testing equipment for conducting tests.

H. Make all adjustments necessary to place equipment in specified working order at time of above tests.

I. Remove and replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

Table 1: Stop Log Schedule

	Area	Commodity	Tag	Size (WXH)	Seating Head (ft)	Unseating Head (ft)	Mount (Embedded/ Surface/ Face)	Stop Log Material	Bottom Sill Seated(Y/N)	Notes
1	01 - IPS	RWW	01-SL-11100	8'-0"x14'-6"	15	Minimal	Embedded	Aluminum	Y	Provide one set of stop logs
2	01 - IPS	RWW	01-SL-11200	8'-0"x14'-6"	15	Minimal	Embedded	Aluminum	Y	

END OF SECTION

SECTION 40 23 13.01

PROCESS VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and process valves and appurtenances as indicated and in compliance with Contract Documents.

1. Provide sizes and capacities as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B1.20.7: Hose Coupling Screw Threads

2. B16.1: Standard for Cast Iron Pipe Flanges and Flanged Fittings, 125 lb

3. B16.4: Cast-Iron Threaded Fittings, Class 125 and 250

4. B16.10: Face-to-Face and End-to-End Dimensions of Ferrous Valves

B. ASTM International (ASTM):

1. A48: Standard Specification for Gray Iron Castings

2. A126: Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings

3. A536: Standard Specification for Ductile Iron Castings

C. American Water Works Association (AWWA):

1. C500: Metal-Seated Gate Valves for Water Supply Service

2. C504: Rubber-Seated Butterfly Valves

3. C509: Standard Specifications for Resilient-Seated Gate Valves for Water and Sewage Systems

4. D102: Coating Steel Water-Storage Tanks

D. NSF International (NSF):

1. 61: Drinking water system components health effects

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Data, regarding valve characteristics and performance including Cv.

2. Shop drawing data for accessory items.

3. Manufacturer's literature as needed to supplement certified data.

4. Operating and maintenance instructions and parts lists.

5. Listing of reference installations as specified with contact names and telephone numbers.

6. Valve shop test results.

7. Qualifications of field service technician.

8. Shop and Field inspections reports.

9. List of recommended spare parts other than those specified.

10. Recommendations for short and long term storage.

11. Special tools.

12. Shop and field testing procedures and equipment to be used.

13. Number of service technician days provided and per diem field service rate.

14. Manufacturer’s product data and specifications for shop painting.

15. Provide a layout drawing, plan and section showing orientation of plug, gate, check, ball valves and actuators and nearest obstructions for each valve.

16. Manufacturer's product data and specifications for shop painting.

17. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

18. The latest ISO 9001 series certification or quality system plan.

19. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

    1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

    2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.04 SPARE PARTS:

A. Comply with requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Provide enclosures for the area classifications specified and indicated.

C. Contractor responsible for verifying outside diameter of pipe to be tapped.

D. Services of Manufacturer's Representative as stated in Section 01 45 00 and specified herein.

E. Manufacturer of valve shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

F. If equipment proposed is heavier, taller, different laying length or requires more operating space than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.

1. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified maximum equipment weight and the lifting capacity of the hoisting equipment indicated and specified.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in AWPA Section 01 66 00 and as specified.

PART 2 - PRODUCTS

2.01 ECCENTRIC PLUG VALVES:

A. Manufacturers:

1. DeZurik

2. Kennedy

3. Val-Matic

B. Type: Non-lubricated, eccentric.

C. Body and Working Pressure:

1. Cast Iron, ASTM A126 Class B or Ductile Iron, ASTM A536, Grade 64-45-12.

a. Valves 4-inch through 12-inch: 175 psi

b. Valves 14-inch and larger: 150 psi

D. Ends:

1. Grooved: ANSI/AWWA C606 for ductile iron valves.

2. Flanged: ANSI B16.1 Class 125 pound for cast iron valves.

3. Buried Valves: Mechanical joint.

E. Valve Ports:

1. Provide rectangular ported valves, circular ports are not acceptable.

2. Valves 20-inch and smaller: Not less than 80 percent of pipe area.

3. Valves 24-inch and larger: Not less than 70 percent of pipe area.

F. Valve Seats:

1. Coat plug with seat material specified. Bolted systems are not acceptable.

a. Seat Material:

(1) Neoprene or Buna-N synthetic rubber.

2. Provide valves with seats clamped to valve with mating seat of 90 percent, minimum, pure nickel welded to the valve body.

G. Upper and Lower Plug Journal Bearings:

1. Removable, permanently lubricated stainless steel bushings for valves 20-inch and smaller.

2. Bronze bearings with Type 316 stainless steel bushings for valves 24-inch and larger.

3. Provide grit seals for upper and lower plug shafts for all valves.

H. Stem Seals:

1. Adjustable multiple V-packing.

2. Replaceable and adjustable without valve disassembly.

3. Provide valves with two sets of packing rated for vacuum service for all pump suction isolation service and for services where a vacuum is specified and indicated.

I. Operators for Valves 4-inch and larger:

1. Manually Operators:

a. Gear operated with handwheels, levers are not acceptable.

b. Provide gear operators rated for bi-directional shutoff at the valve working pressure rating as specified herein.

c. Gear operators: Totally enclosed worm gear, traveling nut type is not acceptable. Provide permanently lubricated, watertight and dustproof, with adjustable open and closed stops and plug position indicator.

d. Provide all work gears designed and certified to withstand input loads up to 300-feet-pounds minimum at the stops without damage.

e. Chainwheels: Provide where required as specified herein.

2. Electric Motor Actuators: Provide where indicated and provide in accordance with Section 40 23 13.03.

J. Shop Testing:

1. Provide all plug valves tested and certified bubble tight in both directions at the full rated working pressure as specified herein.

K. Shop Painting:

1. Provide epoxy painting as specified herein.

2.02 BALL VALVES – GENERAL SERVICE:

A. Manufacturers:

1. Jamesbury

2. KF

3. Inline

4. Kitz

B. Valves 1/2-inch through 4-inch:

1. Materials:

a. Body and End Cap: Three piece, ASTM A351 Grade CF8M

b. Body Seal: PTFE

c. Seat: RTFE

d. Ball: Type 316 stainless steel

e. Stem: Type 316 stainless steel

2. Pressure Rating:

a. 1/2-inch through 2-inch: 1000 psi at 100 degrees F

b. 2-1/2-inch through 4-inch: 800 psi at 100 degrees F

3. Ends:

a. 2-inch and Smaller: Screwed, flanged or Pressfit; see Section 40 23 19.05 for Pressfit specifications

b. 3-inch and larger: Flanged

C. Valves 4-inch through 12-inch.

1. Materials:

a. Body and Adaptor: Two piece, ASTM A351 Grade CF8M

b. Seat: TFE

c. Ball: Type 316 stainless steel

d. Stem: Type 316 stainless steel

2. Pressure Rating: ANSI Class 150

3. Ends: Flanged

D. Actuators:

1. Manual:

a. 4-inch and Smaller: Lever

b. 6-inch and Larger: Gear operator

c. Provide chainwheels where required as specified herein

2. Electric Motor Actuators: Provide in accordance with Section 40 23 13.03.

2.03 RUBBER FLAPPER CHECK VALVES:

A. Manufacturers:

1. Val-Matic

2. DeZurik APCO

3. Crispin

B. Materials:

1. Body and Cover: Ductile Iron ASTM A536 Grade 65-42-12.

a. Valves 8-inch and Smaller: ASTM A351 CF8M.

2. Rubber Flapper: Buna N 70 Durometer ASTM 2000-BG encapsulating an ASTM A36 steel plate.

3. Hinge Pin: AISI 1018.

C. Provide valves with a full pipe size flow area.

D. Provide valves 4-inch and larger capable of passing a 3-inch sphere.

E. Provide a threaded connection with bronze plug on cover and on the bottom of the valve.

F. Working Pressure:

1. 2-inch through 24-inch: 250 psi.

2. 30-inch and 36-inch: 150 psi.

G. Ends: Flanged ANSI B16.1, Class 150.

H. Provide seating surface at a 45 degree angle such that the flapper travels a maximum of 35 degrees from full closed to full open position.

I. Provide valve with cover designed for removal of the valve internals without removing the valve from the pipeline.

J. Position Indicator:

1. Provide a mechanical indicator to provide disc position for valves 4-inch and larger.

2. Provide the indication with continuous contact with the disc.

3. Provide a limit switch for remote indication of valve position. Provide limit switches in accordance with Section 40 23 13.03.

K. Backflow Device:

1. Provide a screw type rising stem backflow device located on the bottom of the check valves.

2. Provide a stainless steel T-handle device with bronzed bushings.

L. Valve Schedule:

Rubber Flapper Check Valve Schedule	
Valve Tag Number	01-CV-1111A, 1122A, 1113A, 1124A, and 1115A
Fluid	Raw Sewage
Fluid Temperature Range, degrees F	50 - 77
Valve Size, inches	30
Number of Valves	5
Max Operating Pressure, psi	150
Valve Port	Circular
Valve Ends	Flanged
Service	Open/Close
Operator Type	N/A
Opening/Closing Time, seconds	N/A

2.04 AIR RELEASE VALVES – WASTEWATER SERVICE:

A. Manufacturers:

1. Val-Matic
2. Crispin
3. DeZurik-APCO
4. ARI

B. Valves: Fully automatic float operated valves designed to release air from the piping system while the system is in operation and under pressure.

C. For wastewater services provide valves with the following:

1. Extended valve body
2. 2-inch cleanout
3. Minimum 2-inch inlet
4. 1/2-inch outlet with stainless steel ball valve with hose connection
5. 1-inch drain with stainless steel ball valve
6. Provide ball valve as specified herein

D. Valves 3-inch and Smaller: NPT inlet and outlet connections equivalent to the valve size.

1. Provide stainless steel ball valve for isolation as specified herein.

E. Valves 4-inch and Larger: Flanged inlet and outlet connections equivalent to the valve size.

1. Provide plug valve for isolation as specified herein.

2. Flanges: ANSI B16.1 Class 125

3. Flanges: ANSI B16.42 Class 300

F. Provide valves with two (2) additional NPT connections for the addition of gauges and for testing, and draining.

G. Provide valve body with a through flow area equal to the nominal valve size.

H. Provide valves with a bolted cover and flat gasket.

1. Valves 4-inch and Larger: Provide cover fitted to the valve body with a machined registered fit.

I. Provide guide shafts supported by bushings.

1. Valves 4-inch and Larger: Provide float double guided and a resilient bumper.

J. Floats: Provide floats with bottom shaped for accelerated closure.

K. Seats to provide drop tight shut off at full valve pressure rating.

L. Provide vacuum check on valve outlet to prevent air from re-entering the system during negative pressure conditions.

M. Materials:

1. Valve Body, Cover and Baffle:

a. ASTM A126 Class B Cast Iron for Class 125 valves

b. ASTM A536 Grade 65-45-12 Cast Ductile Iron, ANSI Class 300

c. ASTM A216 Grade WCB cast steel, ANSI Class 300

d. ASTM A351 Grade CF8M stainless steel

2. Floats, Guide Shafts and Bushings: Type 316 stainless steel

3. Seats: Buna-N

4. Hardware: Type 316 stainless steel

5. Interior Valve Coating: Fusion bonded epoxy

2.05 AIR/VACUUM VALVES – VERTICAL WET PIT PUMPS:

A. Manufacturers:

1. Val-Matic

2. Crispin

3. DeZurik-APCO

4. Vent-O-Mat

B. Valves: Fully automatic float operated valves designed to vent air within the pump discharge column on pump start-up and allow air to re-enter the column on pump shutdown or if a negative pressure occurs.

C. Provide with flanged inlet connections equivalent to the valve size. Provide Valves 6-inch and smaller with NPT outlet connections and valves larger than 6-inch with flanged outlet connections.

1. Flanges: ANSI Class 150

D. Provide valves with two (2) additional NPT connections for the addition of Air Release Valve, gauges, testing, and draining.

E. Provide valve body with a through flow area equal to the nominal valve size.

F. Provide valves with a bolted cover and flat gasket. Provide cover fitted to the valve body with a machined registered fit.

G. Provide guide shafts supported by bushings.

1. Provide float double guided and a resilient bumper.

H. Seats to provide drop tight shut off at full valve pressure rating.

1. Provide an anti-slam device.

I. Anti-Slam Device:

1. Provide for valves 6-inch and larger.

2. Flanged globe pattern spring operated device with a center guided disc and seat assembly.

3. Provide the disc with threaded ports to provide adjustment of flow rate.

4. Provide the device mounted on the valve inlet.

5. Seat and Disc: ASTM A351 Grade CF8M Stainless Steel.

J. Materials:

1. Valve Body, Cover and Baffle:

a. ASTM A126 Class B Cast Iron for Class 125 valves

b. ASTM A536 Grade 65-45-12 Cast Ductile Iron for Class 300 valves

2. Floats, Guide Shafts and Bushings: Type 316 stainless steel

3. Seats: Buna-N

4. Hardware: Type 316 stainless steel

5. Springs: ASTM A313 Type 302 stainless steel

2.06 SOLENOID VALVES:

A. Manufacturers:

1. JD Gould

2. ASCO

3. Berkert

B. Type:

1. Size: 1/8-inch to 2-inch.

2. Globe type.

3. 2-way, internal piston pilot operated.

4. Energize to open.

5. Operating Pressure Differential: 150 psi.

C. Materials:

1. Body: Type 316 stainless steel.

2. Seat Discs: PTFE.

3. Piston Assembly: Type 316 stainless steel.

4. Pilot Assembly: Type 316 stainless steel jacket welded on steel core.

D. Coil: Class F.

E. Electrical: 120 Volt, 1 phase, 60 Hertz.

F. Ends: Threaded.

G. Enclosure: NEMA 4X for locations in non-classified areas and NEMA 7 for use in classified areas.

2.07 CHAINWHEEL OPERATORS – STAINLESS STEEL:

A. Provide chainwheels with chain and chain guides. For all valves with handwheels or gear operators higher than 6.5 feet above operating floor level.

B. Provide chain that reaches to within 3 feet of the operating floor level.

C. For valves with gear operator mount with chainwheel in the vertical position.

D. Provide secondary safety restraint system.

E. Manufacturer:

1. Trumbull

F. Materials:

1. Chainwheels: Pocket type wheel, Type 316 stainless steel.

2. Chain: Type 316 stainless steel straight link machine chain.

3. Hardware and Attachments: Type 316 stainless steel.

4. Safety Restraint Cables and Hardware: Type 316 stainless steel.

2.08 FLOORSTANDS-NRS INDICATING TYPE:

A. Type: Non-Rising Stem (NRS), Indicating.

B. Materials:

1. Pedestal: Cast Type 316 stainless steel with a vertical indicating slot.

2. Indicator: Bronze. Provide indicator that travels on a threaded stem to indicate the position of the valve.

3. Handwheel: Type 316 stainless steel, 12-inch diameter.

4. Couplings: Type 316 stainless steel.

C. Provide the word “OPEN” cast in the pedestal at the top of the indicating slot and provide a “CLOSED” tag mounted to the pedestal, to indicate the closed position of the valve.

D. Floorstands fabricated by welding flanges to pipe are not acceptable.

2.09 EXTENSION STEMS:

A. Provide where indicated and required for operation of all valves

B. Material:

1. Stems: Type 316L solid stainless steel bar or Schedule 40 Type 316L pipe.

a. Minimum Size: 1.25 inch diameter, Slenderness ratio <200.

2. Connectors, thrust relief assemblies, torque tube assemblies, universal joints and operating nuts: Type 316 or Type 316L stainless steel.

3. Miter gears: Cast iron with 2 part epoxy coating.

2.10 STEM GUIDES:

A. Manufacturer:

1. Trumbull Industries

B. Provide valve stem guides where indicated and as required by the valves manufacturer.

C. Stem Guide Spacing: 6 to 8 feet, maximum slenderness ratio of 200.

D. Stem Guides for Stems 2-inch and Smaller:

1. Materials:

a. Stem Guide: Cast Type 316 stainless steel with 2 to 36 inch adjustment.

b. Bushing: Bronze, NSF 61.

c. Hardware: Type 316 stainless steel.

E. Stem Guides for Stems 2-1/8-inch to 4 inch:

1. Materials:

a. Stem Guide: Ductile Iron 65-45-12 with 2-3/4 to 17-1/4 inch adjustment.

b. Bushing: Split type, Bronze, NSF 61.

c. Hardware: Type 316 stainless steel.

2.11 POSITION INDICATORS:

A. Manufacturer:

1. Trumbull Industries

B. Provide position indicators installed on all multi-turn valves and quarter turn valves with gear boxes 3 inch and larger.

1. Type: Planetary gear design.

C. Materials:

1. Provide the sun gear, planet gear, ring gears and scale plate constructed of Delrin.

2. Housings of carbon steel or aluminum are not acceptable.

3. Hardware and Fasteners: Type 316 stainless steel.

D. Position Indicator Design Features:

1. Provide the position indication to show the position of the valve, from fully open to fully closed, identified at ground level.

2. Movement of the indicating arrow must be visible through a window covering a minimum of 300 degrees of the circumference of the indicator.

3. Size of the characters and numerals: minimum 3/16-inch.

4. Provide the top scale plate with markings representing the number of turns, contain the word “CLOSED”, and a directional arrow.

5. Provide permanently recessed, embossed or engraved markings in the scale plate. The use of adhesive labels is not acceptable.

6. Provide the “OPEN” line marked on a transparent polycarbonate window, field adjusted for the number of turns of each valve size.

7. Provide the position of the adjustable “OPEN” window secured to the top surface of the scale plate by the outside diameter of three Type 316 stainless button head cap screws.

8. Provide all adapters to secure the position indicator, for installation in either a floor box or wall bracket as indicated and required.

9. Provide the position indicator and adapter with matching flat sides to prevent rotation of the indicator during operation.

E. Exposed and Submerged Valves:

1. Provide a Type 316 stainless steel extension stem connected to a 2 inch square nut on the valve and extend up through the position indicator, terminating in a 2 inch square nut, operable by a standard waterworks tee-handle wrench.

F. Valves Installed Inside a Structure:

1. Provide the position indicator installed in a floor box.

2. Where a floor is not directly over the valve and extension stem, support position indicators with a Type 316 stainless steel wall bracket mounted to a side wall.

3. When installed in a floor, provide the adapter with a bronze bushing to support and center the extension stem with the bronze bushing retained in the cast iron floor adapter by two Type 316 stainless steel screws and drilled to an inside diameter 1/16-inch larger than the outside diameter of the extension stem.

2.12 ELECTRIC MOTOR ACTUATORS:

A. Provide in accordance with Section 40 23 13.03.

2.13 SHOP PAINTING:

A. Coat internal and external ferrous surfaces of valve with NSF Certified Epoxy in accordance with ANSI/NSF Std. 61, and in conformance to AWWA D102. All valves not specified to have a fusion bonded epoxy coating.

B. Process Valve Color: Match piping system.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Prior to installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.

B. Clean all debris, dirt, gravel, etc, from inside of piping before placing valves in place.

C. Erect and support valves in respective positions free from distortion and strain on appurtenances during handling and installation. Inspect material for defects in workmanship and material. Clean out debris and foreign material from valve openings and seats, test operating mechanisms to check functioning, and check nuts and bolts for tightness. Repair, valves and other equipment which does not operate easily or are otherwise defective at no additional cost to the Owner.

D. Set plumb and support valves in conformance with instructions of manufacturer. Shim valves mounted on face of concrete vertically and grout in place. Install valves in control piping for access.

E. Provide bolted split sleeve coupling or flexible type grooved coupling on downstream side of buried valves to assist in valve removal.

F. Where indicated provide Type 316 stainless steel stem extension to operating floor elevation as shown and provide the bevel gear operator with a fabricated steel floorstand and handwheel.

3.02 CHECK VALVES:

A. Install check valves horizontally in pipelines unless otherwise indicated.

3.03 PLUG VALVES:

A. Install valves in horizontal piping with shaft horizontal such that in open position, plug is located in upper part of valve body. Orient valves so that in closed position, flow is against the face of the plug.

3.04 FLOORSTAND OPERATORS AND STEM GUIDES:

A. Set floorstand operators and stem guides so stems run smoothly in true alignment. Anchor guides to walls. Check distances from centerlines of gates to operating level or base of floorstand and adjust if to suit actual conditions of installation.

3.05 FIELD TESTING:

A. Pressure test valves with pipeline pressure testing.

B. Test functions of each valve.

C. Make all adjustments necessary to place valves in specified working order at time of above tests.

D. Remove all replace valves and appurtenances at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to

demonstrate to the satisfaction of the Engineer that valves will perform the service specified, indicated and as submitted and accepted.

3.06 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 23 13.03

ELECTRIC MOTOR ACTUATORS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide electric motor actuators and appurtenances as indicated and in compliance with Contract Documents.

1. Actuators for all valves, gates and equipment to be the product of one manufacturer.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.

2. B179: Standard Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes.

B. FM Global (FM):

1. 3615: Explosionproof Electrical Equipment General Requirements.

C. Institute of Electrical And Electronics Engineers (IEEE):

1. 802.15.4: Standard for Information Technology.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Certified shop and erection drawings.

a. Drawings shall be in conformance with all other requirements as specified in this specification.

2. Data, regarding actuator and motor characteristics and performance.

3. Actuator and Valve set-up for each application: Position or torque seating

4. Shop drawing data for accessory items.

5. Manufacturer’s literature as needed to supplement certified data.

6. Operating and maintenance instructions and parts lists.

7. Listing of reference installations as specified with contact names and telephone numbers.

8. Actuator shop test results.

9. Motor shop test results.

10. Qualifications of field service engineer.

11. Schematic control and power wiring diagrams.

12. Shop and Field inspections reports.

13. Recommended spare parts other than those specified.

14. Recommendations for short and long term storage.

15. Special tools.

16. Shop and field testing procedures and equipment to be used.

17. Torque capability and settings for each actuator.

    a. Provide a listing of operating torque, safety factor applied and actuator torque capability and actuator safety factor as specified for each valve, gate and equipment.

18. Number of service person days provided and per diem field service rate.

19. Manufacturer's product data and specifications for shop painting including statement of compliance for compatibility with field painting.

20. Provide a listing of the materials recommended for each service specified and indicated.

21. ISO 9001 certification.

22. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a

minimum of three (3) years. Provide proposed materials at no additional cost to the Owner.

b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required".

1. Failure to include all drawings or a statement application to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide for each Actuator:

1. Two fuses of each size and type used in the actuator.

2. One set of back-up batteries for display operation.

C. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. One set of all special tools

2. Supply each actuator with a start-up kit consisting of installation instructions, electrical wiring diagrams and two sets of cover screws and seals.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified herein.

B. Actuators for all valves, gates and equipment to be the product of one manufacturer.

1. Contractor to coordinate actuator sizing and configuration with all valve, gate and equipment suppliers.

C. Actuators to be manufacturer's standard cataloged product and configured to provide compliance with the specifications and the service conditions specified and indicated.

D. Shop tests as specified.

E. Provide Services of Manufacturer's Representative as stated in Section 01 61 00 and as specified herein.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with Section 01 61 00 and as specified herein.

PART 2 - PRODUCTS

2.01 ELECTRIC ACTUATORS – 3 PHASE:

A. Each actuator shall include electric motor, reduction gearing, reversing starters, thermal overloads, controls transformer, limit controls, non-intrusive local controls as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

1. Provide actuators capable of setting of torque, turns, and configuration of indication contacts, through the use of a non-intrusive infrared setting tool without the necessity to remove any electrical compartment covers. The setting tool must be the means for adjustment. The use of control knobs for programming the actuator is not acceptable.

2. Provide actuators with torque capability 150 percent above the maximum operating torque required by each valve, gate or equipment.

3. Enclosure:

a. Watertight to IP68, classification. Enclosure must be certified NEMA 6 for all units except those for use in classified areas.

b. Provide explosion proof Class 1, Division 1, Groups C, D, E, F, & G. NEMA 7 FM (Factory Mutual) certified to FM3615 for actuators as indicated and located in classified areas.

4. Provide an internal watertight compartment to protect switches, contacts, motor and internal electronics from ingress of moisture and dust when the external terminal cover is removed.

5. Breathers, drains and or heaters are not permitted, enclosure must be totally sealed.

6. Provide each actuator with a handwheel for manual operation. Provide a hammerblow device which permits motor to come up to speed before picking up load and unseating valve.

B. Motors:

1. Open/Close applications: Motors, Class F with 15 minute duty rating.

2. Modulating applications: Motors, Class H with a 30 minute duty rating.

3. Motor: Low inertia, high torque type, specifically designed for use with motor actuators, to prevent over travel.

C. Provide internal clutch that cannot engage handwheel operating mechanism and motor-operating mechanism at the same time. Friction type declutching is not acceptable.

1. Provide handwheel with arrow and the word CLOSE or SHUT cast on handwheel to indicate turning direction to close.

2. Handwheel must not rotate during power operation.

3. Provide handwheel and low gear ratio combined to give maximum rate of movement possible with 80 pound rim pull.

D. Drive Unit:

1. Metal worm wheel and worm shaft type.

2. Provide an oil filled drive housing. Grease lubrication is not acceptable.

3. Worm shaft to operate in ball or roller bearings and be machine cut, ground, and highly polished, hot rolled steel, hardness 50-60 Rockwell Scale C bronze worm wheel with large contact area. Provide mating surfaces of dissimilar metals to prevent galling. Cast metals or gears manufactured from non-metallic materials are not acceptable.

4. Worm and shafts: Heat treated steel and accurately machined. Output or driving shaft to operate in bronze bearing or in ball or roller bearings.

5. Make provisions to take thrust in both directions.

6. Worm and wheel to be oil lubricated at all times.

7. Drive housing: Cast iron or aluminum depending on size of actuator offered, all thrust or torque bearing components shall be ductile iron.

8. Provide drive bushing as part of a detachable thrust base making for easy retrofit.

E. Fully wire electric motor operators at factory and furnish complete with terminal strips for external power and control connections.

1. Wiring: Copper with tropical grade PVC cover. Internal wiring to remain in a watertight compartment with external cover removed.

F. Provide manual or automatic control as indicated and specified.

G. Manual Control: Provide the following Control, Status, Alarm and Diagnostic capabilities locally, at the actuator:

1. Control:

a. OPEN/STOP/CLOSE

b. Desired Valve Position Control 0-100 percent

2. Status:

a. Motor Running Open Direction

b. Motor Running Close Direction

c. Fully Open

d. Fully Closed

e. Percentage Open 0-100 percent in 1 percent increments

f. Percentage Output Torque 0-100 percent in 1 percent increments

3. Alarms:

a. Remote Control Communications Failure

b. Actuator Alarm

c. Valve Alarm

d. Battery Low Alarm

4. Diagnostics:

   a. Provide an integral diagnostic module, which will store and enable download of historical actuator data to permit analysis of changes in actuator, gate or valve performance. Access to data shall be via a non-intrusive an IrDA™ port to an appropriate devise capable of standard IRDA communications i.e. Notebook PC, Windows CE based "Personal Digital Assistant (PDA)" or an IrDA™ compatible cellular telephone.

   b. Provide diagnostic software from actuator manufacturer to allow configuration and diagnostic information to be reviewed, analyzed and reconfigured. Provide diagnostic status screens capable of showing multiple functions simultaneously so troubleshooting can be affected rapidly and efficiently.

H. Automatic Control: Provide REMOTE automatic control capability as specified herein.

I. Provide each actuator fitted with four (4) hard-wired configurable contacts. Each Contact shall be rated at 5A, 250VAC, 30VDC and able to provide any one of the following:

   1. Status:

      a. Valve Fully Open

      b. Valve Fully Closed

      c. Valve Opening or Closing

      d. Valve Moving (Continuous or Pulsing)

      e. Local Stop Selected

      f. Local Selected

      g. Remote Selected

      h. Open or Close Interlock Active

      i. ESD Active

   2. Alarms:

      a. Motor Tripped on Torque in Mid-Travel

      b. Motor Tripped on Torque Going Open

      c. Motor Tripped on Torque Going Closed

d. Pre-Set Torque Exceeded

e. Valve Jammed

f. Actuator Being Operated by Handwheel

g. Lost Main Power Phase

h. Customer 24V DC or 120V AC Supply Lost

i. Battery Low

j. Internal Failure Detected

k. Thermostat Tripped

J. Provide a back-up power source integral to the actuator to ensure that in the event of a main power supply loss or failure that the LCD display indication contacts must remain operational for a minimum of 24 hours and still function on change of status.

K. Provide contacts and operating parts made of non-corrodible metal and suitable for a sea atmosphere and for contact with H_2S.

L. Control:

1. Provide non-intrusive selectors on actuator electrical controls cover. One for Local/Stop/Remote selection, pad-lockable in each position and the other for local Open/Close control. Switches penetrating the housing are not acceptable.

M. Starters/Transformers: Consists of two relay contactors, 3-pole, mechanically interlocked, reversing with suitable arc suppressors.

1. Electrical Service:

a. 480V, 3-phase, 60 Hertz.

2. Provide inverse time element overload relays.

3. Provide a control transformer capable of generating either 110VAC (220VAC) or 24VDC as required for the application. Refer to typical Instrument Loop Diagrams in Division 40 61 00.

4. Provide electromechanical starter capable of OPEN/CLOSE sixty starts per hour or solid state starter for modulating service capable of 1200 starts per hour.

5. Provide replaceable fuses to protect wiring, fuses must be locally available.

6. Provide automatic phase correction.

N. Limit Controls:

1. Type: Positive in action ensuring tight seating and full openings.

2. Position Setting Range: 2.5 to 100,000 turns, with resolution of 7.5 degrees of one actuator output revolution.

3. Provide mechanism designed to minimize drift or over-travel and to open or close valve, gate or equipment to fixed, predetermined limits of opening and closing travel.

4. Provide controls that disconnect driving mechanism from stem utilizing Hall effect magnetic pulse system or similar technology. Measurement of torque shall be by direct measurement of force at the output of the actuator. Methods of measuring torque derived from the motor such as motor speed, current, flux, are not acceptable. Position and torque sensor shall accurately measure and control the position of the actuator without the use of mechanical gears. Potentiometers for position transmission are not acceptable.

5. Provide torque switches for both directions of travel.

   a. Sensing to be independent of voltage fluctuation.

   b. Provide torque protection to prevent repeated starting in the same direction.

   c. The initial unseating hammer blow shall not cause overtorque.

   d. Provide torque switch settings independent of OPEN/CLOSE position switches.

O. Provide output drive coupling to accept rising stem for rising spindle valves and include roller and ball type thrust bearings.

P. Provide actuator sized to close valve, gate or equipment against differential pressure as specified and indicated. Size actuator motor to seat and unseat valve gate or equipment and ensure torque switch trip at maximum valve torque when supply voltage is 10 percent below normal. Size motor to open or close valve, gate or equipment to satisfy the process dynamics.

Q. All fasteners and hardware: Type 316 stainless steel.

R. Secondary Gear Boxes:

1. Provide secondary gearing for multi-turn or quarter-turn applications where operating times, thrust or torque considerations require.

   a. Secondary Gearing: Bevel or spur, totally enclosed in a cast iron housing, fully sealed and lubricated for the service indicated and specified.

2. Provide gear assemblies that are a manufacturer's standard selection or combination of as detailed in published product literature.

   a. Provide each gearbox with a removable output drive coupling sized for the service specified and indicated.

   b. Provide quarter-turn gearboxes equipped with adjustable mechanical stops (at 0 and 90 degrees plus or minus 5 percent) to permit limiting open and closed travel during manual operation.

   c. Factory prime and finish paint all gear boxes with 2 part high solids epoxy or as specified herein for the actuator.

2.02 ELECTRIC ACTUATORS – SINGLE PHASE:

A. Each actuator shall include electric motor, reduction gearing, reversing starters, thermal overloads, limit controls as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

1. Provide actuators with torque capability 150 percent above the maximum operating torque required by each valve, gate or equipment.

2. Gearing: Rolled steel worm gear and aluminum bronze worm wheel. Non-metallic gearing is not acceptable.

3. Enclosure:

   a. Watertight to IP68, classification. Enclosure must be certified NEMA 6 for all units except those for use in classified areas.

   b. Provide explosion proof Class 1, Division 1, Groups C, D, E, F, & G. NEMA 7 FM (Factory Mutual) certified to FM3615 for actuators as indicated and located in classified areas.

   c. Material: Aluminum with epoxy-polyester powder coating

4. Provide each actuator with a handwheel for manual operation, auto declutch lever and automatic reset when motor is energized.

5. Provide actuator with a top mounted continuous visual position indicator.

6. Provide 20 watt internal space heater

7. Provide two cam actuated and adjustable end of travel limit switches

8. Provide two can actuated torque switches for over torque protection

9. Provide mechanical stops

B. Provide manual or automatic control as indicated and specified.

C. Automatic Control: Provide REMOTE automatic control specified in Section 40 23 13.03 and as indicated.

D. Electrical Service:

a. 110V, 1-phase, 60 Hertz

E. Limit Controls:

1. Type: Limit switches.

2. Provide torque switches for both directions of travel.

F. Provide actuator sized to close valve against required differential. Size actuator motor to seat and unseat valve and ensure torque switch trip at maximum valve torque when supply voltage is 10 percent below normal. Size motor to open or close valve to satisfy the process dynamics.

G. All fasteners and hardware: Type 316 stainless steel.

2.03 SHOP TESTS:

A. Motor Test:

1. Give each motor a standard commercial test in the shop of the motor manufacturer and submit certified copies of the test results to the Engineer for review prior to installation of the motors.

B. Actuator Testing:

1. Test performance of each actuator. Provide individual test certificates at no additional cost to the Owner simulate a typical valve, gate or equipment load and record the following parameters:

a. Current at maximum torque setting.

b. Torque at maximum torque setting.

c. Test voltage and frequency.

d. Flash test voltage.

e. Actuator output speed or operating time.

2. Test housing oil tightness, 30 psi for 2 minutes.

3. Insulation test on motor and control circuit.

4. In addition, record details of specification on the test certificate, such gear ratios for both manual and automatic drive, closing direction, wiring diagram code number, and when applicable remote transmitter resistance and interposing relay voltage.

C. In event that specified tests indicate that motor or actuator will not meet specifications, Engineer has the right to require complete witnessed tests for all motors and actuators at no additional cost to the Owner.

1. Repeat tests until specified results are obtained.

2. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

2.04 SHOP PAINTING:

A. Paint Finish: Baked on polyester powder coating 70 microns thick and must have passed ASTM B117 35 degrees C Salt Spray Test for 1,000 hours.

1. Provide materials for touch-up of all damaged or abraided surfaces due to installation.

2. Ferrous surfaces obviously not to be painted shall be given a shop applied coat of grease or rust resistant coating.

2.05 DISCONNECT AND LOCAL CONTROL STATION:

A. Enclosure:

1. NEMA 4X (Ingress Protection Rating IP68) Type 316 stainless steel for all non-classified areas.

2. NEMA 7, cast aluminum for all classified areas.

3. Mount on a pedestal, or on adjacent structure.

a. Hardware and Mounting Supports: Type 316 stainless steel.

B. Provide each actuator with a primary voltage rated non-fused disconnect.

C. Provide each actuator mounted in excess of 6.5 feet above the operating level or in a position that cannot be accessed with a single integrated disconnect and local control station. Mount the disconnect and local control station on a wall, column or pedestal 5.0 feet above the operating level.

D. Provide red, green, and yellow indicating lights as on actuator. GREEN light on when valve, gate or equipment is completely closed, RED light on when valve, gate or equipment is completely opened, and YELLOW light when valve, gate or equipment is in mid travel.

E. Control circuits: 24 VAC or 120 VAC as required.

F. LOCAL/STOP/REMOTE switch: Padlockable in all positions. With actuator selector set to "Remote" actuator shall be capable of accepting operation input through separate pushbutton station, that pushbutton station has been selected for remote "COMPUTER" control.

G. OPEN/CLOSE switch: With actuator selector set to "Remote", actuator shall be capable of accepting operation input from separate pushbutton station, when pushbutton station has been selected for local "Open/Close" control.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with manufacturer's printed instructions and as indicated and specified.

3.02 MANUFACTURER SERVICES:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect setting, alignment, field erection; coordination of electrical and miscellaneous utility connections:

   a. 1/2 person-day per actuator

3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.

   a. 1/2 person-day per actuator

4. Field Performance Testing: Field performance test equipment specified.

   a. 1/2 person-day per actuator

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classrooms sessions.

   a. 1 person-day, 1 trip

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

7. Any additional time required of the factory trained service engineer to assist in placing the equipment in operation or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

B. Manufacturer of actuators must have at least five (5) operating installations with actuators of the type and size specified and in the same service as specified operating for not less than five (5) years.

3.03 FIELD TESTING:

A. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by manufacturer's field service engineer, conduct running test for each actuator in presence of Engineer to determine its ability to operate without vibration or jamming and to operate at the speeds specified.

1. During tests, observe and record, motor inputs.

2. Promptly correct or replace all defects or defective equipment revealed by or noted during tests, at no additional cost to the Owner, and repeat tests until specified results and results acceptable to the Engineer are obtained.

3. Contractor to provide all labor, equipment, and materials necessary for conducting tests.

B. Make all adjustments necessary to place equipment in specified working order at time of above tests.

C. Remove and replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to satisfaction of the Engineer that units will perform the service specified and indicated.

3.04 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer. Contractor shall apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.05 CONTRACT CLOSEOUT:

A. Provide submittals in accordance with Section 01 77 00.

END OF SECTION

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SECTION 40 23 13.07

SELF-CONTAINED AUTOMATIC CONTROL VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test self-contained automatic control valves and appurtenances as indicated and in compliance with Contract Documents.

1. Provide sizes and capacities as indicated or in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B16.1: Standard for Cast Iron Pipe Flanges and Flanged Fittings, 125 lb

2. B16.4: Cast-Iron Threaded Fittings, Class 125 and 250

3. B16.42: Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300

B. ASTM International (ASTM):

1. A48: Standard Specification for Gray Iron Castings

2. A126: Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings

3. A536: Standard Specification for Ductile Iron Castings

4. B62: Standard Specification for Composition Bronze or Ounce Metal Castings

C. American Water Works Association (AWWA):

1. C500: Metal-Seated Gate Valves for Water Supply Service

D. NSF International (NSF):

1. 61: Drinking water system components health effects

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Data, regarding valve characteristics and performance including Cv.

2. Shop drawing data for accessory items.

3. Manufacturer's literature as needed to supplement certified data.

4. Operating and maintenance instructions and parts lists.

5. Listing of reference installations as specified with contact names and telephone numbers.

6. Valve shop test results.

7. Qualifications of field service technician.

8. Shop and Field inspections reports.

9. List of recommended spare parts other than those specified.

10. Recommendations for short and long term storage.

11. Special tools.

12. Shop and field testing procedures and equipment to be used.

13. Number of service technician days provided and per diem field service rate.

14. Manufacturer’s product data and specifications for shop painting.

15. Provide a layout drawing, plan and section showing orientation of valves and nearest obstructions for each valve.

16. Manufacturer's product data and specifications for shop coating and painting.

17. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

18. The most recent ISO 9000 series certification or quality system plan.

19. Material Certification:

a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified

are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.04 SPARE PARTS:

A. Comply with requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Provide enclosures for the area classifications specified and indicated.

C. Contractor responsible for verifying outside diameter of pipe to be tapped.

D. Services of Manufacturer's Representative as stated in Section 01 45 00 and specified herein.

E. Manufacturer of valve shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in AWPA Section 01 66 00 and as specified.

PART 2 - MATERIALS

2.01 SELF-CONTAINED AUTOMATIC CONTROL VALVES:

A. Manufacturers:

1. Singer Valve Inc.

2. Ross Controls.

3. Golden Anderson (GA Industries)

B. Type: Pilot operated, piston or diaphragm design, automatic valve.

1. Body Type: Globe or angle body, provide body style as indicated.

2. Provide valve that utilize line pressure as its operating source.

3. Provide valves with all necessary accessories to provide a complete operating unit.

C. Provide size and configuration as specified and indicated.

D. End Connections:

1. Valves 3-inches and Smaller: NPT

2. Valves 1-1/2-inches and Larger: Flanged end connections ANSI standard B16.1 of a class to mate with pipe flanges.

E. Diameter of Seat Opening: Equal to diameter of pipe size.

F. Provide valves designed to remove and replace all internal parts without removing the valve body from the pipeline.

G. Diaphragm style valves: Provide NSF 61 approved replaceable seals designed to prevent metal to metal contact.

1. Material: Type 316 stainless.

H. Piston style valves: Provide treated leather replaceable seals designed to prevent metal to metal contact.

1. Material: Treated leather or polyurethane seats.

I. Minimum pressure rating: 150 psi.

J. Hydrostatic test: 300 psi.

K. Provide a visual position indicator.

L. Materials:

1. Valve Body and Covers: A536 (65-45-12) ductile iron or ASTM A126 cast iron.

   a. Diaphragm style valve cover: Provide a separate stem cap giving access to the stem for alignment check, spring installation and ease of assembly.

      (1) Provide main bonnet cover and locating pins to accurately locate the main valve body.

   b. Internal and External Coating: NSF 61 fusion bonded epoxy.

   c. Provide two NPT connections on each side of the valve body for external control piping and provide Type 316 stainless steel plugs for all unused ports

2. Piston: ASTM B62 Bronze, for piston style valves.

3. Diaphragm: EPDM or Buna N of the rolling type design.

4. Stem: Type 316 stainless steel, for diaphragm style valves.

5. Seat Disc:

   a. Valves 12-inches and Smaller: ASTM B62 Bronze, Cast Iron, Ductile Iron or Type 316 stainless steel.

   b. Valves 14-inches through 36-inches:

      (1) ASTM A126 cast iron center with ASTM B62 bronze outer ring or cast iron.

      (2) One-piece design in ductile iron or Type 316 stainless steel.

   c. Valves 42-inches through 48-inches: Cast steel, Cast Iron, Ductile Iron or Type 316 stainless steel.

6. Plates:

   a. Valves 4-inches through 36-inches: ASTM B62 bronze or ASTM A536 ductile iron (65-45-12).

   b. Valves 42-inches through 48-inches: Cast steel or ASTM A536 ductile iron (65-45-12).

7. Bushings:

   a. Valves 4-inches through 36-inches: ASTM B62 bronze.

b. Valves 42-inches through 48-inches: Type 316 stainless steel.

8. Seat Ring, Stem Nuts, Indicator, and Seat Packing Support: Type 316 stainless steel.

9. External Control Piping, Strainers and Valves: Type 316 stainless steel.

a. Provide tubing or hose.

M. Valve Types:

1. Pressure Reducing Valves:

a. Provide valves designed to maintain a pre-adjusted downstream pressure regardless of changes in flow rate.

b. Provide an external pilot control including an external strainer, needle valve, position indicator, gauges and isolation ball valves.

c. Provide settings as specified and indicated.

2. Surge Relief/Surge Anticipator Valves:

a. Provide valves designed to anticipate the surge wave by monitoring the line pressure and opening when an unusual drop in pressure occurs or on loss of electric power.

b. Provide a relief pilot for over-riding control at all times.

c. Provide an external pilot control including an external strainer, needle valve, position indicator, gauges and isolation ball valves.

d. Provide settings as specified and indicated.

3. Altitude Valves – 1 way:

a. Provide valves designed as a two position control valve, either fully open or fully closed.

(1) Provide valves to allow normal forward flow to fill the reservoir or tank to the maximum level and then closes drip-tight at the set-point.

(2) Provide valves to opens to refill the reservoir or tank once the level drops a fixed distance below the high water level.

(3) Valves do not operate as a check valve to prevent reverse flow.

b. Provide an external pilot control including an external strainer, needle valve, position indicator, gauges and isolation ball valves.

c. Provide settings as specified and indicated.

4. Altitude Valves – 2 way:

a. Provide valves designed as a two-position control valve, either fully open or fully closed.

(1) Provide valves to allow normal forward flow to fill the reservoir or tank to the maximum level and then closes drip-tight at the set-point.

(2) Provide valves to opens to allow reverse flow through the valve when the supply pressure drops a fixed amount below the reservoir or tank head.

(3) When a higher supply pressure is restored the valve will then allow normal forward flow to refill the reservoir or tank to the maximum level.

b. Provide an external pilot control including an external strainer, needle valve, position indicator, gauges and isolation ball valves.

c. Provide settings as specified and indicated.

5. Float Valves:

a. Provide valves designed as a two-position control valve, either fully open or fully closed.

(1) Provide valves to remains closed when the reservoir or tank level drops, until the float reaches the pre-determined adjustable minimum reservoir or tank level.

(2) Provide valves to open to refill the reservoir or tank and close tightly when high water level is achieved.

b. Provide an external pilot control and float, position indicator, gauges and isolation ball valves.

c. Provide settings as specified and indicated.

N. Provide all valves in compliance with NSF 61 for all services.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Prior to installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.

B. Clean all debris, dirt, gravel, etc, from inside of piping before placing valves in place.

C. Erect and support valves in respective positions free from distortion and strain on appurtenances during handling and installation. Inspect material for defects in workmanship and material. Clean out debris and foreign material from valve openings and seats, test operating mechanisms to check functioning, and check nuts and bolts for tightness. Repair, valves and other equipment which does not operate easily or are otherwise defective at no additional cost to the Owner.

D. Set plumb and support valves in conformance with instructions of manufacturer. Shim valves mounted on face of concrete vertically and grout in place. Install valves in control piping for access.

3.02 FIELD TESTING:

A. Pressure test valves with pipeline pressure testing.

B. Test functions of each valve.

C. Make all adjustments necessary to place valves in specified working order at time of above tests.

D. Remove all replace valves and appurtenances at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that valves will perform the service specified, indicated and as submitted and accepted.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 23 13.09

KNIFE GATE VALVES AND APPURTENANCES – BONNETED TYPE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test knife gate valves, actuators and appurtenances as indicated and in compliance with Contract Documents.

1. Provide sizes and capacities as indicated and specified.

2. Conform to American Iron and Steel Requirements set forth by WIFIA, reference specification 01 41 13.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B16.47: "Large Diameter Steel Flanges NPS 26 Through NPS 60 Metric/Inch Standard"

2. B16.34: "Valves-Flanged, Threaded, and Welding End"

B. ASTM International (ASTM):

1. A216: "Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service"

2. A576: "Standard Specification for Steel Bars, Carbon, Hot Wrougt, Special Quality"

3. A276: "Standard Specification for Stainless Steel Bars and Shapes"

C. American Petroleum Institute (API):

1. 598: "Valve Inspection and Testing"

D. Manufacturers Standardization Society (MSS):

1. SP-55: "Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components - Visual Method for Evaluation of Surface Irregularities"

2. SP-25: "Standard Marking System for Valves, Fittings, Flanges, and Unions"

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Certified shop and erection drawings. Contractor shall submit electronic files of the proposed equipment in the performance size and arrangements as indicated and specified.

2. Data, regarding valve characteristics and performance including Cv.

3. Shop drawing data for accessory items.

4. Certified drawings of the valves including valve operators and parts lists.

5. Manufacturer's literature as needed to supplement certified data.

6. Operating and maintenance instructions and parts lists.

7. Listing of reference installations as specified with contact names and telephone numbers.

8. Qualifications of field service technician.

9. Shop and Field inspections reports.

10. Manufacturer’s affidavit stating that valves comply with all provisions of this specification.

11. Certified test reports covering shop performance, leakage, hydrostatic tests and as specified

12. List of recommended spare parts other than those specified.

13. Recommendations for short and long term storage.

14. Special tools.

15. Shop and field testing procedures and equipment to be used.

16. Manufacturer’s product data and specifications for shop painting.

17. Provide a layout drawing, plan and section showing orientation of valve and actuators and nearest obstructions for each valve.

18. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

19. Manufacturer's affidavit stating that valves furnished comply with all pertinent provisions of this specification.

20. The most recent ISO 9001 series certification or quality system plan.

21. Material Certification:

    a. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.04 SPARE PARTS:

A. Comply with requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Provide enclosures for the area classifications specified and indicated.

C. Services of Manufacturer's Representative as stated in Section 01 45 00 and specified herein.

D. Valve manufacturer must have a minimum of ten (10) years of experience with valves of the same design and size specified and larger. Provide a minimum of three (3) references of operating installations with valves of the size specified or larger and in the same service as specified operating for not less than five (5) years.

E. If equipment proposed is heavier, has a different laying length or requires more operating space than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.

1. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified

maximum equipment weight and the lifting capacity of the hoisting equipment indicated and specified.

F. Valves shall be the product of one manufacturer.

G. Valves shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

H. The Contractor shall obtain the valves, actuators and appurtenances from the valve manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00 and as specified.

PART 2 – MATERIALS

2.01 KNIFE GATE VALVES:

A. Manufacturers:

1. Hilton (Special order required)

2. Orbinox

B. Provide in accordance with Section 01 61 00.

C. Valve Construction:

1. Provide all valves with a pressure-retaining bonnet that is rated at the same pressure as the valve body.

2. Internal gate packing or gate wipers are not acceptable.

3. Provide a packing gland located at the top of the bonnet to provide a tight seal around the stem.

4. Provide valves designed in SolidWorks or a similar finite-element stress analysis program to demonstrate the integrity of the valve at the design pressure with the body and flanges unconstrained.

D. Valves Port Design:

1. Resilient Seated Valves: Full ported, with a clear port ID equal to or greater than the pipe ID.

E. Provide bi-directional valves with zero leakage shut off from 5 psi to the valve pressure rating specified. Provide valves such that minimal pressure is required to provide drip-tight shut off.

F. Provide all valves suitable for "dead end" service.

G. Provide stem packing replaceable without disassembling the valve or removing the valve from the pipeline, and replaceable while the valve is under maximum operating pressure.

H. Body Types:

1. Provide body without recesses or cavities.

I. Provide valves with OPEN and CLOSE lockout position devices.

J. Materials:

1. Body and Flanges:

a. Submerged and/or Corrosive Service:

(1) Valves 24-inch and smaller: Cast or fabricated solid Type 316L stainless steel.

(2) Valves larger than 24-inch: Fabricated solid Type 316L stainless steel.

2. Bonnet:

a. Submerged and/or Corrosive Service: Fabricated solid Type 316L stainless steel.

3. Gate: Type 316L Stainless Steel with a 32 micro-inch RMS surface finish.

a. Provide beveled gate edge for uni-directional valves.

b. Beveled gate edges are not acceptable for bi-directional valves.

4. Stem: Type 316 Stainless Steel including a Type 316L stainless steel backseating ring to permit repacking under pressure. Provide the backseating ring with a resilient seal.

5. Seats:

a. Bi-Directional Valves: Provide two (2) Viton resilient seats, one on each side of the gate, with no gate wedges.

6. Packing Gland: Cast or fabricated Type 316 stainless steel. Provide the bottom of the packing gland machined to mate with the stem backseating ring, to allow the packing to be replaced while the valve is pressurized.

7. Packing: Teflon impregnated synthetic fiber.

8. Yoke – Submerged and/or Corrosive Service: Fabricated solid Type 316L stainless steel.

9. Hardware: Type 316 stainless steel.

10. Handwheel: Cast iron or cast steel.

11. Stem Nut and Thrust Washer: Acid resistant bronze.

12. Gate Guide:

    a. Provide internal gate guides for all valves where the valve stem is not installed in the vertical position.

    b. Provide gate guides to fully support the gate and allow the gate to seat as specified when the valve is installed as indicated.

    c. Provide all valves marked to indicate the correct installation orientation.

    d. Gate Guides: UHMW or Type 316L stainless steel.

    e. Provide stainless steel gate guides with Stellite hardfacing and ground smooth, to prevent galling.

13. Ends: Flanged:

    a. Valves 24-inch and Smaller: ASME B16.5 Class 150.

    b. Provide all flange bolt holes threaded, unless otherwise specified or indicated.

    c. Provide all flange gasket surfaces fully machined with a spiral serrated finish.

K. Valve Pressure Rating:

1. Provide values as follows unless otherwise indicated or specified in the Valve Schedule:

    a. All valves 48-inch and smaller: Rated at 150 psi Cold Working Pressure (CWP) unless otherwise specified or indicated.

L. Operator:

1. Where the actual operating pressure is less than the valve pressure rating, the operator shall be sized based on the maximum operating pressure.

2. Manual Operators as indicated:

   a. Provide handwheel for valves 12-inch and smaller requiring a maximum 80 pound handwheel rim pull at the valve pressure rating.

   b. Provide bevel geared operators for all valves larger than 12-inch and all valves requiring a greater than 80 pound handwheel rim pull at the valve maximum operating pressure.

      (1) Bevel Gear Operators:

         (a) Provide steel gears fully enclosed and permanently lubricated.

      (2) Provide bevel gear operators with a gear ratio calculated based on a maximum handwheel rimpull of 80 pound at the valve maximum operating pressure.

3. Provide a clear non-metallic removable stem cover with graduations from 100 percent open to closed.

4. Chainwheels: Provide where required and as specified in Section 40 23 13.01.

5. Where indicated provide Type 316L stainless steel stem extension to operating floor elevation as indicated and provide the bevel gear operator with a fabricated carbon steel floorstand and handwheel.

6. Provide stem guides for extension stems, as required to support the stem and prevent buckling. Stem guides shall be adjustable and as specified in Section 40 23 13.01.

7. Provide all valves capable of being operated using a portable power driver equipped with a torque-limiting device, sized to disengage before excessive torque can be applied to the valve operator. Valve manufacturer to provide valve and sizing for torque limiting device.

8. Provide electric motor actuators where indicated. Provide in accordance with Section 40 23 13.03.

M. Valve Schedule:

Knife Gate Valve Schedule				
Valve Tag Number	FV-11112, 11222, 11132, 11142, and 11152	01-KV-1111B, 1122B, 1113B, 1124B, 1115B	FV-11412 and FV-11422	FV-11413 and FV-11431
Fluid	Raw Sewage	Raw Sewage	Raw Sewage	Raw Sewage
Fluid Temperature Range, degrees F	50 - 77	50 – 77	32 – 110	32 – 110
Valve Size, inches	30	6	42	6
Number of Valves	5	5	2	2
Max Operating Pressure, psi	100	100	100	100
Valve Port	Circular	Circular	Circular	Circular
Valve Ends	Flanged	Flanged	Flanged	Flanged
Service	Open/Close	Open/Closed	Open/Closed	Open/Closed
Operator Type	Electric	Manual	Electric	Electric
Opening/Closing Time, seconds	180	180	180	180

2.02 PAINTING:

A. Provide all external surfaces of the valves free of grease or oil and provide all machined surfaces protected with an anticorrosive preparation.

1. Painting: Provide manufacturer's standard epoxy painting system for ferrous valves.

a. Valve Color: Red

2.03 NAMEPLATES/MARKINGS:

A. Provide data plates or markings bearing serial numbers, ratings, and other essential information placed on the valve body. Provide all data on Type 316 stainless steel nameplates.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Prior to installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.

B. Clean all debris, dirt, gravel, etc., from inside of piping before placing valves in place.

C. Inspect material for defects in workmanship and material.

D. Erect and support valves in respective positions free from distortion and strain on appurtenances during handling and installation.

E. Set plumb and support valves in conformance with instructions of manufacturer.

F. Clean out debris and foreign material from valve openings and seats, test operating mechanisms to check functioning, and check nuts and bolts for tightness.

G. Repair, valves and other equipment which does not operate easily or are otherwise defective at no additional cost to the Owner.

3.02 FIELD TESTING:

A. Pressure test valves with pipeline pressure testing.

B. Test functions specified for each valve.

C. Test opening and closing speeds of actuated valves

D. Make all adjustments necessary to place valves in specified working order at time of above tests.

E. Remove and replace valves and appurtenances at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that valves will perform the service specified, indicated and as submitted and accepted.

3.03 STARTUP AND TESTING:

A. Services of Manufacturer's Representative as stated in Section 01 45 00 and as specified herein.

B. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Comply with requirements for checkout, startup, and testing in Section 01 78 25.

3. Physical Checkout and Field Testing (Functional Completion Testing): Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection;

coordination of piping, electrical and miscellaneous utility connections; certify proper installation:

a. 0.5 person-days per valve diameter larger than 6 inches.

4. Credit to the Owner all unused service person-days specified above, at the manufacturer's published field service rate.

C. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

3.04 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 23 19.01

PIPE SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Design, and provide a complete system of pipe supports with inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, sliding Teflon plates, and accessories as indicated and specified. The term pipe support includes hangers, guides, restraints, anchors and saddles.

B. Provide all support systems and the design of all support systems for all piping as specified herein. The Contractor shall provide pipe support locations, configurations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein.

C. The Contractor shall be responsible for the proper design, fabrication, location, shop drawings and installation of all pipe supports in accordance with the specified requirements.

D. Pipe support locations and types for piping 1/2-inch and larger shall be determined by the Contractor using the guidelines for support spacing specified herein and other criteria contained in this pipe support specification. Guidelines for pipe supports may need to be adjusted based upon field coordination, field routing, or other considerations outlined herein such as structural load limits. The Contractor may revise the pipe support locations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein. The Contractor is responsible for the proper design, installation and fabrication of all pipe supports in accordance with the specified requirements. For pipe supports 1/2-inch and larger pipe support shop drawings together with a marked up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.

1. The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification, including but not limited to the total limitations specified herein.

2. Pipe support details included in plans and specified herein are intended to be guidelines to be used for reference.

E. Design and provide all temporary pipe supports required during installation and testing.

1.02 REFERENCES:

A. The American Society of Mechanical Engineers (AMSE):

1. B31.1: Power Piping.

B. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

3. A312: Seamless and Welded Austenic Stainless Steel Pipe

4. A500: Cold Formed Welded and Seamless Carbon Steel Structural Tubing

5. A572: Specification for Steel Plate

6. E165: Practice for Liquid Penetrant Inspection Method

7. E709: Practice for Magnetic Particle Examination

C. American Welding Society (AWS):

1. D1.1: Structural Welding

D. Canadian Standards Association (CSA):

1. 40.20: General Requirements for Rolled or Welded Structural Quality Steel

2. 40.21: Structural Quality Steel

3. Welding Procedure Specifications

E. Fluid Sealing Association: Technical Handbook

F. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports - Materials and Design

2. SP-69: Pipe Hangers and Supports - Selection and Application

3. SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices

4. SP-90: Guidelines on Terminology for Pipe Hangers and Supports

G. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems and anchorage for equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

2. Pipe support drawings specified herein and including data for accessory items for acceptance prior to fabrication. The Contractor shall submit pipe support coordination drawings including all piping and pipe supports for all trades.

   a. Detailed drawing of the device with dimensions.

   b. A table of applied forces and moments.

   c. A complete bill of materials.

   d. A unique identification and revision level.

   e. Stamp of a Registered Professional Engineer, registered in the state where this project is being constructed, experienced in pipe support design and pipe stress analysis as specified herein.

   f. Detailed connections to existing structure.

   g. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1.

3. Welding Procedure: Submit description required to illustrate each welding procedure to be performed in the specified work.

4. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.

5. Qualification for Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS or ASME qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.

6. Pipe support manufacturers' qualifications as specified herein.

    a. List of at least five (5) successful pipe support projects and current addresses and telephone numbers of persons in charge of representing the owner or the owner of those construction projects during the time of pipe support design, fabrication and installation.

    b. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, who stamps and seals shop drawings and designs.

7. Coordination drawings for pipe supports shall include as a minimum the following information.

    a. Coordination drawings shall include all pipe supports covered by specifications.

    b. These coordination drawings will be used by the Contractor to ensure that the pipe supports do not obstruct access, access for equipment operation or removal including all mechanical and electrical equipment, panels, valves, gauges, and instrumentation.

    c. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.

    d. Prepare reproducible coordination drawings, indicating equipment, piping, valves, expansion joints, ductwork, conduit, cable trays, junction boxes, lighting fixtures, sleeves, inserts, embedments, supports, hangers and appurtenances at not less than 1/4-inch scale. Drawings shall show beams, columns, ceiling heights, wall, floors, partitions and structural features as indicated on the contract drawings. Individual pipes and conduit 2-inches or less in diameter that will be field routed need not be shown on coordination drawings.

    e. Coordination drawings shall include large-scale details as well as cross and longitudinal sections required to fully delineate all conditions. Particular attention shall be given to the location, size, and clearance dimensions of equipment items, shafts, operators and necessary maintenance access.

    f. Make all minor changes in duct, pipe or conduit routings that do not affect the intended function, but items may not be resized or exposed items relocated without the approval of the Owner. No changes shall be made in any wall locations, ceiling heights, door swings or locations, window or other openings or other features affecting the function or aesthetic effect of the building. If conflicts or interferences cannot be resolved, the Owner shall be notified. Any problems of coordination that require architectural or structural changes of design shall be submitted to the Owner for resolution.

g. After the reproducible drawings have been coordinated and all changes have been made, the drawings shall be signed by the Contractor and all subcontractors indicating that all work on that drawing has been coordinated with all associated vendors and subcontractors and all conflicts have been resolved.

h. Relocation of any duct, pipe, conduit or other material that has been installed without proper coordination among all trades shall be performed at no additional cost to the Owner.

8. Written notification of any deviations from the requirements of this specification.

9. Support documentation and justification as specified.

10. Certificates of Design signed by a Registered Professional Engineer in the State of Utah for all pipe supports.

11. Manufacturer's product data and specifications for shop painting.

B. Material Certification:

1. Provide certification from the manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

C. A copy of the contract mechanical process, and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification

compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.

C. Welder Qualifications:

1. Quality and certify welding procedures, welders, and operators in accordance with ANSI B31.1, paragraph 127.5 for shop and project site welding of piping work.

D. Pipe supports: All supports and parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufactures Standardization Society (MSS) Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.

E. Structural Concrete: Conform to the requirements of Section 03 30 00. Concrete strength: 4,000 psi unless noted otherwise.

F. Conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels are ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.

G. Pipe Support Manufacturer Qualifications:

1. Must possess a written quality assurance program.

2. Have a minimum of 5 years' experience in the design and fabrication of pipe supports.

3. Have completed the design and fabrication of at least 5 successful pipe support projects of equal size, complexity, and systems as this project within the past 10 years.

4. Retains the services of a Registered Professional Engineer, registered in the state where this project is being constructed, with a minimum of ten years' experience in the design of piping systems and pipe supports.

5. Manufacturers' Standardization Society (MSS) Member.

6. Have a field service technician on staff with at least 5 years' experience in resolving field installation, interference and interface problems associated with the design, installation and manufacture of pipe supporting components.

H. Hanger inspections shall be performed in accordance with MSS-SP-89 and ASME B31.1.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Provide materials used in pipe supports, which are compatible with the pipes to which they are attached. Provide Type 316L stainless steel supports for all stainless steel piping. Copper plated pipe supports are not acceptable.

B. Allowable materials: As indicated in ANSI B31.1 Appendix A and MSS-SP-58 Table 2.

C. Provide Type 316L stainless steel for pipe supports, hangers, guides, restraints, and anchors that are exterior or interior submerged, in potentially wetted areas in wet wells, channels, screening and grit removal areas and in chemically corrosive atmospheres.

D. Provide only new material. Previously used and/or scrap material is not acceptable.

E. Provide tube steels that are ASTM A500 Grade B, Structural shapes A-36, plates A-572 or equal.

F. Provide sliding Teflon plates. The sliding surfaces shall be a nominal 3/8-inches glass filled Teflon bonded to stainless steel backup plate with a 10 gauge minimum thickness. The bearing pad upper and lower units shall be as follows: Conslide Type CSA elements as manufactured by Con-Serv. Inc., Balco TFE Slide Bearing Plates 10N-cs as manufactured by Balco Inc., or Dynalon Slide Bearings as manufactured by JVI, Inc.

1. The blended TFE material used for this bearing shall be composed of virgin (unreprocessed) TFE resin tested per ASTM D1457 and reinforcing agents milled glass fibers. This structural material shall have the following representative mechanical and physical properties:

2. Tensile strength: 2,000 psi

3. Elongation: 225 percent

4. Specific Gravity: 2.17 to 2.22

5. The coefficient of friction shall average 0.06 under compressive load of 2,000 psi.

6. The compressive creep shall be a minimum of 2 percent at 2,000 psi and 70 degrees F.

7. The elements shall be flat, clean and prepared for installation in the structure. Slots and holes shall be fabricated in the bearing manufacturer's plant.

G. Concrete Anchor Bolts:

1. Hilti Kwik-Bolt II Stud Anchors

2. Rawl Bolt

3. Phillips Wedge Anchors

2.02 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS:

A. Design and provide pipe supports for piping 1/2-inch and larger to include the following loads:

1. Gravity Force: This force includes the weight of pipe, pipe contents (hydro load), valves, in-line equipment, insulation and any other weight imposed on the piping and/or pipe support.

2. Thermal Expansion Force: This force is developed by the restraint of free end displacement of the piping due to thermal growth.

3. Hydrostatic/Dynamic Forces: These forces are developed due to the internal pressure (positive and negative) during operation of the piping system. These forces include the forces due to water hammer, pressure pulses due to rapid valve closure, fluid discharge resulting from pump startup, operation of positive displacement pumps, etc.

4. Wind Loadings: Wind loadings.

5. Seismic Loading: Per Section 01 41 20, Section 22 05 48 and Section 23 05 48.

B. Provide supports, guides, anchors, flexible couplings and expansion joints in accordance with the coupling and joint manufacturers' specifications and requirements.

C. For all pump suction and discharge nozzles provide an anchor located between the pump nozzles and the nearest expansion joint or non-rigid coupling.

D. Where possible, provide pipe supports, which are the manufacturers' standard products.

1. Provide pipe supports with individual means of adjustment for alignment.

2. Provide pipe supports complete with appurtenances including locking and adjusting nuts.

3. Hanger rods shall be subjected to tension only.

4. Where lateral or axial pipe movement occurs, provide hangers for the necessary swing without exceeding 4 degrees. Provide base supports designed using pipe slides. The bearing surfaces: 0.06 coefficient of friction or less.

5. Provide concrete inserts capable of supporting the design loads.

6. Metal framing systems will be acceptable to support piping 2 inch and smaller.

7. Provide insulated piping supported using rigid load bearing insulation (baton board type) with 16 gauge shields to fit between the insulation and the support. Shields to encompass a minimum 1/3 of the pipe circumference and be 12 inch in length.

8. Provide load-bearing insulation capable of supporting the load, as a minimum on the bottom 60 degrees of the pipe support. Cope insulation and adjust to avoid interference of steel structures.

9. Provide supplementary steel as needed.

10. Do not support pipes from other pipe, conduits or metal stairs.

11. Chain, strap, T-bar, perforated bar and/or wire hangers are not acceptable.

12. Contact between piping and dissimilar metals such as hangers, building structural work or equipment subject to galvanic action is not acceptable.

13. All pipe supports located in fluid flow shall be supplied with double nutting.

E. Provide thrust anchors to resist thrust where required. Wall pipes may be used as thrust anchors if so designed. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes.

F. Provide expansion joints where indicated and where required based on Contractor's design of the pipe support system. Indicate expansion joints on submittal drawings.

G. For piping 2-inch and smaller provide manufacturer's standard supports and standard spacing guidelines

H. Pipe supports connected to structural framing and slabs are subject to the following limitations:

1. Less than 100 pounds horizontal load per support.

2. Vertical loads not to exceed in average of 10 PSF for slabs, or a total of 200 PSF including the operating weight, with a maximum vertical load per hanger of 200 lbs. For a maximum of one pipe support per foot of slab width perpendicular to the span.

3. Vertical loads not to exceed 200 pounds per column or 150 pounds per support at walls.

4. Piping not supported from floors by metal framing must meet the limitations as specified above.

I. All outside above ground supports shall be Type 316L stainless steel as specified herein.

J. Provide pipe supports that do not overload or over stress the piping, equipment, or structure that they are supporting or to which they are attached. Allowable pipe stress to be within ANSI B31.1 code allowable.

K. The Contractor shall provide the services of a field service technician (preferably from the pipe support manufacturer) to field coordinate the locations of supports and resolve interferences and conflicts encountered during installation.

2.03 FABRICATION:

A. Provide pipe supports formed in accordance with paragraph 5.1 of MSS-SP-58.

B. Providing welding in accordance with Structural Welding Code.

C. Provide dimensional tolerances as specified in MSS-SP-89.

D. Provide threading and tapping in accordance with MSS-SP-89.

2.04 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10.

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with manufacturers' printed instructions and as indicated and specified herein.

B. Perform welding in accordance with Structural Welding Code:

1. Visually inspect welding while the operators are making the welds and again after the work is completed in accordance with AWS D1.1 Section 6.0. After the welding is completed, hand or power wire brush welds, and clean them before the Qualified Inspector makes the check inspection. The Qualified Inspector shall inspect welds with magnifiers under light for surface cracking, porosity, and slag inclusions; excessive roughness; unfilled craters; gas pockets; undercuts; overlaps; size and insufficient throat and concavity. The Qualified Inspector shall inspect the preparation of grove welds for throat opening and for snug positioning for back-up bars.

2. Nondestructive evaluation of welds connecting structural steel members subjected to critical stresses: Perform in accordance with the weld quality and standards of acceptance in AWS D1.1.

3. Magnetic Particle Inspection: Perform in accordance with ASTM E709.

4. Liquid Penetrant Inspection: Perform in accordance with ASTM E165.

5. For weld areas containing defects exceeding the standards of acceptance in accordance with AWS D1.1, Section 3.7. Provide additional testing of the repaired area at no additional cost to the Owner.

6. Test Locations: As selected by the Owner.

7. Correct any deficiencies detected as directed by the Engineer at no additional cost to the Owner.

C. Proceed with the installation of the pipe supports only after required building structural work has been completed and concrete support structure has reached its 28-day compressive strength as specified in Section 03 30 00.

D. Install pipe supports to comply with MSS-SP-89. Group parallel runs of horizontal piping to be supported together on trapeze type hangers.

E. Install pipe supports to provide indicated pipe slopes. Do not exceed maximum pipe deflection allowed by ANSI B31.1.

F. For exposed continuous pipe runs, install pipe supports of same type and style as installed for adjacent similar piping.

G. Install pipe supports to allow controlled movement of piping systems. Permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Piping to be free to move when it expands or contracts except where fixed anchors are indicated or required by the Contractor's pipe support systems. Where hanger rod swing length cannot be provided or where pipe movement based on expansion of 1 inch/100 feet, for each 100 degrees F change in temperature exceed 1/2-inch, provide sliding supports.

I. Prevent contact between dissimilar metals. Where concrete or metal support is used, place 1/8-inch thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and pipe support.

J. Prevent electrolysis in support of copper tubing by use of pipe supports which are plastic coated. Electrician's tape is not an acceptable isolation method.

K. Apply an anti-seize compound to nuts and bolts on all pipe supports.

L. Locate reinforcing steel in concrete structure with x-ray prior to drilling for embedment plates and anchor bolts. Avoid contact or interference with reinforcing steel.

3.02 INSTALLATION OF BUILDING ATTACHMENTS:

A. Support piping from structural framing, unless otherwise indicated.

B. Concrete Inserts:

1. Use existing embedded concrete items whenever possible.

2. Use expansion anchors only when existing embedded attachment points are not available or unsuitable. Attach to hardened concrete or completed masonry.

3.03 THRUST ANCHORS AND GUIDES:

A. Thrust Anchors:

1. Center thrust anchors between expansion joints and between elbows and expansion joints for suspended piping. Anchors must hold pipe rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.

2. Restraining rod size and number shall be as indicated and adhere to manufacturers recommendations as a minimum.

B. Pipe guides: Provide adjacent to sliding expansion joints in accordance with recommendations of the National Association of Expansion Joint Manufacturers and the specific joint manufacturer.

3.04 PIPE SUPPORTS:

A. Where piping of various sizes is to be supported together, space supports for the largest pipe size and install intermediate supports for smaller diameter pipes.

B. Provide minimum of two pipe supports for each pipe piece.

C. Where pipe connects to equipment, support pipe independently from the equipment. Do not use equipment to support piping.

D. Provide pipe supports so that there is no interference with maintenance or removal of equipment.

E. Unless otherwise indicated or authorized by the Engineer, place piping running parallel to walls approximately 1-1/2 inch out from face of wall and at least 3 inches below ceiling.

F. Pedestal pipe supports: adjustable with stanchion, saddle, and anchoring flange. Provide grout between baseplate and floor.

G. Piping supports for vertical piping passing through floor sleeves: use hot dipped galvanized steel riser clamps.

H. Support piping to prevent strain on valves, fittings, and equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise indicated. Do not install pipe supports in equipment access areas or bridge crane runs.

I. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

J. Do not support piping from other piping.

K. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized whenever possible.

L. Whenever possible, pipe attachments for horizontal piping shall be pipe clamps.

M. All rigid rod hangers shall provide a means of vertical adjustment after erection.

N. Where the piping system is subjected to shock loads, such as disturbances due to pump discharge or thrust due to actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices.

O. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage shall be provided to permit rod swing.

P. Hanger spacing shall not exceed the spacing listed below:

1. In the case of concentrated loads the supports shall be placed as close as possible to the load to reduce the bending stress.

2. Where changes in direction of the piping system occur between supports, the total length between supports shall be kept to less than three-fourths of the full span. When practical, a support shall be placed immediately adjacent to any change in direction of the piping system.

Q. Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp shear lugs. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes. If friction is relied upon to support riser piping proper justification and documentation shall be submitted to ensure that enough friction force is provided to resist the applied loading.

R. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

S. All threads shall be UNC unless otherwise specified.

T. TFE slide bearing plates with steel backup plates shall be stitch weld attachments to the structure. A 1/8-inch fillet weld, 1/2-inch long every 3 inches on center each side of an element shall be used unless otherwise indicated or specified by the manufacturers' written recommendations. Bearing elements with slots or holes shall be stitch welded in place for location. The TFE surfaces of the bearings shall be maintained clean and free from grit, dirt or grease.

3.05 INSULATED PIPING:

A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.

B. Where vapor barriers are indicated on water piping, install coated protective shields.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 23 19.03

STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test steel pipe 10-inch in diameter and larger, fittings and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

3. A307: Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile

4. A325: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi minimum Tensile Strength

B. American National Standards Institute (ANSI) Standards:

1. B31.1: Power Piping

C. American Society of Mechanical Engineers (ASME):

1. B1.1: Unified Screw Threads

2. B18.2.2: Square and Hex Nuts

3. Boiler and Pressure Vessel Code Section IX

D. American Water Works Association (AWWA):

1. C200: Standard for Steel Water Pipe, 6 Inches and Larger

2. C205: Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4-in. and Larger - Shop Applied

3. C206: Standard for Field Welding of Steel Water Pipe

4. C207: Standard for Steel Pipe Flanges for Waterworks Service, sizes 4 in. through 144 in.

5. C208: Standard for Dimensions for Steel Water Pipe Fittings

6. C209: Standard for Cold Applied Tape Coatings for Special Sections, Connections and Fittings for Steel Water Pipelines

7. C210: Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines

8. C213: Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines

9. C214: Standard for Tape Coating Systems for the Exterior of Steel Water Pipelines

10. C222: Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings

11. C602: Standard for Cement-Mortar Lining of Water Pipelines - 4-in. and Larger - In Place

12. C604: Installation of Buried Steel Water Pipe – 4 inches (100 mm) and Larger

E. Expansion Joint Manufacturers Association: Standards

F. Fluid Sealing Association - Technical Handbook

G. Structural Steel Painting Council (SSPC):

1. SSPC-SP10

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Certified shop and erection drawings. Contractor shall submit electronic files of the piping layout including the following.

a. Pipe layouts in full detail.

b. Location of hangers and supports.

c. Location and type of anchors.

d. Location of couplings and expansion joints.

e. 1/2 inch = 1 foot-0 inches scale details of all wall penetrations and fabricated fittings or special fittings.

f. Schedules of pipe, fittings, expansion joints and other appurtenances.

g. Electronic files shall conform to the following minimum requirements:

(1) Electronic Files: AutoCAD latest version, drawn to scale.

(2) Submit electronic files as part of the Shop Drawing submittal.

(3) Submit electronic files on CD or DVD.

(4) Drawings shall be in conformance with all other requirements as specified in this specification.

2. Sworn certificates in duplicate of shop tests showing compliance with appropriate standard.

3. Reports of ASME Section IX welding certifications.

4. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.

5. Brochures and technical data on coatings and linings and proposed method for application and repair.

6. Provide record drawings.

7. Provide tag names and numbers for all sections of piping and fittings.

B. Material Certification:

1. Provide certification from the piping and fittings manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.

C. A copy of the contract mechanical process, civil and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes

necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

    a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

    b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

A. Welder Qualifications:

1. Qualify and certify welding procedures, welders, and operators in accordance with ASME Section IX, for shop welding and AWS D1.1 for project site welding of piping work.

2. Qualification for welders: Welding shall be performed by welders holding current certification for the welding procedures in use.

3. Visually inspect welding while the operators are making the welds and again after the work is completed. After the welding is completed, hand or power wire brush welds and clean them before the inspector makes the check inspection. Inspect welds for defects exceeding tolerances allowed by code under which the weld was made. Repair all defects exceeding tolerance.

B. Job Conditions:

1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, and other equipment to be installed in piping system.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with APWA Section 01 66 00.

B. During loading, transportation and unloading, prevent damage to pipes and coatings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to protect pipe, lining, and coating.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Northwest Pipe

B. Ameron

C. Hanson

D. American Spiral Weld

E. Mid America

2.02 WALL THICKNESS:

A. Steel pipe 10-inch to 24-inch: ASTM A53 Type E or S, Grade B, Black.

Nominal Pipe Size, inches	Minimum Wall Thickness, inches
10	0.250 (SCH 20)
12	0.250 (SCH 20)
14	0.250 (SCH 10)
16	0.250 (SCH 10)
18	0.250 (SCH 10)
24	0.250 (SCH 10)

B. Steel Pipe 30-inch diameter and larger: AWWA C200.

Nominal Pipe Size, in	Minimum Wall Thickness, in Interior Piping	Minimum Wall Thickness, in Buried Piping
28	0.250	0.134
30	0.250	0.134
32	0.250	0.156
36	0.250	0.156
40	0.250	0.181
42	0.250	0.181
48	0.250	0.206
54	0.312	0.231
60	0.312	0.256

Nominal Pipe Size, in	Minimum Wall Thickness, in Interior Piping	Minimum Wall Thickness, in Buried Piping
66	0.375	0.282
72	0.375	0.308
84	0.500	0.358
90	0.500	0.383
96	0.500	0.408
102	0.500	0.433
108	0.500	0.458
114	0.500	0.483
120	0.500	0.508

C. Interior piping wall thickness: Increase wall thickness to limit combined stress (circumferential longitudinal and localized) to 75 percent of the minimum yield of the steel used.

2.03 PIPE:

A. Fabricate to sizes, dimensions, and shapes indicated.

B. Sizes, Pipe, Fittings and Specials:

1. 12 inch and smaller: Nominal

2. 14 inch thru 24 inch: Actual outside diameter

3. 30 inch and larger: Nominal size to be I.D. after lining

C. Seams:

1. Except for seamless mill type pipe, provide piping fabricated from steel plates rolled into cylinders or sections thereof with longitudinal seams or spiral seams butt welded.

2. Do not use more than two longitudinal seams in piping 72 inch and smaller in size.

3. Butt weld girth seams at least 6 feet apart, except in specials and fittings.

2.04 FITTINGS:

A. Fabricate in accordance with AWWA C208.

B. Provide elbows with the following radius:

1. Interior and Exposed Piping: 1.50 times the nominal diameter

2. Buried Piping: 2.50 times nominal diameter, unless otherwise indicated or specified.

3. Provide elbows in accordance with the following:

Fitting Bend Angle, degrees	Number of Pieces
0 to 22.50	2
23 to 45	3
46 to 67.50	4
68 to 90	5

C. Provide reinforced tees, laterals, and outlets in accordance with ASME Pressure Vessel Code, Section VIII, Paragraph UG-37 or AWWA M-11, Chapter 13.

D. Provide reducing sections with same shell thicknesses required for larger ends.

E. Special Sections:

1. Provide fittings and special sections with ends as indicated and fabricated to shapes, sizes, and dimensions indicated.

F. Small Branch Connections:

1. Provide branch connections 2-1/2 inch and smaller fabricated with welding fittings with threaded outlets.

2. Provide branch connections 3 inch through 12 inch fabricated with pipe nipples or with welding fittings.

3. Provide pipe nipples and welding fittings welded to pipe shell and reinforced to meet working and test pressure requirements.

4. Provide pipe nipples of black steel pipe in accordance with ASTM A53 Type E or S Grade B, minimum thicknesses as listed in the above table.

5. Provide threaded and welded outlets as indicated.

6. Provide small branch connections located so as not to interfere with joints, supports, or other details.

G. Provide fittings shop fabricated from previously hydrostatically tested straight pipe with magnetic particle non-destructive testing of all welds that were not previously tested in the straight pipe.

2.05 FIELD JOINTS:

A. Type as indicated:

1. Location and type of joint may be modified to provide for lining, coating and flexibility in field assembly as accepted by the Engineer.

B. Provide pipe end preparation and tolerances in accordance with AWWA C200.

2.06 FLANGES:

A. Provide in accordance with AWWA C207 depending on pressures.

B. Provide flanged end pipe fitted with slip-on flanges. Provide longitudinal or spiral welds ground flush to accommodate type of flanges provided.

1. Provide bolts and bolt-studs in accordance with AWWA C207 with hexagonal or square heads, coarse thread fit, threaded full length with ends chamfered or rounded.

2. Project bolt ends 1/4-inch beyond surface of nuts.

3. Provide hexagonal nuts with dimensions in accordance with ANSI B18.2.2 and coarse threads in accordance with ASME B1.1.

C. Provide face and finish flanges per AWWA C207.

D. Provide flanges attached normal to axis of pipe for alignment.

E. Provide flanges tested, after welding to pipe, for true plane and reface, to bring them within specified tolerances.

F. Blind Flanges: Conforming in diameter, drilling, and thickness to flanges to which they mate and reinforced to produce a watertight joint under test pressures indicated in the Process Pipe Schedule.

G. Gaskets:

1. Provide gaskets per AWWA C207 made from 1/8-inch thick compressed non-asbestos material.

2. Materials:

a. Water, Wastewater and Sludge Services: Buna N, Neoprene

b. UV Systems: Viton

2.07 WELDED JOINTS:

A. Welds:

1. Sound and free from embedded scale or slag, with tensile strength of weld not less than that of thinner of connected sections. Welds to be watertight.

B. Field welding of lined pipe is not acceptable unless otherwise indicated.

C. Field welds of interior piping: Butt welds.

1. Outside back-up bar may be used.

D. Field welds of buried piping: Bell and spigot lap welds with single weld inside or outside.

E. Provide field welds, in accordance with AWWA C206.

2.08 BOLTED SPLIT SLEEVE COUPLINGS:

A. Provide in accordance with Section 40 23 19.05.

2.09 SLEEVE TYPE COUPLINGS:

A. Provide in accordance with Section 40 23 19.05.

2.10 FLANGED COUPLING ADAPTERS:

A. Manufacturers:

1. Dresser "Style 128"

2. Baker

3. ROMAC

B. Provide restrained flanged coupling adapters.

C. Provide tie rods of sufficient number and strength to restrain coupling at test pressure as indicated in Process Pipe Schedule.

2.11 EXPANSION JOINTS:

A. Provide in accordance with 40 23 19.05.

2.12 LINING AND COATING:

A. Lining:

1. Provide lining to the interior of steel pipe, fittings, sleeve couplings and maintenance holes.

2. Provide epoxy lining for all interior piping as indicated in the Process Pipe Schedule.

B. Polyurethane Lining:

1. Provide lining in accordance with AWWA C222

2. For buried piping provide 20 mils interior and 25 mils exterior

3. For exposed piping provide 20 mils interior and painting as specified for the exterior

4. Applied per manufacturer's written instruction.

C. Epoxy Lining:

1. Epoxy-phenolic lining shop applied over grit blast cleaned surface, near white per SSPC-SP10.

2. Minimum of two coats providing a total dry film thickness of at least 12 mils of liquid epoxy in accordance with AWWA C210, Tnemec FC22 or fusion bonded epoxy in accordance with AWWA C213.

3. Applied per manufacturer's written instruction.

D. Cement Lining:

1. Provide in-place lining in accordance with AWWA C602 or factory lined in accordance with AWWA C205 as indicated in the Process Pipe Schedule.

2. If piping is factory lined, provide field line welded joints or O-ring field joints in accordance with Section 7 of AWWA C205.

E. Coating:

1. Where sleeve couplings are used, provide coating to pipe ends and exterior surface for a distance of 9 inch with same material as specified for lining.

2. Exposed exterior surfaces of pipe within the building: Commercial blast (SSPC-SP6) and paint with one shop coat of universal primer compatible with field painting Section 09 91 10.

3. Exterior of buried pipe: Coat and wrap with prefabricated multilayer cold-applied polyethylene tape coating in accordance with AWWA C214 Standard.

   a. The total nominal thickness of coating: 80 mils consisting of: Primer, 20 mil inner wrap for corrosion protection and two 30 mil outer wraps for mechanical protections.

   b. Coat and wrap fittings and field joints with prefabricated multilayer cold-applied polyethylene tape coating in accordance with AWWA C209 Standard. The total thickness of coating shall be 70 mils consisting of: Primer and 2 wraps of 35 mil tape.

      (1) Alternate field joint coating: Heat-Shrink sleeves per AWWA C216. Interior welding of joints with Heat-Shrink sleeves can begin once 3 feet of backfill is placed on the pipe.

2.13 SHOP PAINTING:

A. Provide in accordance with Section 09 91 10.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPE:

A. Install pipelines per AWWA C604 and parallel to building walls wherever possible. Install piping to lines and grades indicated and support. Where temporary supports are used, provide temporary supports as specified in Section 40 23 19.01 to prevent shifting or distortion of pipe. Provide for expansion.

B. Slope piping toward low points and provide for draining at low points.

C. Before assembly, remove debris from inside pipes and fittings.

D. Before flanges pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth burrs. Make up flanged joints tight, and prevent strain upon valves or other pieces of equipment.

   1. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch excess thread protruding from the nut.

E. Install tierods, pipe clamps or bridles when sleeve type couplings or fittings are used in piping system as indicated, and at changes in direction or other places to prevent joints from pulling apart under pressures indicated in the Process Pipe Schedule.

F. Examine pieces for damage. Do not install pieces that are damaged according to Engineer. If any damaged piece should be discovered after having been installed, remove and replace with a sound piece at no additional cost to the Authority.

G. Handle pipe with equipment such as nylon slings and padded skids, designed to prevent damage to the coating. Repair abrasions and injuries to the coating prior to the application of insulation or prior to the application of final field coating.

3.02 INSTALLATION OF LINING AND COATING:

A. After installation of pipe, fittings, and specials, clean, prime, line, and coat as specified for pipe adjacent to weld unlined or uncoated ends adjacent to field welded joints, including weld proper. Repair any damage to lining in accordance with lining manufacturers written recommendations.

B. Preparation of surfaces to be lined and coated after installation of pipe for shop application of coal tar epoxy, except remove foreign matter, including all damaged lining or coating materials, by scraping, chipping, or brushing, and surfaces cleaned to bright metal free of all rust, slag, and scale by means of wire brushing or sand blasting.

C. Use open ends or access maintenance holes for entry for application of interior linings to unlined ends.

D. Pour holes are not allowed.

E. After installation of pipe, fittings, and specials, shop coat on exterior shall be touched up followed by a field coat prior to encasing in concrete.

3.03 INSTALLATION OF FLANGED COUPLING ADAPTERS:

A. Install flange coupling adapters in strict accordance with coupling manufacturer's recommendations.

3.04 INSTALLATION OF PIPE SUPPORTS:

A. Provide in accordance with Section 40 23 19.01.

B. Proceed with installation of pipe supports only after required building structural work has been completed and concrete has reached its 28 day compressive strength.

C. Support piping to prevent forces applied on valves and equipment.

3.05 PHYSICAL CHECKOUT, FIELD AND FUNCTIONAL TESTING:

A. Clean dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.

B. Water for testing provided by the Contractor.

C. Pressure and Leakage Tests shall be done per C604:

1. Provide temporary testing plugs or caps; pressure pumps, pipe connections, meters, gages, equipment, and labor.

2. Test pipelines in sections of accepted length.

3. Fill section of pipe with water and expel air.

4. Pressure and leakage test consists of first raising pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to test pressures indicated in the Process Pipe Schedule.

5. No visible leakage in joint is acceptable.

6. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section has failed to pass test.

7. If section fails pressure and/or leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, and conduct additional tests and repairs until section passes test at no additional cost and without any time extensions.

D. Make piping connections to equipment with pipe in a free supported state and without application of vertical or horizontal forces to align piping with the equipment flanges.

3.06 FIELD PAINTING:

A. Provide in accordance with Section 09 90 00.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 40 23 19.05

PROCESS PIPING AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test process piping and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B16.1: AN Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800

2. B16.3: Malleable Iron Threaded Fittings Classes 150 and 300

3. B16.5: AN Standard for Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys

4. B16.9: Factory-Made Wrought Buttwelding Fittings

5. B31.1: Power Piping

B. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A47: Standard Specification for Ferritic Malleable Iron Castings

3. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

4. A105: Standard Specification for Carbon Steel Forgings for Piping Applications

5. A139: Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

6. A181: Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

7. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

8. A194: Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

9. A197: Standard Specification for Cupola Malleable Iron

10. A216: Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service

11. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

12. A256: Standard Method of Compression Testing of Cast Iron

13. A269: Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

14. A278: Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F (350°C)

15. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

16. A312: Seamless and Welded Austenic Stainless Steel Pipe

17. A351: Standard Specification for Castings, Austenitic, for Pressure-Containing Parts

18. A449: Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

19. A536: Ductile Iron Castings

20. C177: Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

21. C1136: Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

22. D256: Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

23. D570: Standard Test Method for Water Absorption of Plastics

24. D638: Standard Test Method for Tensile Properties of Plastics

25. D696: Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between-30 Degree C and 30 Degree C with a Vitreous Silica Dilatometer

26. D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

27. D792: Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

28. D1330: Standard Specification for Rubber-Sheet Gaskets

29. D1457: Standard Specification for Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials

30. D1599: Standard Test for Short-Time Rupture Strength of Plastic Pipe, Tubing and Fittings

31. D1784: Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

32. D1785: Standard Specification for Polyvinylchloride (PVC) and Chlorinated Polyvinylchloride (CPVC) Plastic Pipe, Schedules 40, 80 and 120

33. D2000: Rubber Products in Automotive Applications

34. D2105: Standard Test for Longitudinal Tensile Properties of Reinforced Thermosetting Plastic Pipe and Tube

35. D2412: Standard Test for External Loading Properties of Plastic Pipe by Parallel-Plate Loading

36. D2467: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

37. D2564: Standard Specification for Solvent Cements for Polyvinylchloride (PVC) and Chlorinated Polyvinylchloride (CPVC) Plastic Pipe and Fittings

38. D2855: Standard Practice for Making Solvent Cemented Joints with Polyvinylchloride (PVC) and Chlorinated Polyvinylchloride (CPVC) Pipe and Fittings

39. D3035: Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter

40. D3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

41. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

42. F441: Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

43. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

44. F1476: Standard Specification for the Performance of Gasketed Mechanical Couplings for Use In Piping Applications.

C. American Welding Society (AWS):

1. B3.0: Welding Procedure and Performance Qualification

D. American Water Works Association (AWWA):

1. C219: Bolted, Sleeve-Type Couplings for Plain-End Pipe

2. C606: Grooved and Shouldered Joints

E. Expansion Joint Manufacturers Association Standards.

F. Fluid Sealing Association - Technical Handbook.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Submit manufacturer's certificates of conformance.

2. Submit certified copies of test reports.

3. Piping layouts in full detail.

4. Location of pipe hangers and supports.

5. Large scale details of wall penetrations and fabricated fittings.

6. Schedules of all pipe, fittings, special castings, flexible connectors, adapters, couplings, expansion joints, and other appurtenances.

7. Reports as required for welding certifications per ASME B31.1.

8. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.

B. Grooved joint couplings and fittings: Provide product submittals with products specifically identified by the manufacturer's style or series designation.

1. Brochures and technical data on coatings and linings and proposed method for application and repair.

2. Manufacturer's descriptive literature and technical data on insulation and proposed method of installation.

3. Shop drawing data for accessory items.

4. Manufacturer's literature as needed to supplement certified data.

5. Operating and maintenance instructions and parts lists.

6. Shop and Field inspections reports.

7. List of recommended spare parts other than those specified.

8. Recommendations for short and long term storage.

9. Special tools.

10. Shop and field testing procedures and equipment to be used.

11. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and as indicated.

12. The latest ISO 9001 series certification or quality system plan.

13. Material Certification:

a. Provide certification from the piping and equipment manufacturers that the materials of construction specified are recommended and suitable for the service conditions specified and as indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified. And indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Authority.

b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

C. A copy of the contract mechanical process, civil, structural, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required".

1. Failure to include all drawings applicable to the equipment specified in this section will result in submittal return without review.

D. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.04 QUALITY ASSURANCE:

A. Welder Qualifications:

1. Qualify and certify welding procedures, welders, and operators in accordance with ASME B31.1, for shop and project site welding of piping work.

2. Qualification for Welders: Welding shall be performed by welders holding current certification for the welding procedures in use.

3. Visually inspect welding while the operators are making the welds and again after the work is completed. After the welding is completed, hand or power wire brush welds and clean them before the inspector makes the check inspection. Inspect welds for defects exceeding tolerances allowed by code under which the weld was made. Repair all defects exceeding tolerance.

B. Provide all grooved joint couplings, fittings, valves, and specialties to be the products of a single manufacturer. Grooving tools used must be of the same manufacturer as the grooved components.

1. Provide all castings used for coupling housings, fittings, and valve bodies date stamped for quality assurance and traceability.

C. Job Conditions:

1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, and other equipment to be installed in piping system.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with APWA Section 01 66 00.

B. During loading, transportation and unloading, prevent damage to pipes and coatings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to protect pipe, lining, and coating.

PART 2 - PRODUCTS

2.01 STEEL PIPE AND FITTINGS 2-1/2-INCH AND LARGER:

A. Provide in accordance with Section 40 23 19.03.

2.02 CPVC PIPE AND FITTINGS:

A. Schedule 80.

B. Material: Type IV, Grade I Chlorinated Polyvinyl Chloride (CPVC) compound with a Cell Classification of 23447 per ASTM D1784.

C. Provide pipe and fittings manufactured in compliance to ASTM F441 meeting the Quality Assurance test requirements of this standard with regard to material, workmanship, burst pressure, flattening, and extrusion quality.

D. Provide pipe and fittings produced in the USA using domestic materials, by an ISO 9002 certified manufacturer, and shall be stored indoors after production, at the manufacturing site, until shipped from factory.

E. Provide pipe and fittings with the National Sanitation Foundation (NSF) seal of approval for potable water applications.

F. Joining:

1. Solvent cementing process.

2. Use only Weld-On 724 for all sodium hypochlorite services.

3. Provide flanges at valves pumps and equipment only or as indicated and specified.

4. Threaded connections are not acceptable.

5. Provide Type 316 stainless steel flange bolting and hardware for all piping system except sodium hypochorite use titanium.

2.03 PVC PIPE AND FITTINGS:

A. Schedule 80

B. Material: Type I, Grade I Polyvinyl Chloride (PVC) compound with a Cell Classification of 12454 per ASTM D1784.

C. Provide pipe and fittings manufactured in compliance to ASTM D1785 meeting and/or exceeding the Quality Assurance test requirements of this standard with regard to material, workmanship, burst pressure, flattening, and extrusion quality.

D. Provide pipe and fittings manufactured in the USA, using domestic materials, by an ISO 9002 certified manufacturer. Store all pipe shall be stored indoors after production at the manufacturing site until shipped from factory.

E. Provide standard lengths of pipe sizes 10-inch and larger beveled each end by the pipe manufacturer.

F. Provide pipe and fittings with the National Sanitation Foundation (NSF) seal of approval for potable water applications.

G. Joining:

1. Solvent cementing process. Solvent shall be suitable for the size of pipe to be joined.

2. Provide flanges at valves, pumps and equipment only or as indicated and specified.

3. Provide Type 316 stainless steel flange bolting and hardware for all piping system except sodium hypochorite use titanium.

2.04 PVC CLEAR PIPE AND FITTINGS:

A. Schedule 80 Clear pipe.

B. Material: Type I, Grade I Polyvinyl Chloride (PVC) compound with a Cell Classification of 12454 per ASTM D1784.

C. Provide pipe and fittings manufactured in compliance to ASTM D1785, consistently meeting and/or exceeding the applicable Quality Assurance test requirements of this standard with regard to material, workmanship, burst pressure, flattening, and extrusion quality.

D. Provide pipe and fittings manufactured in the USA by an ISO 9002 certified manufacturer.

E. Provide all Clear PVC pipe and fittings packaged immediately after its manufacture to prevent damage, and stored indoors at the manufacturing site until shipped from factory.

F. Joining:

1. Solvent cementing process. Use a clear, medium-bodied, fast-setting cement in conjunction with a clear primer for optimum joint integrity, such as IPS Weld-on 705 Clear cement and IPS Weld-On P-70 Clear primer or acceptable equivalent product.

2. Clear female threaded transition fittings, incorporating a Type 316 stainless steel retaining ring. Provide all threaded joints with three wraps of tape in the direction of the threads on the male end, followed by one to two turns beyond finger tight.

3. Standard rigid thermoplastic pipe fittings with flanges, molded grooved coupling adapters and unions.

4. Provide Type 316 stainless steel flange bolting and hardware for all piping system except sodium hypochorite use titanium.

2.05 STEEL PIPE AND FITTINGS 10-INCH AND SMALLER:

A. Materials: Carbon steel, ASTM A53, Schedule 40, 80 or 120 black or galvanized as indicated in the Process Piping Schedule.

B. Joints:

1. Pipe 2-1/2 inch and Smaller: Screwed joints using malleable-iron fittings, black or galvanized, to match pipe.

2. Pipe 3-inch and Larger: Grooved Joints and fittings. Provide flanged connections to equipment and valves with 150-lb. weld neck flat faced flanges.

3. Welding of pipe within classified areas in operation is not acceptable. Provide shop fabricated sub-assemblies and install with flanges or grooved-couplings as specified and indicated.

C. Fittings:

1. 2-1/2-inch and Smaller: Screwed type, 150-lb. malleable iron, black or galvanized to match the pipe, ASTM A197 or A47, conforming to ASME B16.3. Unions of 150-lb. malleable iron with brass to iron seat.

2. 3-inch and Larger: Butt welded carbon steel to match pipe wall thickness, ASTM A234, conforming to ASME B16.9 standards.

3. Grooved end fittings, 2-inch and Larger (where indicated): Ductile iron ASTM A536 Grade 65-45-12; Wrought steel ASTM A234 Grade WPB; or Factory-fabricated from steel pipe conforming to ASTM A53.

D. Grooved Joint Couplings: Provide couplings consisting of two ductile iron housing segments to ASTM A536, pressure responsive gasket to ASTM D2000, and Type 316 stainless steel bolts and nuts. Provide couplings complying with ASTM F1476 Standard Specification for the Performance of Gasketed Mechanical Couplings for Use In Piping Applications.

1. Rigid Type: Provide coupling housings cast with offsetting angle-pattern bolt pads to provide joint rigidity and support and hanging in accordance with ANSI B31.1 and B31.9 or equal.

a. Victaulic Style 107H, Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket, suitable for water service to plus 250 degrees F.

b. Victaulic Style 07 “Zero-Flex”.

2. Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for the elimination of flexible connectors. Victaulic Installation-Ready Style 177 or Style 77.

E. Branch Connections:

1. 2-inch and Smaller Connections to Welded Pipe: Screwed, forged carbon steel, ASTM A105, 3,000-lb. half-couplings or welding saddle with threaded outlet.

2. 2-1/2-inch and Larger Pipe Connections: Tees or reducing tees. Butt welded carbon steel to match pipe wall thickness, ASTM A181 GR1 or A105 GR1, conforming to ASME B16.1 standards.

F. Flanges: Forged steel, ASTM A181.

1. Slip-on or welding neck type as specified and indicated.

2. Provide 150-lb. flanges drilled and faced.

3. Raised face type: 1/16-inch raised faced in accordance with ASME B16.5.

4. Flat-face, welding neck type: ASME B16.1 Standard for all connections to valves and equipment.

5. Gaskets: For flanged joints, 1/16 inch thick suitable for the service specified and indicated.

6. Flange Adapters: Flat face, ductile iron housing with elastomer pressure responsive gasket, suitable for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741 / W741 (where indicated).

2.06 STEEL PIPE 12-INCH AND LARGER:

A. Provide in accordance with Section 40 23 19.03.

2.07 STAINLESS STEEL PIPE AND FITTINGS 1/2-INCH TO 2-INCH:

A. Provide either Pressfit, grooved or a socket welded system.

1. Provide a sufficient number of unions for Vic-Press and socket welded systems to allow removal of all valves and inline devices.

2. Provide threaded connections only where required.

B. Vic-Press Schedule 10S System:

1. Vic-Press system, 1/2-inch through 2-inch Schedule 10S comprised of stainless steel Vic-Press fittings, couplings and pipe.

2. Type 316 stainless steel Pressfit couplings and fittings and Type 316 stainless steel Pressfit pipe UL classified to ANSI/NSF 61 for cold plus 86 degrees F and hot plus 180 degrees F potable water service.

a. Maximum working pressure of 500 psi for water, oil, gas, chemical, air and vacuum services.

3. Couplings, Fittings: Pressfit products formed of Type 316/316L stainless steel tubing including a self-contained O-ring seals molded of synthetic HNBR rubber suitable for water operating temperatures to plus 210 degrees F.

4. Valves 1/2-inch through 2-inch ball valves with Type 316 stainless steel plain ends for Pressfit assembly. Victaulic Series 569.

a. Pressure Rating: 300 PSI.

b. CF8M stainless steel body and ball

c. Type 316 stainless steel stem

d. PTFE seats.

5. Pipe: Type 316/316L ASTM A312 stainless steel

a. Schedule 10S.

C. Socket Welded System:

1. Schedule 40 Type 316L stainless steel pipe and fittings with socket welded connections.

D. Grooved System:

1. Schedule 10S type 316L stainless steel pipe and fittings with Type 316 stainless steel grooved end connections and couplings.

2. Fittings: ASTM A403 or be factory fabricated from ASTM A312 stainless steel pipe.

3. Provide couplings consisting of ductile iron or stainless steel housings, with pressure responsive elastomer gasket.

a. Rigid Type: Victaulic Style 489 (SS).

b. Flexible Type: Victaulic Style 77S (SS).

2.08 HDPE PIPE AND FITTINGS:

A. Provide in accordance with Section 40 05 33.

2.09 CHEMICAL TUBING AND FITTINGS:

A. Manufacturers:

1. New Age Industries

2. Nalge lnc.

3. Norton Company

B. Construction:

1. Provide braided reinforced flexible PVC tubing resistant to the chemical specified.

2. Tubing to allow tight compression fittings for leak proof connections.

3. Tubing to comply with FDA standards.

4. Tubing to handle a maximum of 130 psi at 70 degrees F.

C. Fittings:

1. Provide no flow restriction compression fittings when connecting pieces is required.

2. Provide transition connections as detailed on the drawings.

2.10 PRESSURE GAUGES:

A. Per Section 40 73 00.

2.11 PRESSURE AND FLOW INSTRUMENTATION:

A. Provide in accordance with Section 40 70 00.

2.12 COUPLINGS-SLEEVE TYPE:

A. Manufacturers:

1. Romac

2. Smith Blair

3. Viking Johnson.

4. Dresser.

B. Provide couplings meeting AWWA C219.

C. Couplings 12-inch and smaller:

1. End rings and center rings: ASTM A536 ductile iron, fusion bonded epoxy coated.

2. Gaskets: Buna-N, NSF 61 approved

3. Hardware: Type 316 stainless steel.

D. Couplings 14-inch and larger:

1. End rings and center rings: ASTM A36 steel, fusion bonded epoxy coated.

2. Gaskets: Buna-N, NSF 61 approved.

3. Hardware: Type 316 stainless steel.

E. Bridles and tie rods: Minimum 3/4-inch diameter, except where tie rods replace flange bolts of smaller size, in which case fit with nut on each side of pair of flanges.

1. Provide as indicated.

F. Lining and Coating: Fusion bonded epoxy in accordance with AWWA C213.

2.13 COUPLINGS-BOLTED SPLIT SLEEVE TYPE:

A. Manufacturers:

1. Victaulic Depend-O-Lok.

B. Type: Bolted, split-sleeve type coupling consisting of four basic components; one piece housing, gaskets assembly, bolts and nuts, and restraint rings as required for restraint.

1. Provide split-sleeve with a double arch cross section closing around pipe ends that are smooth for expansion or contraction requirements or pipe ends with end rings affixed for pipe end restraint requirements. As the coupling housing closes, it confines the elastomeric gasket beneath the arches of the sleeve to create the radial seal. The axial seal is affected by the sealing plate at the closure plates as the bolts pull the coupling housing snug around the pipe.

2. Provide sealing members comprised of two O-ring gaskets and an elastomer sealing pad bonded to the integral sealing plate.

C. Provide couplings designed for the type, size, and working pressure of the piping system as indicated in the Process Piping Schedule and specified.

D. Materials:

1. Split-sleeve:

a. Carbon Steel and Ductile Iron pipelines: ASTM A36 Carbon Steel.

b. Stainless steel pipelines, ASTM A240 Type 316L stainless steel.

c. Provide stainless steel couplings where there is a transition for ductile iron to stainless steel piping.

2. Gaskets:

a. Material: Elastomers in accordance with ASTM D2000.

(1) Air Service: Silicone conforming to ASTM D2000 for air service up to 240 degrees F with intermittent exposure to 280 degrees F.

(2) Liquid Service: Isoprene or Buna-N conforming to ASTM D2000 for service within the temperature range of minus 20 degrees F to 180 degrees F.

3. Bolts and Nuts:

   a. Bolts: Stainless steel conforming to ASTM F593 Type 316, minimum tensile strength 85,000 psi, (or threaded studs to ASTM A193, Class 2 Grade B8M Type 316).

   b. Nuts: ASTM F593 Type 316.

4. End Restraint Rings:

   a. Provide restraint rings of the same material as the coupling housing.

   b. Non-restrained (ExE) type couplings allows for up to 4 degree deflection. Provides for coupling joint where restraint is not required. If restraint is required, it must be provided independent of the coupling.

   c. Fixed x Expansion (FxE) type couplings: Allows for thermal expansion and contraction at the pipe joint. Provide one or two restraint rings fixed to one end of the pipe to keep coupling in the proper location. Where split sleeve coupling FxE for expansion is used provide the expansion side of the coupling with a combination of fixed and sliding supports for thermal movement.

   d. Fixed x Fixed (FxF) type couplings: Provides a fully restrained pipe joint. Provide one restraint ring welded to each of the pipe ends fitting beneath the coupling to prevent the pipe joint from pulling apart.

   e. Provide type as indicated and specified.

   f. Follow manufacturer's written recommendations and instructions for location dimensions and welding detail required to attach the restraint rings.

E. Provide a Type 316 stainless steel nameplate welded to each coupling with the following data:

   1. Manufacturer and date fabricated.

   2. Type of Coupling (ExE, FxE, FxF).

   3. Working Pressure in psi.

   4. Test Pressure in psi.

   5. Materials for coupling, hardware and gaskets.

F. Protective Coating: Prior to installation, couplings shall be coated on the I.D. and O.D. in accordance with Sections 09 90 00.

G. Couplings installed underground: Provide bitumastic coating or joint tape wrap.

H. Installation of couplings shall be in accordance with manufacturer's recommendation.

1. The coupling housing shall be assembled pulling the closure plates together with the bolts tightened to assure snug coupling housing contact with the pipe OD. Follow the manufacturer's recommendation regarding the installation and tightening of the bolts.

2.14 EXPANSION JOINTS-ELASTOMERIC FLEXIBLE CONNECTION:

A. General: Provide flexible connectors as indicated, specified and as required for ductile iron, HDPE, steel and stainless steel piping

1. At equipment connection: To eliminate vibration and stress on equipment.

2. Elsewhere: Designed for expansion/contraction. See Section 40 23 19.01.

B. Manufacturers:

1. Mercer Rubber Co. (Series 450 and Series 500)

2. General Rubber Co.

3. Garlock, Inc.

4. Proco

C. Products:

1. Straight-through or tapered design as required.

2. Unless indicated otherwise on drawings, provide dual arch type for wastewater, reclaimed water, glycol service, sludge and scum applications.

a. For sludge service provide filled arches

b. All other services shall be unfilled arches

3. For 12 inch and smaller provide Mercer Flexmore Series 450. For greater than 12 inch provide Mercer Invincible Heavy Duty Expansion Joints.

4. Furnish control rods for test pressures as indicated or required.

5. Materials: EPDM or alternative material suitable for service specified and indicated.

6. At expansion joints, provide guide supports located per manufacturer's recommendations.

7. Flanges: 125 lb drilling.

8. Provide Type 316 stainless steel retaining rings.

D. Install joints in their neutral position.

2.15 EXPANSION JOINTS-CHEMICAL SERVICE:

A. Service Conditions:

1. 5 to 20 percent sodium hypochlorite solution.

a. Temperature: 110 degrees C.

b. pH: 11 to 13.5.

2. Polymer:

a. Temperature: 110 degrees C.

3. 50 percent caustic soda.

4. Working Pressure: 150 psi.

5. Mating Pipe: SCH 80 CPVC, SCH 80 PVC, Kynar lined steel, titanium or stainless steel as indicated in the Process Piping Schedule.

B. Type: Bellows.

1. Capable of angular, parallel and rotary misalignment at maximum extended and minimum retracted length when mechanically limited by restraints.

2. Joints, as specified, must be manufacturer’s standard cataloged product.

C. Materials:

1. Convoluted Components: Pure white virgin PTFE-Fluorocarbon resin conforming to ASTM D1457 without pigments, lubricants or additives of any kind and suitable for the service specified. Provide a written recommendation from the expansion joint manufacturer.

a. Wall thickness: Suitable for the service specified or indicated and as recommended by the joint manufacturer.

2. Reinforcing rings:

   a. Type 316 stainless steel for caustic service and polymer.

   b. Titanium or Kynar coated for sodium hypochlorite service.

3. Flanges: Drilled and tapped to 150-lb ANSI standard.

   a. Type 316 stainless steel for caustic service and polymer.

   b. Titanium or Kynar coated for sodium hypochlorite service.

4. Hardware:

   a. Type 316 stainless steel for caustic service and polymer.

   b. Titanium for sodium hypochlorite service.

D. Joint Testing:

1. Leak free after 100,000 cycles at maximum rated travel 10 cycles per minute at 21 degrees C.

2. Test at 75 psi.

3. Provide high intensity light test to detect any imperfections or inclusions.

4. Provide a 10,000 volt spark test, no arcing is acceptable.

2.16 SAFETY SHIELDS-CHEMICAL SERVICE:

A. Provide shield type and materials for the service specified. Provide a written recommendation from the safety shield manufacturer.

B. Material: Non-porous Teflon-impregnated glass cloth with a 5 mil thickness and sewn with 100 percent Teflon thread and Velcro closures and folded in a trifold design with an 0.82 mil Teflon cord inserted on the sides to act as a draw string tying on the flange neck. Provide for use with 150 lb ANSI flanges.

C. Draw string or cord: 100 percent virgin unbleached Teflon fiber.

D. Provide a clear leak indicating window with a pH paper insert that will change color to indicate a leak.

E. Provide shields with a working temperature rating of 93 degrees C and a working pressure rating of 200 psi.

F. Install safety shield for the following:

1. Expansion joints chemical services.

2. Flanged connections on chemical system pipe and fittings.

3. Safety shields are NOT required for expansion joints on the polymer system.

2.17 HOSE, HOSE FITTINGS AND ACCESSORIES:

A. Hose Manufacturers:

1. Goodrich, HPD Industries

2. Goodyear

3. United Rubber Supply

4. Goodall

B. Hose: 1-inch:

1. Provide 4-ply rubber-lined and rubber-covered water hose for 150 psi working pressure.

2. Nozzle:

a. Shatter proof and UV resistant Lexan constant flow nozzle with bumper.

C. Hose Reels:

1. Type 316 stainless steel, mill finish.

2. Heavy duty square tubing frame.

3. Spring rewind with declutching arbor.

4. Stainless steel ball bearing swivel joint.

5. 1-inch female NPT.

6. 50 feet of hose.

7. Provide a flexible connector between the inlet pipe and inlet swivel joint.

8. Manufacturer: Hannay Model SS800.

2.18 CHEMICAL HOSE AND FITTINGS:

A. Provide hoses that are suitable for suction and discharge application.

B. Materials:

1. Tube: Type T (FEP) Teflon with crosslinked polyethylene backing.

2. Reinforcement: Synthetic textile with steel helix.

3. Cover: EPDM.

C. Sizes:

1. 3/4-inch through 2 inch: 200 psi.

2. 2.5 and 3 inch: 150 psi.

3. 4 inch: 125 psi.

4. 3/4 inch through 4 inch: 30 in Hg vacuum.

D. Coupling: Provide type and materials as recommended by the hose manufacturer for the service conditions specified and indicated.

1. For sodium hypochlorite and sodium hydroxide provide flanged connection.

2.19 BASKET STRAINERS-CHEMICAL SERVICE:

A. Service Conditions:

1. Provide strainers suitable for the chemical service as indicated in the equipment schedules.

2. Provide size and type, simplex and duplex, as indicated.

B. Materials:

1. Body and Cover: CPVC

2. Valves for duplex strainers: CPVC

3. O-rings: EPDM or suitable for the service specified and indicated.

4. Baskets: CPVC with 1/16-inch perforations

C. Covers: Threaded with hand operable vent.

D. Body:

1. Provide with and operable drain.

E. Provide with integral flat mounting base.

F. Ball Valves for duplex strainers: Provide a 3-way ball valve at the inlet and outlet, mechanically connected with true-union connections.

G. Pressure Rating: 150 psi.

H. End Connections: Flanged 150 psi ANSI (Class 150) standard.

I. Duplex Strainer Configuration: Provide configuration as indicated.

2.20 WALL AND FLOOR SLEEVES:

A. Materials:

1. Floor Sleeves:

a. Schedule 40 Galvanized steel ASTM A53 GRB unless otherwise indicated on the Drawings.

2. Wall Sleeves Between a Dry Area and a Wet Area (Tank, Channel, etc.):

a. Schedule 40 Galvanized steel unless otherwise indicated on the Drawings.

3. Wall Sleeves Between Dry Area or Between Dry Area and Ground:

a. Schedule 40 Galvanized steel ASTM A53 GRB unless otherwise indicated on the Drawings.

B. Water Stops: Provide water stops welded on both sides. Provide water stops 1/4-inch thick and 2-inch high and centered on the wall thickness.

C. Where indicated provide modular, mechanical type seals, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.

D. Provide the elastomeric elements sized and selected per manufacturer's recommendations and have the following properties as designated by ASTM. Coloration shall be throughout elastomer for positive field inspection. Each link shall have a permanent identification of the size and manufacturer's name molded into it.

E. Temperature Range: -40 to +250 degrees F.

1. Material: EPDM, ATSM D2000 M3 BA510.

2. Color: Black.

F. Modular seal pressure plates: Molded of glass reinforced Nylon Polymer with the following properties:

1. Izod Impact – Notched: 2.05 ft-lb/in. per ASTM D256

2. Flexural Strength at Yield: 30,750 psi per ASTM D790

3. Flexural Modulus: 1,124,000 psi per ASTM D790

4. Elongation Break: 11.07 percent per ASTM D638

5. Specific Gravity: 1.38 per ASTM D792

G. Hardware: Type 316 stainless steel.

2.21 TRANSITION COUPLINGS:

A. Provide coupling in accordance with AWWA C219 as specified herein

B. Sizes: 2-inch through 24-inch.

C. Materials:

1. End rings and center rings: Ductile iron ASTM A536.

2. Gaskets: Virgin Styrene Butadiene Rubber (SBR) suitable for potable water and wastewater service, ASTM D2000 MBA 710.

3. Provide Type 316 Stainless steel bolts and nuts

D. Working Pressure: 250 psi.

E. Lining and Coating: Fusion bonded epoxy in accordance with AWWA C213.

2.22 DISMANTLING JOINTS:

A. Materials:

1. Flanged Spool: AWWA Class D steel ring flange compatible with ANSI Class 125 and 150 bolt circles. Provide pipe of ASTM A36 plate 1 percent cold expanded to size.

2. End Ring and Body: ASTM A36 steel

3. Gaskets: ASTM 2000 Virgin NBR suitable for wastewater service

4. Bolts and Nuts: Type 316 stainless steel

5. Tie Rods: Type 316 stainless steel

B. Assembly Tolerance: 3 inches

C. Coating: Fusion bonded epoxy, NSF 61 certified

D. Pressure Rating: 150 psi working pressure

E. Manufacturers:

1. Romac

2. Viking Johnson

2.23 INSULATION:

A. General:

1. Provide insulation where specified and indicated.

2. Provide pre-molded or pre-formed pipe insulation.

3. Provide insulation with a flame spread index of less than 25, and a smoke-developed index of less than 50 when tested in accordance with ASTM E84.

4. Provide insulation with a maximum thermal conductivity of 0.7 Btu-in/h-ft^2-degrees F at 75 degrees F mean temperature when tested in accordance with ASTM C177.

B. Insulation for systems with an operating temperature of 60 degrees F or higher:

1. Type:

a. Pre-Molded Fiberglass.

b. Provide All Service Jacket (ASJ) consisting of white draft paper bonded to aluminum foil with fiberglass reinforcement in accordance with ASTM C1136 Type 1.

c. Provide self-sealing lap.

d. Provide insulation thickness as indicated on the Process Pipe Schedule.

2. Manufacturers:

a. Knauf Insulation

3. Accessories:

   a. Butt Strips: Provide self-adhesive butt strips for sealing circumferential joints between insulation sections. Provide strips manufactured from white Kraft paper bonded to aluminum foil with fiberglass reinforcement in accordance with ASTM C1136 Type 1.

   b. PVC Fitting Covers: Provide pre-molded, insulated, white glass finish, suitable for inside and outside use. Provide fitting covers manufactured from PVC material having a flame spread index of less than 25, and a smoke-developed index of less than 50 when tested in accordance with ASTM E84, PVC material shall meet the requirements of ASTM D1784.

   c. Vinyl Tape: Provide white, adhesive backed vinyl tape, minimum 1-inch wide for sealing PVC fitting covers to insulation.

   d. Tacks: Provide white coated, stainless steel, barbed tacks.

   e. Aluminum Protective Jacketing: Provide 0.020 inch Stucco Embossed Aluminum Jacketing.

   f. Sound Barrier Jacketing: Provide a composite sound attenuating system comprised of an acoustic decoupler material laminated to 0.020 inch Stucco Embossed Aluminum Jacketing.

   g. Stainless Steel Strapping: Provide Type 316 stainless steel strapping and wing seals. Provide strapping 1.2-inch wide or greater with a minimum thickness of 0.015-inch. Provide wing seals 1/2-inch wide or greater with a minimum thickness of 0.032 inches.

   h. Sheet Metal Screws: Provide Type 304 stainless steel sheet metal screws.

C. Insulation for systems with an operating temperature below 60 degrees F.

   1. Type: Pre-molded, Flexible Closed Cell Elastomeric Foam.

   2. Insulation for the foul air system shall be flexible closed cell elastomeric foam.

   3. Provide self-sealing lap for pipe sizes 6-inch and smaller. For pipe sizes above 6-inch and equipment provide Closed Cell Elastomeric Foam Sheets.

   4. Manufacturers:

      a. Armacell Engineered Foams, AP Armaflex SS and AP Armaflex.

5. Accessories:

a. Adhesive: Provide contact adhesive specifically designed for use with the insulation supplied.

b. Pipe support inserts: Provide a pre-fabricated insert designed to prevent damage to the insulation at the pipe support attachment point.

c. Provide an aluminum or stainless steel outer jacket, a foam inner core with plastic support and self-sealing closure, or acceptable equivalent product.

2.24 CHEMICAL INJECTORS:

A. General:

1. All materials of construction for chemical injectors shall be compatible with the service chemicals being injected.

B. Provide assemblies consisting of the following components:

1. Corporation stop with safety device to prevent release of solution tube under line pressure of ball valve.

2. Flange tapped to accept the corporation stop or ball valve.

3. Solution Tube of the length indicated with a locking device to prevent release of the tube under line pressure.

a. Ball check valve as specified in Section 40 23 13.01.

b. Type 316 stainless steel safety chain.

4. Chemical line connection to the assembly:

a. Provide a section of flexible tubing or hose suitable for the service conditions specified and indicated.

b. Isolation valve of the type indicated and specified.

2.25 SEAL WATER CONTROL AND MONITORING UNIT

A. Manufacturer

1. John Crane/Safeunit

2. Chesterton Flow Guardian

B. Provide a single assembly to control and monitor seal water flow and pressure

1. Provide a flow rate indicator with memory pin

2. Provide a pressure gauge with memory pin

3. Provide a flow regulating valve

4. Provide an inductive low flow alarm and signal

5. Provide non-clog valves

6. Provide manual cleaning valve capable of operation while unit and pump is in service

C. Pressure and Temperature Ration:

1. 150 psi

2. Maximum Temperature: 175 degrees F

D. Flow Range: Provide range suitable for system flow rate and as recommended by pump manufacturer.

2.26 SHOP PAINTING:

A. Provide in accordance with Section 09 91 10.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPE:

A. Install pipelines parallel to building walls wherever possible. Install piping to lines and grades indicated and support. Provide for expansion.

B. Where temporary supports are used, provide temporary supports as specified in Section 40 23 19.01 to prevent shifting or distortion of pipe. Provide for expansion.

C. Slope piping toward low points and provide for draining at low points.

D. Before assembly, remove debris from inside pipes and fittings.

E. Before flanges pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth burrs. Make up flanged joints tight, and prevent strain upon valves or other pieces of equipment.

1. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch excess thread protruding from the nut.

F. Install grooved joints in accordance with the manufacturer's written recommendations.

1. Grooved Ends: Clean and free from indentations, projections, or roll marks.

2. Gaskets: Molded and produced by the coupling manufacturer of an elastomer suitable for the service pecified and indicated.

3. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed.

G. Install tierods, pipe clamps or bridles when sleeve type couplings or fittings are used in piping system as indicated, and at changes in direction or other places to prevent joints from pulling apart under pressures indicated in the Process Pipe Schedule.

H. Examine pieces for damage. Do not install pieces that are damaged according to Engineer. If any damaged piece should be discovered after having been installed, remove and replace with a sound piece at no additional cost to the Authority.

I. Handle pipe with equipment such as nylon slings and padded skids, designed to prevent damage to the coating. Repair abrasions and injuries to the coating prior to the application of insulation or prior to the application of final field coating.

J. Support piping laid in trenches in trench on bed of selected backfill material which maintains desired line and grade.

K. Use dielectric bushings or unions when ferrous pipes join nonferrous pipes carrying liquid either underground or elsewhere.

L. Welding in accordance with ASME B31.1 and AWS B3.0.

3.02 WALL SLEEVE SEALS:

A. Expand rubber against pipe and sleeve by tightening bolts when assembled around pipe and inserted in wall.

3.03 TEMPORARY PLUGS:

A. Close open ends of pipe with temporary plugs or caps when pipe installation is not in progress. Use watertight plugs for exterior, buried piping and if water or debris is in trench when work is resumed, do not remove until adequate provision has been made to prevent any water or debris entering pipe even if it necessitates dewatering trench.

3.04 PHYSICAL CHECKOUT, FIELD AND FUNCTIONAL TESTING:

A. Clean dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.

B. Water for testing provided by the Contractor.

C. Pressure and Leakage Tests:

1. Provide temporary testing plugs or caps; pressure pumps, pipe connections, meters, gages, equipment, and labor.

2. Test pipelines in sections of acceptable length.

3. Fill section of pipe with water and expel air.

4. Pressure and leakage test consists of first raising pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to test pressures indicated in the Process Pipe Schedule.

5. No visible leakage in joint is acceptable.

6. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section has failed to pass test.

7. If section fails pressure and/or leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, and conduct additional tests and repairs until section passes test at no additional cost and without any time extensions.

D. Make piping connections to equipment with pipe in a free supported state and without application of vertical or horizontal forces to align piping with the equipment flanges.

E. Do not cover joints in underground piping with backfill material until piping has successfully passed pressure test.

F. Test pressures as indicated in Process Pipe Schedule.

G. Repair faulty joints even to extent of disassembling and remaking joint, remove defective pipe and fittings and replace in manner satisfactory to the Owner.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

3.06 PROCESS MECHANICAL PIPING SCHEDULE:

A. See Contract Drawings.

END OF SECTION

SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide process control system general provisions as indicated and in compliance with Contract Documents.

1.02 REQUIREMENTS OF WORK:

A. Supply, install, commission and provide warranty for a complete and fully documented instrumentation and control (I&C) system as shown on the drawings and specified herein. The I&C system will form a subsystem of the overall plant control system and contains vendor component subsystems specified in this and other sections of the specification.

B. Overall plant-wide control system integration including configuration and programming of PLC systems, SCADA systems, and related communication systems is not part of this contract and will be supplied under separate contract.

C. Programming of individual vendor packaged PLC systems, operator interface terminals and related communication systems are specified within the respective equipment specification sections.

D. This contract shall coordinate and cooperate with the plant-wide control system integrator and packaged equipment control system integrators to; establish and test communication systems, fully test all control system I/O, verify analog input & output signal polarity and scaling, test all control loops for correct functionality, and verify system performance under operating conditions.

E. Component subsystems of the I&C system will include, but are not limited to, the following:

1. Primary elements and transmitters

2. Final control elements

3. I&C field devices

4. I&C junction boxes, local control panels, and marshalling panels.

5. Where instrumentation, field devices, and final control elements are concentrated in plant areas, provide Analog Junction Boxes (AJB), and Control Junction Boxes (CJB) to concentrate wiring for home runs to the main PLC control panels.

6. Instrumentation cabling

7. SCADA, security, fire and business communication network cabling systems.

8. Communication network cabinets, switches, routers, and media conversion.

9. Instrumentation and communication systems power supplies

10. Conduit and cable tray

11. Distributed Programmable logic controller (PLC) based control system.

12. Operator interface terminals.

13. Human Machine Interfaces (HMI).

F. The Contractor's responsibility also includes receiving, un-crating, examining for shortages or damage, assembling, field fitting, installing, mounting, wiring and testing of vendor supplied component subsystems including all loose supplied components of the vendor package(s).

G. Where packaged, stand-alone control systems are supplied under other divisions of this specification, provide installation and cabling to connect to the required remote monitoring and/or controllers and all loose supplied components of the vendor package(s). Provide end-to-end commissioning and ensure the correct functionality of any equipment supplied under other divisions of this specification.

H. Documentation provided by the Contractor shall include as a minimum:

1. Equipment descriptive data.

2. Equipment installation instructions, service manuals, operation and maintenance (O&M) manuals, bills of materials, and recommended spare parts lists.

3. Schematics and interconnection wiring diagrams sealed by a Professional Engineer registered in the State of Utah.

4. Records of conductor identification, field terminals, cable lists, changes, etc.

5. I&C panel Shop Drawings, face layouts, schematics, and point-to-point wiring diagrams sealed by a Professional Engineer registered in the State of Utah.

6. Records of record drawing information for the complete instrumentation system.

7. For vendor package programmable logic controller (PLC) based control system, the Contractor shall provide detailed documentation of the system hardware and software. Minimum software documentation shall include a detailed operating description, flow charts that describe the functionality of the PLC program, a memory map, and the PLC program documentation. This information shall be submitted at the Shop Drawing stage.

8. For vendor package OIT and HMI systems, the Contractor shall provide detailed documentation of the system hardware and software.

I. Documentation provided by the Contractor shall be formatted as follows:

1. Process and Instrumentation Diagrams (P&IDs): Depict the general design intent of the process and control systems.

2. Instrument Index: A tabular index of the detailed information for control system devices shown on the P&IDs. The index lists the appropriate support documentation for the specified devices' supply and installation.

3. Input/Output (I/O) Index: A tabular index of the control system I/O points shown on the P&IDs, providing a description of the application and function together with references to supporting documentation.

4. Instrument Specifications: Detail the relevant technical data for the supply of instruments and devices. Instrument specifications and related process application data are provided in section 40 70 00 and related sub-sections detailing the requirements for each instrument to be supplied for the project. Instruments supplied shall meet these requirements. Record drawing Instrument Specification Sheets based on ISA S20 templates shall be provided for each instrument and shall include instrument particulars obtained from reviewed shop drawings and testing and commissioning data.

5. Instrument Loop Diagrams (ILDs): Show typical interconnections and hook-up of devices and control circuits. The Contractor is to produce an ILD for each device and record all relevant record drawing information on each sheet for submission at the completion of the work. Fill in all terminal and wiring numbers etc. from the reviewed shop drawings as they become available. A set of 'B' size (11" x 17") ACAD drawings and associated files will be made available to the successful bidder. Where an ILD is not shown for wiring of simple devices provide a legible sketch for record drawing information.

6. Location Drawings: Indicate in plan and/or elevation views where the instrument elements are physically located. These drawings are provided to assist the Contractor in estimating the amount of wire, cable, cable tray and ducting required.

7. Standard Details: Provide a reference for installation, operation, and other instructions pertinent to a particular device. Where standard details are not provided, The Contractor shall follow manufacturers recommended installation details. All instrument installations shall include provisions for calibration, and maintenance of the respective device.

8. Detailed Specification: Lists qualifications, quality of materials and workmanship, and supplementary information.

J. Codes, Rules, Permits and Fees:

1. Comply with all laws, ordinances, rules, regulations, codes, and orders of all authorities having jurisdiction relating to this work.

2. Comply with all rules of the electrical Safety Act of the State, National Fire Protection Association (NFPA), Underwriters Laboratories (UL) and the applicable building codes, whether specifically shown on drawings or not.

3. Give all required notices, submit drawings, obtain all permits, licenses, and certificates, and pay all fees required for this work.

4. Furnish a certificate of final inspection and approvals from inspection authorities to the Engineer.

K. Qualifications:

1. The instrumentation subcontractor shall be a firm normally engaged and fully competent in the type of work described in this section of the specification. The firm shall have been continuously and successfully engaged in this business for at least five (5) years.

2. Submit with the bid a list of similar projects recently completed and resumes of the personnel proposed for the project.

3. The Instrumentation Subcontractor shall be experienced in the process and instrument requirements of this contract.

4. The Instrumentation Subcontractor shall show that it maintains a fully equipped and qualified organization, capable of performing the present work and of providing warranty service to the system after installation.

5. Qualified journeyman instrument mechanics that are familiar with the devices being installed shall perform all instrument hook-ups, calibrations and checkouts.

6. Qualified journeyman electricians shall perform all control wiring installation and connections.

L. Standards of Workmanship:

1. Execute all work in a manner which will result in the completed installation presenting an acceptable appearance, to a level of quality defined in the general conditions of this specification.

2. Employ a competent supervisor and all necessary licensed tradesmen to complete the work in the required time.

3. Arrange and install products to fit properly into designated building spaces.

4. Install products in accordance with the recommendations and ratings of the product manufacturers.

5. Supply and execute installation of all instrumentation control tubing in accordance with Division 40.

M. Contract Drawings and Specifications:

1. Refer to Division 01.

2. Supply and install all items and accessories specified by the drawings or the specification in the quality and quantity required. Perform all operations as designated by the specifications according to the methods prescribed, complete with all necessary labor and incidentals.

3. Treat any item or subject omitted from this division's Specifications or drawings, but which is mentioned or reasonably specified in other divisions' specifications or drawings and pertains to the I&C system, as being integral to the overall system. Provide such specified items or subjects.

4. Provide all minor items and work not shown or specified but which are reasonably necessary to complete the work.

5. If discrepancies or omissions in the drawings or specifications are found, or if intent or meaning is not clear, consult the Contract Administrator for clarification before submitting the bid response.

6. The responsibility to determine which division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

1.03 REFERENCES:

A. American National Standards Institute (ANSI):

1. C106: Gray-Iron pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids

2. MC 4.1: Dynamic Response Testing of Process Control Instrumentation

3. MC 6.1: Electrical Transducer Nomenclature and Terminology

4. MC 11.1: Quality Standard for Instrument Air

5. Z358.1: Emergency Eyewash and Shower Equipment

B. American Society of Mechanical Engineers (ASME).

C. ASTM International (ASTM).

D. International Electrotechnical Commission (IEC).

E. Institute of Electrical and Electronics Engineers (IEEE).

F. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S5.4: Instrument Loop Diagrams

3. S7: Instrument Air

4. S12: Electrical Equipment for Hazardous Locations

5. S18.2: Alarm Management

6. S20: Instrument Specifications

7. S50: Electrical Control Signals

8. S75: Control Valve Design, Specification and Testing

9. S96: Valve Actuators

10. S99: Control System Cyber Security

11. S101: Human-Machine Interfaces

G. National Electrical Manufacturers Association (NEMA)

H. National Fire Protection Association (NFPA):

1. 70: National Electrical Code

2. 820: Standard for Fire Protection in Wastewater Treatment and Collection Facilities

I. North American Electric Reliability Corporation (NERC)

J. Telecommunications Industry Association (TIA):

1. 455: General Requirements for Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

2. 568: Broadband Coaxial Cabling and Components Standard

K. Underwriters Laboratories (UL).

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Delegated Design Submittals: For each control panel, marshalling panel, equipment rack, or appurtenance thereto, provide written certification from Professional Engineer licensed in the State of Utah stating that supports, systems and anchorage for equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

C. Tender submittals:

1. Submit an equipment list indicating the type and make of all equipment and materials proposed for this project within 10 business days of award of contract.

D. Receiving, storing, and protection of components during construction:

1. Examine each component upon delivery to site. Report all damage noted to the Contract Administrator prior to accepting or rejecting delivery. All instrumentation primary elements, control components, panels, etc. shall be placed in a secure, dry, heated storage building. Maintain the space temperature above 50 degrees F and the space relative humidity below 50 percent.

2. Perform a preliminary examination upon delivery to ensure that:

a. All I&C components supplied for this project under this section of the specifications comply with the requirements stated in the instrument specification sheets.

b. All I&C components supplied under other sections of these specifications, to be connected to I&C components supplied under this section of the specifications, comply with the requirements stated in the contract documents.

c. Itemize all non-conformities noted above and forward them to the Contract Administrator. Any delays in construction resulting from the delivery to site of non-conforming I&C components shall be borne by the Contractor.

d. Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Engineer prior to installing any equipment of this type.

e. Ensure that covers where required are properly installed on all equipment. Provide all covers, padding, guards, etc. as required to guard any equipment against damage.

f. Follow the manufacturer's recommendation for the storage of all I&C components.

3. Take all necessary precautions to ensure that equipment is supplied free of damage. If deemed necessary by the Contract Administrator, damaged equipment shall be replaced with new Product. The Contractor shall bear any costs due to construction delays resulting from the delay in delivery of acceptable equipment.

E. Submit a schedule within 30 days of award of contract to the Contract Administrator showing projected ordering and delivery dates of all products to meet the required construction schedule. Provide all necessary information regarding ordering and delivery dates for those product whose delivery effects the construction schedule.

F. Submit shop drawings for all products supplied by this Division. Submit shop drawings for review prior to purchase of any products or equipment and sufficiently in advance to allow ample time for checking.

G. Contractor to review, modify, and approve the shop drawings prior to submitting shop drawings to the Contract Administrator for review. Contractor approval of a drawing indicates the following:

1. The drawing has been checked by the person making the approval.

2. The equipment or material complies in all respects with the requirements of the specifications and drawings.

3. The quantities indicated are correct.

4. The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and after installation, there are sufficient clearances on all sides for maintenance, servicing and operation of the equipment.

5. The points of attachment are clearly indicated, i.e. TOP, BOTTOM, SIDE, etc.

6. The arrangement and location are properly oriented.

7. The product is suitable for its intended use.

8. The submission consists of sufficient information to adequately convey the scope of supply and the specific product to be supplied is highlighted.

9. The submission contains sufficient information to install the equipment or systems.

H. Stamp and sign the shop drawing to show approval, indicating the above has been complied with. If Contractor revisions are too extensive, return the submission to the manufacturer for revision, then repeat the shop drawing approval process before submitting to the Contract Administrator.

I. Manufacture of products shall conform to shop drawings marked as reviewed by the Contract Administrator and returned to the Contractor.

J. Keep one complete, maintained set of shop drawings at the job site during the construction period. Record site modifications.

K. Refer to Division 01 for further information on Shop Drawing submittals.

L. Operation & Maintenance Manuals:

1. Refer to Division 01 for general O&M manual submittal information.

2. In addition to the requirements specified in Division 01, provide the following information:

a. Table of Contents: Arrange contents sequentially by systems under section numbers. Label tabs of dividers between each to match section numbers in the Table of Contents.

b. Systems Descriptions: A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.

c. O&M Instructions of All Equipment and Controls: These operating instructions need not be manufacturer's data but may be typewritten instructions in simple language to guide the City in the proper O&M of this installation.

d. A copy of all wiring diagrams complete with wiring coding.

e. Include type and accuracy of instruments used.

f. Set of final reviewed Shop Drawings.

g. Provide a tabulated list of all consumables utilized (fuses, lamps, etc.) indicating where used, type, rating and reorder details.

M. Record Drawings:

1. Maintain on-site a complete set of record drawings as listed in Division 01 of this specification.

2. In addition to the requirements as stated in Division 01, record on the drawings the following information:

a. All changes alterations or additions

b. All instrumentation cable and control tubing

c. All changes to the numbers and location of outlets, motors, panels and end devices that may occur during the course of the work

3. Before requesting the final completion certificate make any necessary final corrections to the drawings, sign each print as a certification of accuracy and deliver all sets to the Contract Administrator for approval.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.09 PROJECT/SITE CONDITIONS:

A. Classification of Plant Areas:

1. Refer to Division 26 and project contract drawings

PART 2 - PRODUCTS

2.01 GENERAL:

A. Refer to the requirements of Division 01.

B. Selected Products:

1. Provide products and materials that are new and free from all defects.

2. Products and materials called for on the drawings or in the specifications by trade names, manufacturer's name and catalogue reference are to be used as the basis for the bid submission.

3. The design has been based on the use of the first named product where multiple products have been listed.

C. Quality of Products:

1. All Products provided to be NEC and UL approved where applicable.

2. If Products specified are not NEC and UL approved, obtain approval of the relevant State regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

3. Refer to Division 01 of this specification for further information.

D. Uniformity of Manufacture:

1. Unless otherwise specifically called for in the specification, uniformity of manufacture to be maintained for similar products throughout the work.

E. Product Finishes:

1. Contractor to specify proposed finishes to be used for Contract Administrator's review.

F. Use of Products During Construction:

1. Any equipment used for temporary or construction purposes is to be approved by the Contract Administrator and in accordance with Division 01 of this specification. Clean and restore to "as new" condition all equipment prior to the time of substantial completion.

2.02 INSTRUMENTATION:

A. General:

1. Instruments are to be suitable for the environmental conditions in which they are to be installed. In this facility, many areas are wet and corrosive, subject to hose washdown, and may have been deemed electrically hazardous with a designation of Class 1, Division 1 or Class 1, Division 2. Refer to electrical plan drawings and process plan drawings for additional details pertaining to each area.

2. Determine where injurious conditions may be expected to occur and make proper provision to protect the instruments to ensure their proper and reliable operation.

3. Provide power surge protection, heating cables, and devices to protect instruments, equipment, and lines from being functionally impaired or damaged by power surges or environmental conditions such as moisture or freezing.

B. Identification:

1. Refer to Division 26 for general identification requirements. Provide lamacoid nameplates with 0.25 inch black lettering on white background. Identify the loop tag number (where applicable) and the device name, function, and instrument range or setpoint value on the nameplate.

2. Where it is not possible to attach a lamacoid nameplate to a field instrument component, provide the component with a stainless steel metal tag firmly wired to the device and identified with the loop tag number.

3. Identify all wires where they terminate at the marshalling panels, junction boxes, control panels, and field devices with a heat shrink sleeve with machine printed labelling.

4. Clearly mark all panels, pull boxes, junction boxes, etc. to indicate the nature of service.

5. Provide neatly typed circuit directories for panel power distribution systems to indicate loops or devices powered by the circuit and the fuse size.

6. Identify all exposed control conduits at all pull box locations, where the conduits enter or leave a room, and 40 feet on center throughout the room. This shall apply to conduits above removable ceilings. Refer to Division 26 for conduit identification.

7. For direct current wiring use black for positive and white for negative.

8. For thermistor wiring to motors use red and blue colored insulated wire.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Refer to the requirements of Division 01.

B. No additional compensation will be given for extra work due to existing conditions which a site examination prior to tender should have disclosed.

3.02 COORDINATION WITH OTHER DIVISIONS:

A. Examine the drawings and specifications of all divisions and become fully familiar with the work. Before commencing work, obtain a ruling from the Contract Administrator on any conflicting issues between divisions. No compensation will be made for any costs arising from conflict not identified before work has commenced.

B. Coordinate the work to be performed under this section of the specification with all divisions installing equipment to ensure that there are no conflicts.

C. Install anchors, bolts, pipe sleeves, hanger inserts, etc. required in ample time to prevent delays to other divisions' installation work.

D. Lay out the work and equipment with due regard to architectural, structural, and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors, and equipment.

E. Structural members shall not be cut without prior approval of the Contract Administrator.

F. Examine previously constructed work and notify the Contract Administrator of any conditions which prejudice the proper completion of this work.

3.03 PRODUCT HANDLING:

A. Use all means necessary to protect the products included in this division before, during and after installation, and to protect products and installed work of all other trades.

B. Any damage to the products and/or installed work shall be repaired or replaced to the approval of the Contract Administrator by the Contractor at no additional cost to the Owner.

C. Remove advertising labels from all products installed that have such labels attached. Identification, NEC, and UL labels are not to be removed.

D. Remove dirt, rubbish, grease, etc. resulting from work performed under this section of the contract from all surfaces.

3.04 SEPARATION OF SERVICES:

A. Maintain separation between the electrical wiring system, piping, ductwork and the instrumentation cables so that each system is isolated (except at approved connections to such systems) to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.

B. Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Contract Administrator and the ceiling installer, and only if approved clips or hangers are used.

C. Classifications of Circuits:

1. The circuit categorization shall of first priority follow National Electric Code (NEC, NFPA 70) with respect to separation for electrical safety and the following shall apply with respect to electro-magnetic compatibility:

Very Noisy	High voltage circuits and their associated grounding
	High current (>200A) LV circuits.
	Harmonic-rich LV circuits.
	DC circuits: un-suppressed or above 50V.
Noisy	Low current class two (2) circuits.
	Medium power pulsed or radio frequency circuits.
Indifferent	ELV digital status circuits.
	Intrinsically safe circuits.
	Telecommunications circuits.
	Fire alarm and emergency lighting circuits (note that some fire alarm circuits may fall into the category of signal circuits).
	Any other emergency, shutdown, or high integrity circuit (e.g. toxic gas alarm).
Sensitive	Analogue signal circuits.
	Data communication circuits.
Very Sensitive	Low level voltage and current signals (e.g. from instrument sensors).

D. Separation of Circuits:

1. This section relates to the running of cables carrying differing types of circuit in close proximity to one another and to other services. Sensitive circuits shall normally be run in overall shielded cable. Very sensitive circuits shall normally be run in individually twisted pair shielded cable.

2. For cables sharing the same support/containment system, the following shall provide guidance to minimize extraneous interference.

Segregation between circuits	Very Noisy	Noisy	Indifferent	Sensitive	Very Sensitive
Very Noisy	Thermal grouping as per NEC.	6 inches	12 inches	12 inches	12 inches
Noisy	6 inches	Thermal grouping as per NEC Code.	6 inches	6 inches	6 inches
Indifferent	12 inches	6 inches	Separation of circuit types.	4 inches	4 inches
Sensitive	12 inches	6 inches	4 inches	Touching	2 inches
Very Sensitive	12 inches	6 inches	4 inches	2 inches	Touching

3.05 WIRE AND CABLE:

A. Refer to Section 40 66 33. Coordinate with Division 26 and Division 28 of the project documents.

3.06 EQUIPMENT CONNECTIONS:

A. Prior to the connection of signal wiring to process control and instrumentation devices, check the device voltage rating and polarity for compatibility with the corresponding loop and/or schematic diagram. Where device and circuit characteristics are found to be incompatible, the connections are not to be made. Report the condition immediately to the Contract Administrator.

B. All control wiring diagrams illustrate typical control circuits applicable to the type of equipment specified. Control circuits may vary with different manufacturers' equipment. Verify all control circuits with the manufacturers of the equipment and make any corrections to the control wiring diagrams that may be required.

C. Provide circuit breakers in control panels for all instruments fed from the control panel and provide fused disconnect terminals in control panels for PLC inputs/outputs sourced from the panel. Provide local power disconnect switches for all 120VAC powered instruments. Mount the disconnect switches adjacent to the respective instrument.

D. Provide a disconnecting means in the cable connecting each ultrasonic transponder to the transmitter. This disconnect shall consist of a terminal strip in a local water proof junction box.

3.07 WIRING TO EQUIPMENT SUPPLIED BY OTHERS:

A. Equipment supplied by others, that have loose supplied external or field mount control devices, are to be installed, wired and commissioned by this division.

3.08 ACCESS PANELS:

A. Provide access panels where I&C system junction boxes are concealed. Panels to be of adequate size for servicing of the concealed junction box and complete with necessary frames and hinged doors held closed with captive fasteners.

B. In removable ceiling areas provide markers on ceiling tile to locate equipment requiring access. Use a 1 inch diameter blue circle painted on the access panel to indicate that it is for instrumentation and control system access.

3.09 INSTRUMENT MOUNTING STANDS:

A. Supply and install instrumentation mounting stands as required. Stands are to be either floor or wall mounted. The mounting stands are to be fabricated from aluminum or galvanized steel.

B. Supply and install protective drip shields for any exterior stand-mounted instrumentation equipment. The drip shield is to extend 2 inches at the top and sides from the front face of the equipment. The drip shield is to be fabricated from aluminum.

3.10 SEALING OF WALL AND FLOOR OPENINGS:

A. Seal all conduit and cable entries passing through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade.

B. Seal openings after all wiring entries have been completed.

C. Sealing material shall be fire resistant and not contain any compounds which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations, if required, are to be sealed in accordance with Division 26.

D. Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

E. For wall partitions and ceilings the ends shall be flush with the finish on both sides. For floors, the ends shall extend 4 inches above finished floor level.

F. Fill the space between the sleeve and the conduit with fire stop material and caulk around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.

G. Locate the sleeves and position exactly prior to construction of the walls and floors.

H. Failure to comply with the above requirements shall be remedied at the Contractor's expense.

3.11 CONNECTIONS TO MECHANICAL, ELECTRICAL AND EXISTING SYSTEMS:

A. Refer to Division 26 for the required tie-in procedures.

3.12 TAGGING STANDARDS FOR DEVICES AND WIRING:

A. Tag all devices, wires, and I/O using the assigned loop, equipment, or device tag name. Where tag naming and numbering is not defined the Contract Administrator will provide naming and numbering that is consistent with the plant naming conventions.

3.13 TESTING OF INSTRUMENTATION LOOPS:

A. After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops, where applicable. Provide written notice to the Contract Administrator when the loops are going to be tested so that the tests may be witnessed at the Contract Administrator's discretion.

B. Check the operation of final control elements such as solenoid valves, actuators, etc. by manual control before checking with automatic control.

C. Check and simulate all alarms and shutdown functions.

D. Verify the status of all points connected or accessible to the plant control and monitoring system.

E. Where applicable, test all tubing for leaks in compliance with ISA RP7.1. Isolate all instruments when tubing is being tested to protect against over pressure.

F. Perform tests and record results on the test data forms that are included in this section. Develop additional and/or more detailed test forms as necessary to suit more complex instrumentation.

G. Sign and date all test reports. Submit the test reports to the Contract Administrator within five (5) working days of testing.

3.14 CALIBRATION:

A. Instruments are to be factory pre-calibrated. Verify calibration “in situ” after installation. Provide a printed record of the factory calibration and as constructed parameters for “smart” devices. Include device tag numbers and serial numbers in the calibration records.

B. Instruments are to be set up and calibrated by an accredited instrument technician working under the approval of the instrument manufacturer.

C. Calibrate all instruments to the accuracy specified in in Section 40 70 00, or to the manufacturer’s stated accuracy of the instrument when required accuracy is not specified.

D. Following instrument installation, perform the following “in situ” calibration for each instrument and its associated signal conditioning equipment:

1. Calibrate all inline flow meters by a draw-down test. Take at least three calibration points to demonstrate linearity.

2. Calibrate all density meters by lab samples. Take at least three calibration points to demonstrate linearity.

3. Calibrate all vacuum and pressure instruments by manometer or certified calibration standard. Take at least three calibration points to demonstrate linearity.

4. Calibrate gas detectors using standard gas samples for zero and upscale.

5. Calibrate temperature instruments against a standard lab thermometer or certified calibration standard. Take at least three calibration points to demonstrate linearity.

6. Calibrate level instruments by comparison to a known physical reference measurement and by adjusting tank level throughout the measurement range.

7. Calibrate analytical instruments using manufacturer’s prepared calibration standards, or suitable calibration standards prepared in on-site or local lab as appropriate

3.15 INSTALLATION AND PERFORMANCE TESTING:

A. Refer to the requirements of Division 01 for additional requirements.

B. Inspections:

1. Provide two (2) weeks written notice to the Contract Administrator prior to energizing any system to allow for inspection by the Contract Administrator of the following:

a. Proper mounting

b. Proper connections

C. During commissioning, demonstrate to the Contract Administrator proper calibration and correct operation of instruments and gauges.

D. Commissioning of the I&C system is to include but not be limited to the following:

1. Verify installation of components, wiring connections, and piping connections.

2. Supervise wiring continuity and pipe leak tests.

3. Verify instrument calibration "in-situ" and provide written reports. Refer to attached sample instrument test report form at the end of this section

4. Perform instrument loop checks, function check and adjust the I&C equipment under operational conditions. Refer to attached sample Loop Check Form at the end of this section

5. Coordinate I&C equipment supplier's service personnel as required for complete system testing.

6. Instruct plant personnel in correct method of I&C equipment operation.

7. Direct plant personnel at hand-over as to final adjustment of the system for correct operation of plant.

8. Ensure that the I&C equipment suppliers cooperate to complete the Work of this Section.

9. Verify signal levels and wiring connections to all I&C equipment.

10. Coordinate and cooperate with City staff, the control system integrator, and the Contract Administrator to commission the interface between the Plant supervisory control and data acquisition (SCADA) and the PLC based control system.

3.16 TRAINING:

A. Provide training, described in detail in Division 01, as required by the plant's personnel to become fully competent in the proper operation and maintenance of all control

devices, control valves, and ancillary instrumentation described under this section of the specifications.

B. For the PLC based control system, the control system integrator shall provide maintenance training that includes a review of the PLC program, system troubleshooting, and identification of programmed system variables such as set-points, alarms, and statuses.

3.17 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

3.18 SCHEDULES:

A. Instrument Test Report (ITR)

B. Loop Check Report (LCR)

INSTRUMENT TEST REPORT

SYSTEM: _____ _____
SERVICE: _____ TAG NO.: _____
LOCATION: _____ _____
MAKE: _____ MODEL: _____
SERIAL NO.: _____ CSA: _____
ELEMENT: _____ RANGE: _____
DESIGN SETTING/RANGE: _____ CONTACT TO: _____ ON: _____
SIGNAL IN: _____ OUT: _____ ASSOCIATED INSTRUMENT:_____
INSTRUMENT CONDITION: _____ CONFORM TO SPEC: _____
PROJECT NO: _____ DATA SHEET: _____

	TEST 1				TEST 2			
TEST METHOD								
	INPUT		OUTPUT		INPUT		OUTPUT	
PROCESS	INC.	DEC.	INC.	DEC.	INC.	DEC.	INC.	DEC.
TEST POINT 1								
TEST POINT 2								
TEST POINT 3								
TEST POINT 4								
TEST POINT 5								
COMMENTS								
GRAPHS								

TESTED BY: _____ CHECKED BY: _____

DATE: _____ DATE: _____

LOOP CHECK REPORT

☐ CHECKED OUT OK
☐ NOT APPLICABLE
☐ FURTHER ACTION REQUIRED

	INSTRUMENT TAG NO.								
LOOP NO. _____ SHEET NO. _____ P & I DWG. NO. _____									
INSTALLATION COMPLETE									
Primary Element.									
Impulse Lines.									
Block and Drain Valves.									
Air Supply/Filter/Reg.									
Wiring.									
Tracing/Insulation/Housing.									
Mounting and Location.									
PLC/SCADA I/O & Status.									
CALIBRATED									
Impulse Lines Press. Tested.									
LOOP CHECKED									
Element to Receiver.									
X Mtr. To Receiver.									
X Mtr./Trans. to Receiver.									
X Mtr./Trans. to Switches.									
Switches to Annunciator.									
Interlocking Circuit.									
Controller to Valve.									
Controller Action D or R.									

REMARKS:

READY FOR START-UP

Date: _____

Installed by: _____

Checked by: _____

END OF SECTION

Area	P&ID	Tag	Equipment	Alarm Description	Alarm Level	Alarm Response	Alarm Level	Meaning
01 - Influent Pump Station	0100-X601	01-FIT-10101	Maintenance Hole #3A Flowmeter	Fault	1	Alarm Notification	1	Operator Acknowledgment
01 - Influent Pump Station	0100-X601	01-FIT-10101	Maintenance Hole #3A Flowmeter	High Flow Alarm	1	Alarm Notification	2	Operator Corrective Action Required
01 - Influent Pump Station	0100-X601	01-FIT-10101	Maintenance Hole #3A Flowmeter	High Flow Warning	1	Alarm Notification	3	Treatment Interruption
01 - Influent Pump Station	0100-X601	01-FIT-10101	Maintenance Hole #3A Flowmeter	Low Flow Warning	1	Alarm Notification	4	Potential Safety Hazard / Licence Violation
01 - Influent Pump Station	0100-X601	01-FIT-10101	Maintenance Hole #3A Flowmeter	Low Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X601	01-FIT-10201	Exisiting Metering Maintenance Hole	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X601	01-FIT-10201	Exisiting Metering Maintenance Hole	High Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X601	01-FIT-10201	Exisiting Metering Maintenance Hole	High Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X601	01-FIT-10201	Exisiting Metering Maintenance Hole	Low Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X601	01-FIT-10201	Exisiting Metering Maintenance Hole	Low Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X601	01-FIT-10301	Maintenance Hole #5B Flowmeter	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X601	01-FIT-10301	Maintenance Hole #5B Flowmeter	High Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X601	01-FIT-10301	Maintenance Hole #5B Flowmeter	High Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X601	01-FIT-10301	Maintenance Hole #5B Flowmeter	Low Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X601	01-FIT-10301	Maintenance Hole #5B Flowmeter	Low Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-AIT-80001	H2S Gas Detector	Fault	4	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-AIT-80001	H2S Gas Detector	High Gas Warning	2	Alarm Notification (BMS to purge air)		
01 - Influent Pump Station	0100-X602	01-AIT-80001	H2S Gas Detector	High Gas Alarm	4	Alarm Notification (BMS to purge air)		
01 - Influent Pump Station	0100-X602	01-LSL-11108	Raw Wastewarer Wetwell 1 Low Level Switch	Low Level Warning	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	Motor Trip	3	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	High Winding Temperature	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	High Bearing Temperature	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	High Bearing Vibration	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	Leak Detected	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	High Motor Temperature	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	Fault	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	Fail to Start	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	Suction Valve Closed While Running	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	No Open Discharge Valve While Running	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11110	Raw Wastewater Pump 1	Speed Not Equal Speed Command	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FV-1111A	Raw Wastewater Pump 1 Discharge Check Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FV-1111A	Raw Wastewater Pump 1 Discharge Check Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-PSH-11114	Raw Wastewater Pump 1 Discharge Pressure Switch	High Pressure Alarm	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-PIT-11113	Raw Wastewater Pump 1 Discharge Pressure Transmitter	High Pressure Alarm	2	Shutdown RWW Pump 1, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-PIT-11113	Raw Wastewater Pump 1 Discharge Pressure Transmitter	High Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-PIT-11113	Raw Wastewater Pump 1 Discharge Pressure Transmitter	Low Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-PIT-11113	Raw Wastewater Pump 1 Discharge Pressure Transmitter	Low Pressure Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FV-11112	Raw Wastewater Pump 1 Discharge Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FV-11112	Raw Wastewater Pump 1 Discharge Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FIT-11312	Raw Wastewater Pump 1 W2CW Flowmeter	Low Flow Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-SOL-11311	Raw Wastewater Pump 1 W2CW Intake Valve	Fail to Open	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-SOL-11311	Raw Wastewater Pump 1 W2CW Intake Valve	Fail to Close	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	Fault	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	Fail to Start	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	Suction Valve Closed While Running	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	No Open Discharge Valve While Running	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	Speed Not Equal Speed Command	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	Motor Trip	3	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	High Winding Temperature	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	High Bearing Temperature	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	High Bearing Vibration	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	Leak Detected	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11130	Raw Wastewater Pump 3	High Motor Temperature	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-FV-1113A	Raw Wastewater Pump 3 Discharge Check Valve	Fail to Open	2	Alarm Notification		

Area	P&ID	Tag	Equipment	Alarm Description	Alarm Level	Alarm Response	Alarm Level	Meaning
01 - Influent Pump Station	0100-X602	01-FV-1113A	Raw Wastewater Pump 3 Discharge Check Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-PSH-11134	Raw Wastewater Pump 3 Discharge Pressure Switch	High Pressure Alarm	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-PIT-11133	Raw Wastewater Pump 3 Discharge Pressure Transmitter	High Pressure Alarm	2	Shutdown RWW Pump 3, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-PIT-11133	Raw Wastewater Pump 3 Discharge Pressure Transmitter	High Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-PIT-11133	Raw Wastewater Pump 3 Discharge Pressure Transmitter	Low Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-PIT-11133	Raw Wastewater Pump 3 Discharge Pressure Transmitter	Low Pressure Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FV-11132	Raw Wastewater Pump 3 Discharge Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FV-11132	Raw Wastewater Pump 3 Discharge Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FIT-11332	Raw Wastewater Pump 3 W2CW Flowmeter	Low Flow Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-SOL-11331	Raw Wastewater Pump 3 W2CW Intake Valve	Fail to Open	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-SOL-11331	Raw Wastewater Pump 3 W2CW Intake Valve	Fail to Close	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	Fault	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	Fail to Start	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	Suction Valve Closed While Running	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	No Open Discharge Valve While Running	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	Speed Not Equal Speed Command	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	Motor Trip	3	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	High Winding Temperature	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	High Bearing Temperature	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	High Bearing Vibration	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	Leak Detected	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-P-11150	Raw Wastewater Pump 5	High Motor Temperature	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-FV-1115A	Raw Wastewater Pump 5 Discharge Check Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FV-1115A	Raw Wastewater Pump 5 Discharge Check Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-PSH-11154	Raw Wastewater Pump 5 Discharge Pressure Switch	High Pressure Alarm	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-PIT-11153	Raw Wastewater Pump 5 Discharge Pressure Transmitter	High Pressure Alarm	2	Shutdown RWW Pump 5, Start Standby Pump		
01 - Influent Pump Station	0100-X602	01-PIT-11153	Raw Wastewater Pump 5 Discharge Pressure Transmitter	High Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-PIT-11153	Raw Wastewater Pump 5 Discharge Pressure Transmitter	Low Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-PIT-11153	Raw Wastewater Pump 5 Discharge Pressure Transmitter	Low Pressure Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FV-11152	Raw Wastewater Pump 5 Discharge Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-PIT-11153	Raw Wastewater Pump 5 Discharge Pressure Transmitter	Low Pressure Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FV-11152	Raw Wastewater Pump 5 Discharge Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FV-11152	Raw Wastewater Pump 5 Discharge Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FIT-11352	Raw Wastewater Pump 5 W2CW Flowmeter	Low Flow Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-SOL-11351	Raw Wastewater Pump 5 W2CW Intake Valve	Fail to Open	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-SOL-11351	Raw Wastewater Pump 5 W2CW Intake Valve	Fail to Close	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	N/A	Raw Wastewater Wetwell 1 Analog Level Transmitters	LT Readings Disagree by more than 10%	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-LSHH-11105	Raw Wastewater Wetwell 1 High High Level Switch	High Level Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-LSH-11107	Raw Wastewater Wetwell 1 High Level Switch 1	High Level Warning 1	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-LSH-11106	Raw Wastewater Wetwell 1 High Level Switch 2	High Level Warning 2	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FCV-11101	Raw Wastewater Wetwell 1 Influent Slide Gate	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FCV-11101	Raw Wastewater Wetwell 1 Influent Slide Gate	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-FCV-11101	Raw Wastewater Wetwell 1 Influent Slide Gate	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-LIT-11102	Raw Wastewater Wetwell 1 Level Transmitter 1	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-LIT-11102	Raw Wastewater Wetwell 1 Level Transmitter 1	High Level Alarm	2	Start RWW Pumps 1, 3, & 5		
01 - Influent Pump Station	0100-X602	01-LIT-11102	Raw Wastewater Wetwell 1 Level Transmitter 1	High Level Warning	1	Start one of RWW Pump 1, 3, or 5		
01 - Influent Pump Station	0100-X602	01-LIT-11102	Raw Wastewater Wetwell 1 Level Transmitter 1	Low Level Warning	1	Shutdown one of RWW Pump 1, 3, or 5		
01 - Influent Pump Station	0100-X602	01-LIT-11102	Raw Wastewater Wetwell 1 Level Transmitter 1	Low Level Alarm	2	Shutdown RWW Pumps 1, 3, & 5		
01 - Influent Pump Station	0100-X602	01-LIT-11103	Raw Wastewater Wetwell 1 Level Transmitter 2	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-LIT-11103	Raw Wastewater Wetwell 1 Level Transmitter 2	High Level Alarm	2	Start RWW Pumps 1, 3, & 5		
01 - Influent Pump Station	0100-X602	01-LIT-11103	Raw Wastewater Wetwell 1 Level Transmitter 2	High Level Warning	1	Start one of RWW Pump 1, 3, or 5		
01 - Influent Pump Station	0100-X602	01-LIT-11103	Raw Wastewater Wetwell 1 Level Transmitter 2	Low Level Warning	1	Shutdown one of RWW Pump 1, 3, or 5		
01 - Influent Pump Station	0100-X602	01-LIT-11103	Raw Wastewater Wetwell 1 Level Transmitter 2	Low Level Alarm	2	Shutdown RWW Pumps 1, 3, & 5		
01 - Influent Pump Station	0100-X602	01-LSLL-11104	Raw Wastewater Wetwell 1 Low Low Level Switch	Low Level Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	N/A	Raw Wastewater Wetwell 1 Pumps	Force Main 1 and Cross Connect Valve Closed	2	Alarm Notification		
01 - Influent Pump Station	0100-X602	01-LCP-11100	Raw Wastewater Wetwell 1 Smart Relay	Float Mode Active	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-LSL-11208	Raw Wastewarer Wetwell 2 Low Level Switch	Low Level Warning	2	Alarm Notification		

Area	P&ID	Tag	Equipment	Alarm Description	Alarm Level	Alarm Response	Alarm Level	Meaning
01 - Influent Pump Station	0100-X603	01-P-11220	Raw Wastewater Pump 2	Fault	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11220	Raw Wastewater Pump 2	Fail to Start	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11220	Raw Wastewater Pump 2	Motor Leak	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11220	Raw Wastewater Pump 2	High Winding Temperature	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11220	Raw Wastewater Pump 2	High Bearing Temperature	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11220	Raw Wastewater Pump 2	High Bearing Vibration	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11220	Raw Wastewater Pump 2	Leak Detected	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11220	Raw Wastewater Pump 2	High Motor Temperature	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-FV-1122A	Raw Wastewater Pump 2 Discharge Check Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FV-1122A	Raw Wastewater Pump 2 Discharge Check Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-PSH-11224	Raw Wastewater Pump 2 Discharge Pressure Switch	High Pressure Alarm	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-PIT-11223	Raw Wastewater Pump 2 Discharge Pressure Transmitter	High Pressure Alarm	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-PIT-11223	Raw Wastewater Pump 2 Discharge Pressure Transmitter	High Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-PIT-11223	Raw Wastewater Pump 2 Discharge Pressure Transmitter	Low Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-PIT-11223	Raw Wastewater Pump 2 Discharge Pressure Transmitter	Low Pressure Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FV-11222	Raw Wastewater Pump 2 Discharge Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FV-11222	Raw Wastewater Pump 2 Discharge Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FIT-11322	Raw Wastewater Pump 2 W2CW Flowmeter	Low Flow Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-SOL-11321	Raw Wastewater Pump 2 W2CW Intake Valve	Fail to Open	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-SOL-11321	Raw Wastewater Pump 2 W2CW Intake Valve	Fail to Close	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	Fault	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	Fail to Start	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	No Open Discharge Valve While Running	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	Speed Not Equal Speed Command	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	Motor Trip	3	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	Motor Leak	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	High Winding Temperature	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	High Bearing Temperature	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	High Bearing Vibration	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	Leak Detected	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-P-11240	Raw Wastewater Pump 4	High Motor Temperature	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-FV-1124A	Raw Wastewater Pump 4 Discharge Check Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FV-1124A	Raw Wastewater Pump 4 Discharge Check Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-PSH-11244	Raw Wastewater Pump 4 Discharge Pressure Switch	High Pressure Alarm	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-PIT-11243	Raw Wastewater Pump 4 Discharge Pressure Transmitter	High Pressure Alarm	2	Shutdown RWW Pump 4, Start Standby Pump		
01 - Influent Pump Station	0100-X603	01-PIT-11243	Raw Wastewater Pump 4 Discharge Pressure Transmitter	High Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-PIT-11243	Raw Wastewater Pump 4 Discharge Pressure Transmitter	Low Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-PIT-11243	Raw Wastewater Pump 4 Discharge Pressure Transmitter	Low Pressure Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FV-11242	Raw Wastewater Pump 4 Discharge Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FV-11242	Raw Wastewater Pump 4 Discharge Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FIT-11342	Raw Wastewater Pump 4 W2CW Flowmeter	Low Flow Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-SOL-11341	Raw Wastewater Pump 4 W2CW Intake Valve	Fail to Open	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-SOL-11341	Raw Wastewater Pump 4 W2CW Intake Valve	Fail to Close	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FIT-11411	Raw Wastewater Wetwell 1 Discharge Flowmeter	High Flow Alarm	2	Shutdown one of RWW Pump 1, 3, or 5		
01 - Influent Pump Station	0100-X603	01-FIT-11411	Raw Wastewater Wetwell 1 Discharge Flowmeter	High Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FIT-11411	Raw Wastewater Wetwell 1 Discharge Flowmeter	Low Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FIT-11411	Raw Wastewater Wetwell 1 Discharge Flowmeter	Low Flow Alarm	2	Start one of RWW Pump 1, 3, or 5		
01 - Influent Pump Station	0100-X603	01-FV-11412	Raw Wastewater Wetwell 1 Force Main 1 Control Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	N/A	Raw Wastewater Wetwell 2 Analog Level Transmitters	LT Readings Disagree by more than 10%	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-LSHH-11205	Raw Wastewater Wetwell 2 High High Level Switch	High Level Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-LSH-11207	Raw Wastewater Wetwell 2 High Level Switch 1	High Level Warning 1	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-LSH-11206	Raw Wastewater Wetwell 2 High Level Switch 2	High Level Warning 2	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-FCV-11201	Raw Wastewater Wetwell 2 Influent Slide Gate	Fault	1	Shutdown one of RWW Pump 1, 3, or 5		
01 - Influent Pump Station	0100-X603	01-FCV-11201	Raw Wastewater Wetwell 2 Influent Slide Gate	Fail to Open	2	Shutdown RWW Pumps 1, 3, & 5		
01 - Influent Pump Station	0100-X603	01-FCV-11201	Raw Wastewater Wetwell 2 Influent Slide Gate	Fail to Close	2	Alarm Notification		

Area	P&ID	Tag	Equipment	Alarm Description	Alarm Level	Alarm Response	Alarm Level	Meaning
01 - Influent Pump Station	0100-X603	01-LIT-11202	Raw Wastewater Wetwell 2 Level Transmitter 1	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-LIT-11202	Raw Wastewater Wetwell 2 Level Transmitter 1	High Level Alarm	2	Start RWW Pumps 2 & 4		
01 - Influent Pump Station	0100-X603	01-LIT-11202	Raw Wastewater Wetwell 2 Level Transmitter 1	High Level Warning	1	Start one of RWW Pump 2 or 4		
01 - Influent Pump Station	0100-X603	01-LIT-11202	Raw Wastewater Wetwell 2 Level Transmitter 1	Low Level Warning	1	Shutdown one of RWW Pump 2 or 4		
01 - Influent Pump Station	0100-X603	01-LIT-11202	Raw Wastewater Wetwell 2 Level Transmitter 1	Low Level Alarm	2	Shutdown RWW Pumps 2 & 4		
01 - Influent Pump Station	0100-X603	01-LIT-11203	Raw Wastewater Wetwell 2 Level Transmitter 2	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-LIT-11203	Raw Wastewater Wetwell 2 Level Transmitter 2	High Level Alarm	2	Start RWW Pumps 2 & 4		
01 - Influent Pump Station	0100-X603	01-LIT-11203	Raw Wastewater Wetwell 2 Level Transmitter 2	High Level Warning	1	Start one of RWW Pump 2 or 4		
01 - Influent Pump Station	0100-X603	01-LIT-11203	Raw Wastewater Wetwell 2 Level Transmitter 2	Low Level Warning	1	Shutdown one of RWW Pump 2 or 4		
01 - Influent Pump Station	0100-X603	01-LIT-11203	Raw Wastewater Wetwell 2 Level Transmitter 2	Low Level Alarm	2	Shutdown RWW Pumps 2 & 4		
01 - Influent Pump Station	0100-X603	01-LSLL-11204	Raw Wastewater Wetwell 2 Low Low Level Switch	Low Level Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	N/A	Raw Wastewater Wetwell 2 Pumps	Force Main 2 and Cross Connect Valve Closed	2	Alarm Notification		
01 - Influent Pump Station	0100-X603	01-LCP-11200	Raw Wastewater Wetwell 2 Smart Relay	Float Mode Active	1	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-P-11220	Raw Wastewater Pump 2	No Open Discharge Valve While Running	2	Shutdown RWW Pump 2, Start Standby Pump		
01 - Influent Pump Station	0100-X604	01-FV-11412	Raw Wastewater Wetwell 1 Force Main 1 Control Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FV-11412	Raw Wastewater Wetwell 1 Force Main 1 Control Valve	Wetwell 1 In-service and Cross Connect Valve Closed	1	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FV-11413	Raw Wastewater Wetwell 1 Drain Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FV-11413	Raw Wastewater Wetwell 1 Drain Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FV-11413	Raw Wastewater Wetwell 1 Drain Valve	Drain Valve Open While Pumps are Running	2	Close Valve		
01 - Influent Pump Station	0100-X604	01-FIT-11421	Raw Wastewater Wetwell 2 Discharge Flowmeter	High Flow Alarm	2	Shutdown one of RWW Pump 2 or 4		
01 - Influent Pump Station	0100-X604	01-FIT-11421	Raw Wastewater Wetwell 2 Discharge Flowmeter	High Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FIT-11421	Raw Wastewater Wetwell 2 Discharge Flowmeter	Low Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FIT-11421	Raw Wastewater Wetwell 2 Discharge Flowmeter	Low Flow Alarm	2	Start one of RWW Pump 2 or 4		
01 - Influent Pump Station	0100-X604	01-FIT-11421	Raw Wastewater Wetwell 2 Discharge Flowmeter	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FV-11422	Raw Wastewater Wetwell 2 Force Main 2 Control Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FV-11422	Raw Wastewater Wetwell 2 Force Main 2 Control Valve	Wetwell 2 In-service and Cross Connect Valve Closed	1	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FV-11423	Raw Wastewater Wetwell 2 Drain Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FV-11423	Raw Wastewater Wetwell 2 Drain Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-FV-11423	Raw Wastewater Wetwell 2 Drain Valve	Drain Valve Open While Pumps are Running	2	Close Valve		
01 - Influent Pump Station	0100-X604	01-FV-11431	Raw Wastewater Wetwell Cross Connect Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-PIT-40006	IPS Odor Control Foul Air Intake Pressure Transmitter	High Pressure Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-PIT-40006	IPS Odor Control Foul Air Intake Pressure Transmitter	High Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-PIT-40006	IPS Odor Control Foul Air Intake Pressure Transmitter	Low Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-PIT-40006	IPS Odor Control Foul Air Intake Pressure Transmitter	Low Pressure Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X604	01-MD-40101	IPS Odor Control Damper	Fault	2	Alarm Notification		
01 - Influent Pump Station	0100-X604	N/A	Raw Wastewater Wetwell Valves	All Five Valves Closed	2	Shutdown all five RWW Pumps		
01 - Influent Pump Station	0100-X605	01-P-11220	Raw Wastewater Pump 2	Speed Not Equal Speed Command	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-MD-40101	IPS Odor Control Damper	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-MD-40101	IPS Odor Control Damper	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-PDIT-40102	IPS Odor Control Differential Pressure Transmitter	Fault	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-PDIT-40102	IPS Odor Control Differential Pressure Transmitter	High Pressure	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-TIT-40103	Bioscrubber Temperature Transmitter	High Temperature Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-TIT-40103	Bioscrubber Temperature Transmitter	High Temperature Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-TIT-40103	Bioscrubber Temperature Transmitter	Low Temperature Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-TIT-40103	Bioscrubber Temperature Transmitter	Low Temperature Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-PDIT-40104	Bioscrubber Differential Pressure Transmitter	Fault	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-PDIT-40104	Bioscrubber Differential Pressure Transmitter	High Pressure	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-LSL-40105	Bioscrubber Low Level Switch	Low Level Warning	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-LSH-40106	Bioscrubber High Level Switch	High Level Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-LSHH-40107	Bioscrubber High High Level Switch	High Level Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-SOL-40108	W2 to Bioscrubber Solenoid Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-SOL-40108	W2 to Bioscrubber Solenoid Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-P-40110	Recirc Pump	Fault	2	Shutdown		

Area	P&ID	Tag	Equipment	Alarm Description	Alarm Level	Alarm Response	Alarm Level	Meaning
01 - Influent Pump Station	0100-X605	01-P-40110	Recirc Pump	Fail to Start	2	Shutdown		
01 - Influent Pump Station	0100-X605	01-P-40110	Recirc Pump	Motor Trip	3	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-EWH-40120	Water Heater	High Limit	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-PIT-40131	Bioscrubber Sprayer Pressure Transmitter	High Pressure Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-PIT-40131	Bioscrubber Sprayer Pressure Transmitter	High Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-PIT-40131	Bioscrubber Sprayer Pressure Transmitter	Low Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-PIT-40131	Bioscrubber Sprayer Pressure Transmitter	Low Pressure Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-FIT-40132	Bioscrubber Sprayer Flowmeter	High Flow Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-FIT-40132	Bioscrubber Sprayer Flowmeter	High Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-FIT-40132	Bioscrubber Sprayer Flowmeter	Low Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-FIT-40132	Bioscrubber Sprayer Flowmeter	Low Flow Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-TIT-40141	Biofilter 1 Temperature Transmitter	High Temperature Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-TIT-40141	Biofilter 1 Temperature Transmitter	High Temperature Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-TIT-40141	Biofilter 1 Temperature Transmitter	Low Temperature Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-TIT-40141	Biofilter 1 Temperature Transmitter	Low Temperature Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X605	01-PDIT-40142	Biofilter 1 Differential Pressure Transmitter	Fault	2	Alarm Notification		
01 - Influent Pump Station	0100-X606	01-P-11220	Raw Wastewater Pump 2	Motor Trip	3	Alarm Notification		
01 - Influent Pump Station	0100-X606	01-PDIT-40142	Biofilter 1 Differential Pressure Transmitter	High Pressure	2	Alarm Notificaiton		
01 - Influent Pump Station	0100-X606	01-FS-40143	W2 to Biofilter 1 Flow Switch	Low Flow	2	Alarm Notification		
01 - Influent Pump Station	0100-X606	01-PV-40144	W2 to Biofilter 1 Pressure Valve	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X606	01-PV-40144	W2 to Biofilter 1 Pressure Valve	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X606	01-BL-40150	FOA Fan	Fault	2	Shutdown		
01 - Influent Pump Station	0100-X606	01-BL-40150	FOA Fan	Fail to Start	2	Shutdown		
01 - Influent Pump Station	0100-X606	01-BL-40150	FOA Fan	No Open Discharge Valve While Running	2	Shutdown		
01 - Influent Pump Station	0100-X606	01-BL-40150	FOA Fan	Speed Not Equal Speed Command	1	Alarm Notification		
01 - Influent Pump Station	0100-X606	01-BL-40150	FOA Fan	Motor Trip	3	Alarm Notification		
01 - Influent Pump Station	0100-X607	01-BL-40150	FOA Fan	High Bearing Temperature	3	Shutdown		
01 - Influent Pump Station	0100-X607	01-BL-40150	FOA Fan	High Winding Temperature	3	Shutdown		
01 - Influent Pump Station	0100-X607	01-BL-40150	FOA Fan	High Bearing Vibration	3	Shutdown		
01 - Influent Pump Station	0100-X607	01-PIT-40152	FOA Fan Suction Pressure Transmitter	High Pressure Alarm	2	Alarm Notification		
01 - Influent Pump Station	0100-X607	01-PIT-40152	FOA Fan Suction Pressure Transmitter	High Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X607	01-PIT-40152	FOA Fan Suction Pressure Transmitter	Low Pressure Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X607	01-PIT-40152	FOA Fan Suction Pressure Transmitter	Low Pressure Alarm	2	Shutdown FOA Fan		
01 - Influent Pump Station	0100-X607	01-MD-40153	FOA Fan Discharge Modulating Damper	Fault	2	Alarm Notification		
01 - Influent Pump Station	0100-X607	01-MD-40153	FOA Fan Discharge Modulating Damper	Fail to Open	2	Alarm Notification		
01 - Influent Pump Station	0100-X607	01-MD-40153	FOA Fan Discharge Modulating Damper	Fail to Close	2	Alarm Notification		
01 - Influent Pump Station	0100-X631	01-P-71010	W2 Pump 1	Fault	2	Shutdown		
01 - Influent Pump Station	0100-X631	01-P-71010	W2 Pump 1	Fail to Start	2	Shutdown		
01 - Influent Pump Station	0100-X631	01-P-71010	W2 Pump 1	Motor Trip	3	Alarm Notification		
01 - Influent Pump Station	0100-X631	01-FIT-71010	W2 Break Tank Influent Flowmeter	High Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X631	01-FIT-71010	W2 Break Tank Influent Flowmeter	High Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X631	01-FIT-71010	W2 Break Tank Influent Flowmeter	Low Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X631	01-FIT-71010	W2 Break Tank Influent Flowmeter	Low Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X631	01-P-71020	W2 Pump 2	Fault	2	Shutdown		
01 - Influent Pump Station	0100-X631	01-P-71020	W2 Pump 2	Fail to Start	2	Shutdown		
01 - Influent Pump Station	0100-X631	01-P-71020	W2 Pump 2	Motor Trip	3	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71020	W3CW Distribution Flowmeter 1	High Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71020	W3CW Distribution Flowmeter 1	High Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71020	W3CW Distribution Flowmeter 1	Low Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71020	W3CW Distribution Flowmeter 1	Low Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71030	W3CW Distribution Flowmeter 2	High Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71030	W3CW Distribution Flowmeter 2	High Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71030	W3CW Distribution Flowmeter 2	Low Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71030	W3CW Distribution Flowmeter 2	Low Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71040	W1 Distribution Flowmeter	High Flow Alarm	1	Alarm Notification		

Area	P&ID	Tag	Equipment	Alarm Description	Alarm Level	Alarm Response	Alarm Level	Meaning
01 - Influent Pump Station	0100-X632	01-FIT-71040	W1 Distribution Flowmeter	High Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71040	W1 Distribution Flowmeter	Low Flow Warning	1	Alarm Notification		
01 - Influent Pump Station	0100-X632	01-FIT-71040	W1 Distribution Flowmeter	Low Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X651	01-YC-81410	Supply Fan	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X651	01-YC-81420	Exhaust Fan	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X652	01-YC-81210	Gas-Fired Unit	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X653	01-YC-81310	Air Handling Unit 1	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X654	01-YC-81320	Air Handling Unit 2	Fault	1	Alarm Notification		
01 - Influent Pump Station	0100-X655	01-XC-90000	Generator Fueling System	Low Level Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X655	01-XC-90000	Generator Fueling System	Low Level Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X655	01-XC-90000	Generator Fueling System	Low Level Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X655	01-XC-90000	Generator Fueling System	Low Level Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X655	01-XC-90000	Generator Fueling System	General Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X655	01-XC-90000	Generator Fueling System	General Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X655	01-XC-90000	Generator Fueling System	High Pressure Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X655	01-XC-90000	Generator Fueling System	High Flow Alarm	1	Alarm Notification		
01 - Influent Pump Station	0100-X655	01-XC-90000	Generator Fueling System	High Vacuum Alarm	1	Alarm Notification		

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FIELD PROCESS AREA

COMBUSTIBLE OR TOXIC GAS DETECTOR TRANSMITTER

24 VDC POWER SUPPLY (+ / -)

CHANNEL 1 4-20 mA DC ISOLATED OUTPUT (+ / -)

CHANNEL 2 4-20 mA DC ISOLATED OUTPUT (+ / -)

3Pr #16 TPSH CABLES IN CODE SIZED RPVC CONDUIT

AIT

WARNING RELAY (NOTE 2)

ALARM RELAY (NOTE 2)

FAULT RELAY (NOTE 2)

AE2 LEL/H_2S

AE1 LEL/H_2S

NOTE 3

4C #14 SHIELDED TRAY CABLE IN CODE SIZED RPVC CONDUIT

FIELD JUNCTION BOX

NOTE 1

SHD

SHD

2Pr #16 TPSH CABLES IN CODE SIZED RPVC CONDUIT

I&C MARSHALLING CABINET

1Pr #16 TPSH CABLES IN CODE SIZED RPVC CONDUIT

120VAC - 24VDC SUPPLY

PLC CONTROL PANEL

CIRCUIT BREAKER

SHD

120VAC POWER SUPPLY

FUSED

SHD

___-AnH2s/Lel ANALOG INPUT CHANNEL 1 INDICATION

FUSED

SHD

___-AnH2s/Lel ANALOG INPUT CHANNEL 2 INDICATION

GAS NOTIFICATION RELAY PANEL

R-W1 (R)

R-A1 (R)

R-F1 (R)

NOTE 4, 6, & 8

3C #14 SHIELDED TRAY CABLE IN CODE SIZED RPVC CONDUIT

BMS CONTROLLER

FUSED

120 VAC POWER SUPPLY

TO BMS NETWORK CONTROLLER

NOTES:

1. PROVIDE FIELD JUNCTION BOXES AS SPECIFIED.
2. CONFIGURE ALARM RELAY TO TRANSFER STATE UPON ALARM OR POWER FAILURE. CURRENTLY SHOWN DE-ENERGIZED.
3. FIELD WIRING SUITABLE FOR CLASS 1, DIVISION 1 AREA.
4. REFER TO ILD-A.H.4AS FOR ADDITIONAL CONNECTIONS IN NOTIFICATION RELAY PANEL.
5. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
6. PROVIDE LAMACOID STATING "CAUTION: MULTIPLE VOLTAGE SOURCES PRESENT".
7. RELAY WETTING POWER CIRCUIT TO BE SERVICED BY EMERGENCY GENERATOR. IN AREAS WITHOUT EMERGENCY GENERATOR SERVICE, PROVIDE UPS SIZED TO SUPPORT LOADS FOR MINIMUM 30MIN RUNTIME.
8. NOTIFICATION RELAY PANEL SHOWN WITH ONLY ONE TRANSMITTER CONNECTED FOR CLARITY. WHERE MULTIPLE TRANSMITTERS ARE CONNECTED TO THE RELAY PANEL, PROVIDE ADDITIONAL R-W#, R-A#, AND R-F# FOR EACH TRANSMITTER.

DRAWING No.

ILD-A.H.3AS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL COMBUSTIBLE OR TOXIC GAS DETECTOR

REVISIONS

NO.	DATE		MADE BY	AUTH. BY
A	23-04-03	SW-1A: ISSUED FOR BID	JEP	CR

LAST CONFORMED SET:

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FIELD

GAS NOTIFICATION
RELAY PANEL (NOTE 2)

NOTE 4
- R-W1
- R-A1
- R-F1

NOTE 6
- R-W1 ● ● ● R-W#
- R-A1 ● ● ● R-A#
- R-F1 ● ● ● R-F#

C1 — NOTE 5

Y — NOTE 3

FUSED

C1-1 — NOTE 5

GAS WARNING — R — NOTE 3

SR

GAS WARNING BUZZER

SILENCE

SILENCE RELAY — SR

SR

SEE CONTINUATION ON
DRAWING ILD-A.H.4A_2S

PLC CONTROL PANEL

FUSED

120 VAC
POWER
SUPPLY

___-Warn
DISCRETE INPUT
GAS WARNING

___-Alarm
DISCRETE INPUT
GAS ALARM

___-Flt
DISCRETE INPUT
GAS DETECTOR
TROUBLE

6C #14 SHIELDED TRAY
CABLE IN CODE SIZED
RPVC CONDUIT

I&C MARSHALLING CABINET

120 VAC
POWER
SUPPLY

2C #14 SHIELDED TRAY
CABLE IN CODE SIZED
RPVC CONDUIT

NOTES:
1. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
2. REFER TO TYPICAL LOOP DRAWING A.H.3AS FOR GAS DETECTOR AND RELAY COIL WIRING.
3. USE EDWARDS WEATHERPROOF FLASHING LED BEACON 125 LED SERIES OR EQUAL.
4. TYPICAL DISCRETE CONNECTIONS FOR A SINGLE TRANSMITTER SHOWN. REPEAT CONNECTIONS FOR EACH TRANSMITTER CONNECTED TO THE GAS DETECTION PANEL. REFER TO P&IDS FOR TRANSMITTER QUANTITIES.
5. PROVIDE ADDITIONAL CONTRACTOR POLES TO SUIT NUMBER OF JUNCTION BOXES. SEE ILD-A.H.4A_2S.
6. WHERE MULTIPLE TRANSMITTERS ARE CONNECTED TO THE NOTIFICATION RELAY PANEL, ADD THEIR ASSOCIATED WARNING, FAULT, AND ALARM CONTACTS IN SERIES.

DRAWING No.

ILD-A.H.4A_1S

SHEET 1 OF 2

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

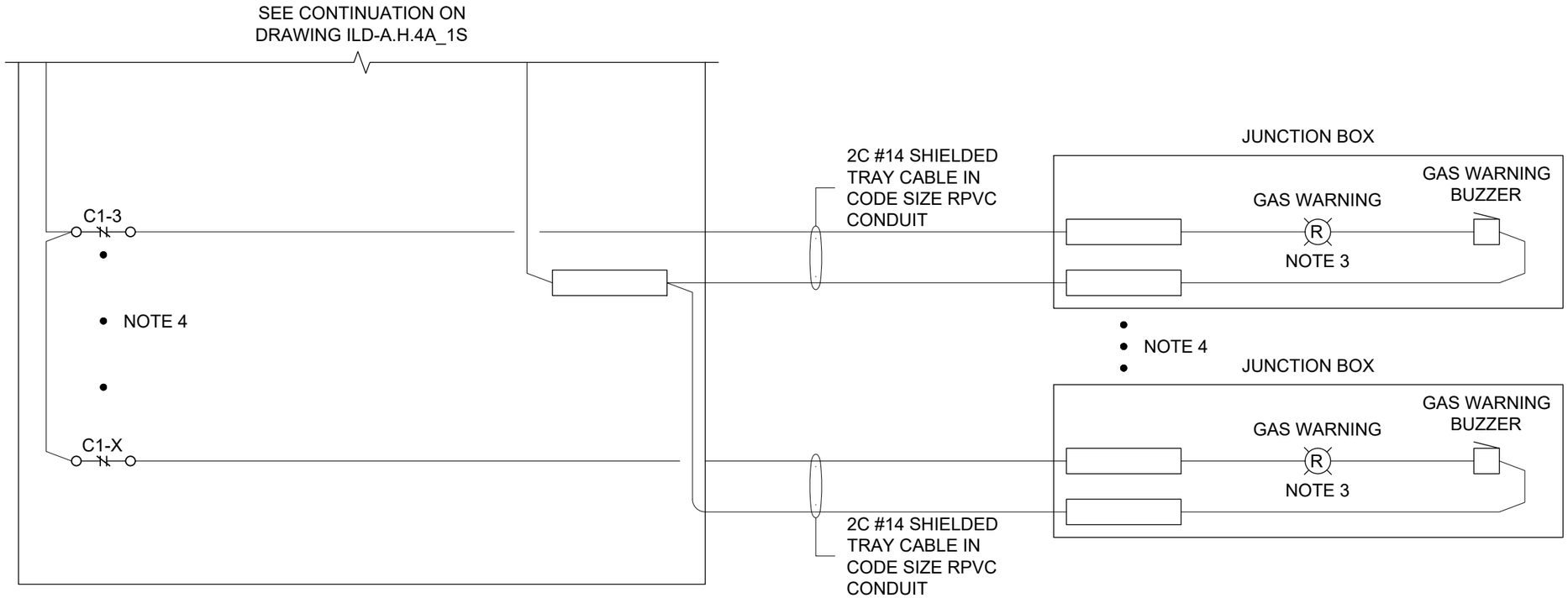
INSTRUMENT LOOP DIAGRAM
TYPICAL GAS ALARMS
SHEET 1 OF 2

REVISIONS

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FIELD



NOTES:

1. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
2. REFER TO TYPICAL LOOP DRAWING A.H.3AS FOR GAS DETECTOR AND RELAY COIL WIRING.
3. USE EDWARDS WEATHERPROOF FLASHING LED BEACON 125 LED SERIES OR EQUAL.
4. ADJUST QUANTITY OF FIELD JUNCTION BOXES AND QUANTITY OF CONTACTOR POLES IN THE RELAY PANEL TO SUIT QUANTITIES OF STROBE/HORN JUNCTION BOXES SHOWN ON DRAWING.
5. PROVIDE FIELD JUNCTION BOXES AS SPECIFIED.

DRAWING No.

ILD-A.H.4A_2S

SHEET 2 OF 2

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL GAS ALARMS
SHEET 2 OF 2

REVISIONS

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FIELD PROCESS AREA

I&C MARSHALLING CABINET

PLC CONTROL PANEL

MODULATING MOTORIZED VALVE

FCV

MOTORIZED CONTROL VALVE

VALVE CONTROL

HS O/C

VALVE POSITION

HS L/R

REMOTE SELECTED

C

NO

NC

C

NO

ZSC

NC

C

NO

ZSO

POWER SUPPLY NOTE 3

FIELD JUNCTION BOX

NOTE 1

SH

SH

2Pr TPSH CABLES IN CODE SIZE RPVC CONDUIT

NOTE 1

6C #14 SHIELDED TRAY CABLE IN CODE SIZE RPVC CONDUIT

NOTES:

1. PROVIDE FIELD JUNCTION BOXES AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
3. POWER TO BE PROVIDED FROM SEPARATE SUPPLY, NOT THE PLC PANEL. REFER TO ELECTRICAL DRAWINGS FOR VOLTAGE, PHASE, AND ASSOCIATED CIRCUIT.

SH

SH

___-PosCmd
PLC ANALOG
OUTPUT 4-20maDC
VALVE CONTROL

SH

SH

___-Pos
PLC ANALOG
INPUT 4-20maDC
VALVE POSITION

FUSED

L

N

120 VAC
POWER
SUPPLY

___-Rem
DISCRETE INPUT
REMOTE SELECTED

___-Cls
DISCRETE INPUT
CLOSED STATUS

___-Opn
DISCRETE INPUT
OPEN STATUS

DRAWING No.

ILD-FCV.H.1AS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL MODULATING MOTORIZED VALVE

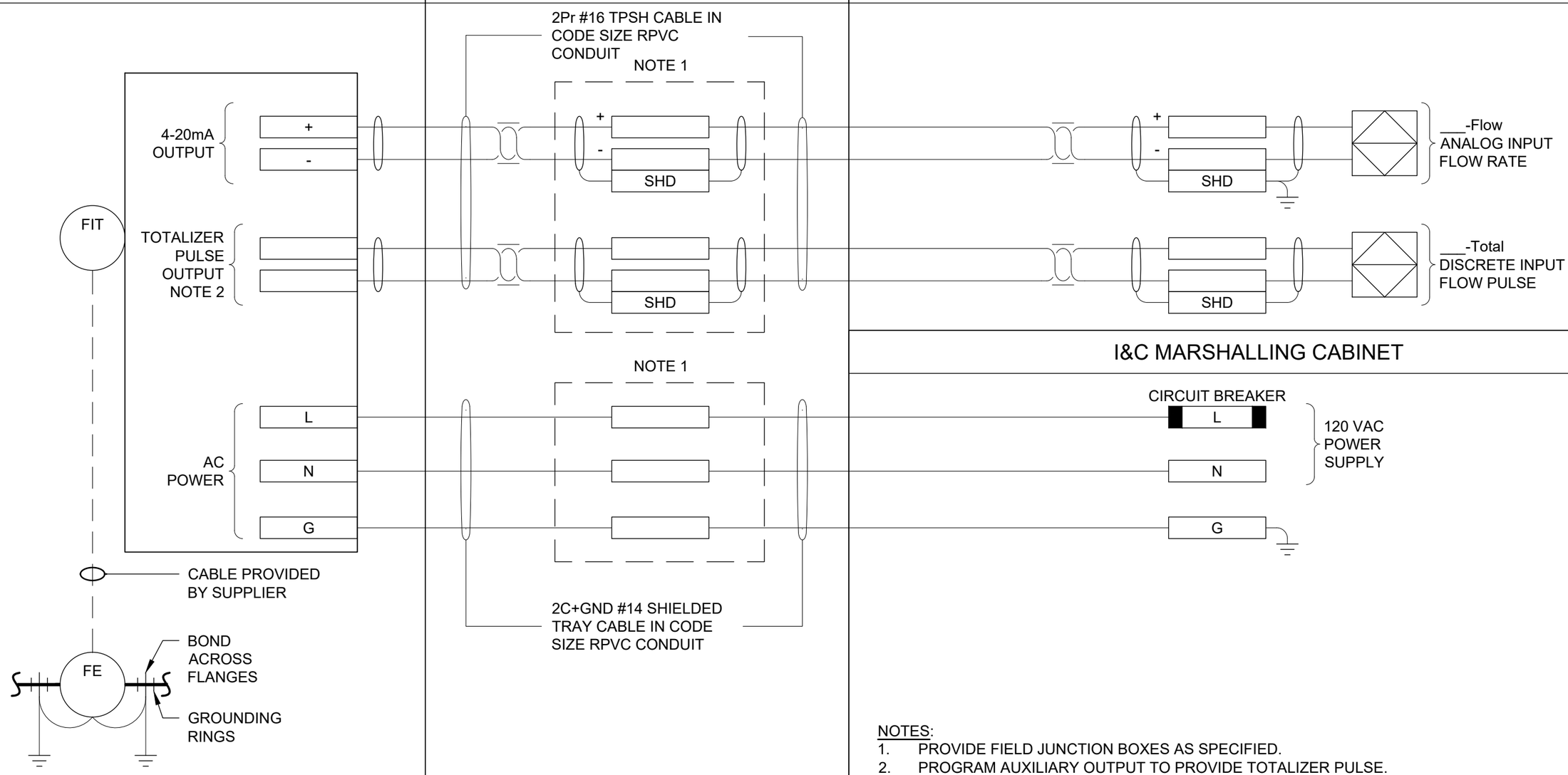
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NOTES:
1. PROVIDE FIELD JUNCTION BOXES AS SPECIFIED.
2. PROGRAM AUXILIARY OUTPUT TO PROVIDE TOTALIZER PULSE. PROVIDE INTERPOSING RELAY IN PLC CONTROL PANEL IF REQUIRED.
3. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.

DRAWING No.

ILD-FE.H.1AS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL MAGNETIC FLOW METER

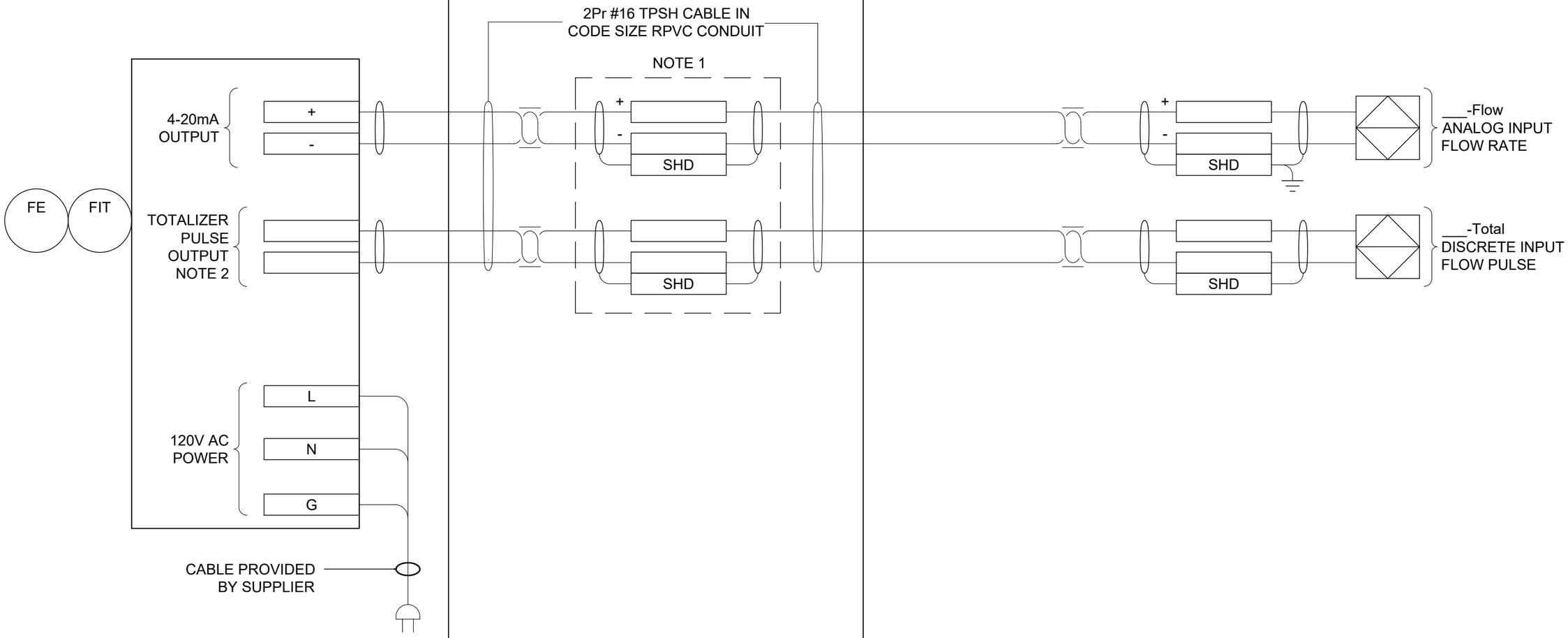
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FIELD PROCESS AREA	FIELD JUNCTION BOX	PLC CONTROL PANEL



NOTES:
1. PROVIDE FIELD JUNCTION BOXES AS SPECIFIED.
2. PROGRAM AUXILIARY OUTPUT TO PROVIDE TOTALIZER PULSE. PROVIDE INTERPOSING RELAY IN PLC CONTROL PANEL IF REQUIRED.
3. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.

DRAWING No.

ILD-FE.H.3AS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL ULTRASONIC FLOW METER

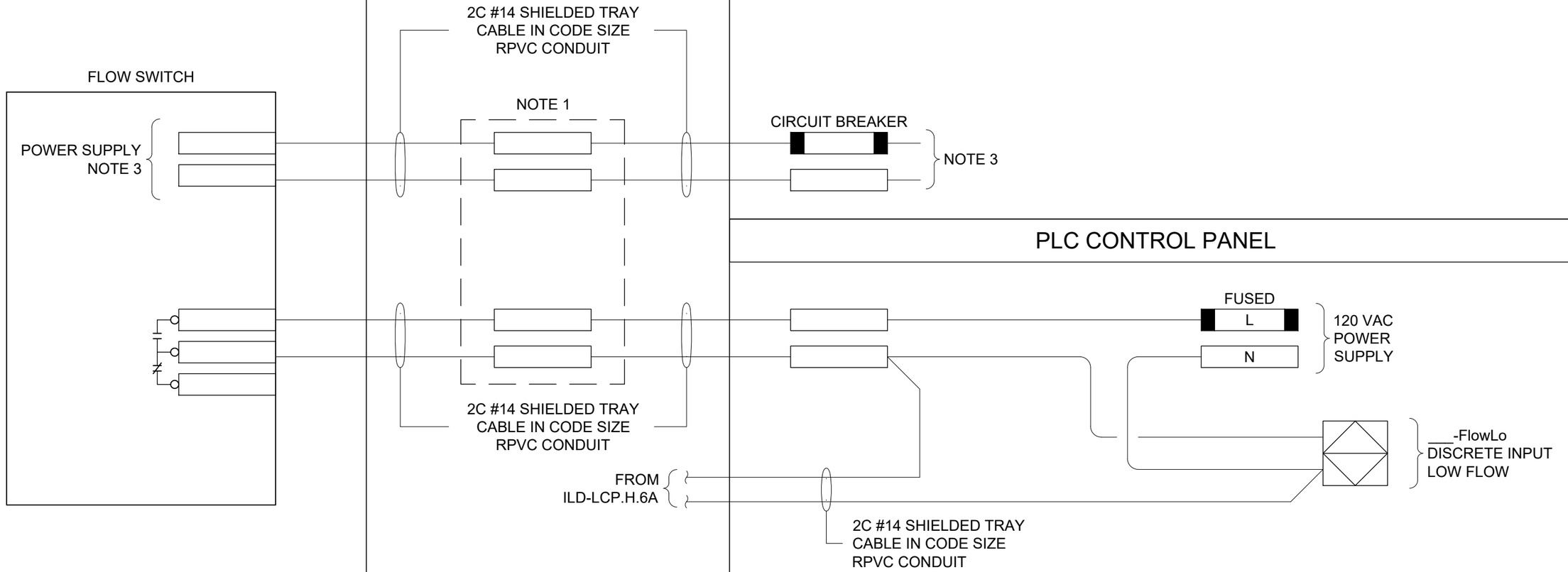
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FIELD PROCESS AREA	FIELD JUNCTION BOX	I&C MARSHALLING CABINET



NOTES:
1. PROVIDE FIELD JUNCTION BOXES AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
3. PROVIDE POWER SUPPLY BASED ON REVIEWED SHOP DRAWING FOR DEVICE.

DRAWING No.

ILD-FSL.H.1AS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL FLOW SWITCH

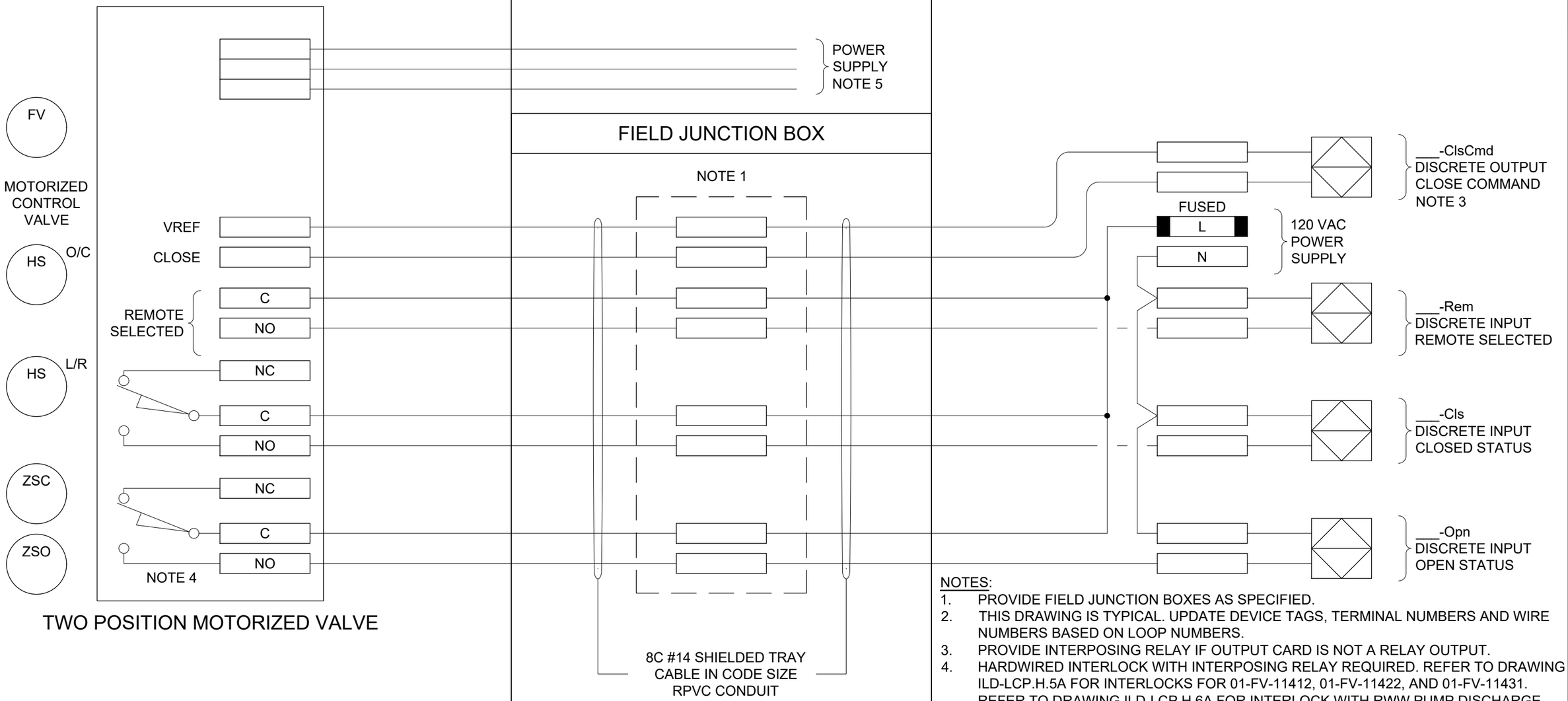
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FIELD PROCESS AREA	I&C MARSHALLING CABINET	PLC CONTROL PANEL



TWO POSITION MOTORIZED VALVE

NOTES:
1. PROVIDE FIELD JUNCTION BOXES AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
3. PROVIDE INTERPOSING RELAY IF OUTPUT CARD IS NOT A RELAY OUTPUT.
4. HARDWIRED INTERLOCK WITH INTERPOSING RELAY REQUIRED. REFER TO DRAWING ILD-LCP.H.5A FOR INTERLOCKS FOR 01-FV-11412, 01-FV-11422, AND 01-FV-11431. REFER TO DRAWING ILD-LCP.H.6A FOR INTERLOCK WITH RWW PUMP DISCHARGE VALVES.
5. POWER TO BE PROVIDED FROM SEPARATE SUPPLY, NOT THE PLC PANEL. REFER TO ELECTRICAL DRAWINGS FOR VOLTAGE, PHASE, AND ASSOCIATED CIRCUIT.

DRAWING No.

ILD-FV.H.1B

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL TWO POSITION MOTORIZED VALVE

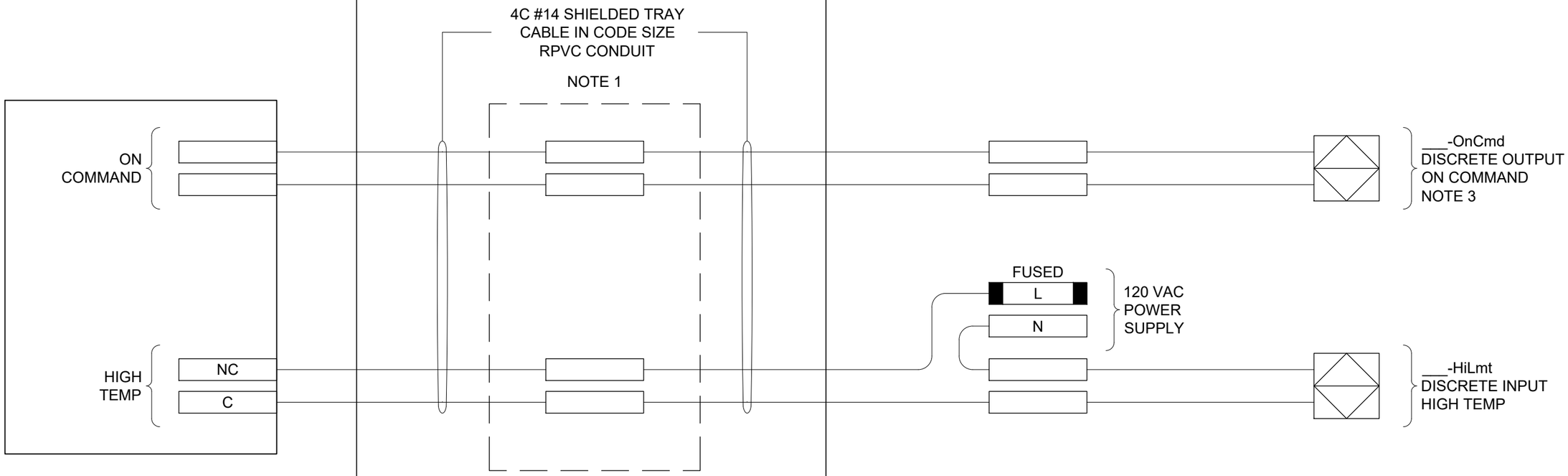
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FIELD PROCESS AREA	FIELD JUNCTION BOX	PLC CONTROL PANEL



NOTES:
1. PROVIDE FIELD JUNCTION BOX AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
3. PROVIDE INTERPOSING RELAY IF OUTPUT CARD IS NOT A RELAY OUTPUT.

DRAWING No.

ILD-HE.H.1A

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL WATER HEATER

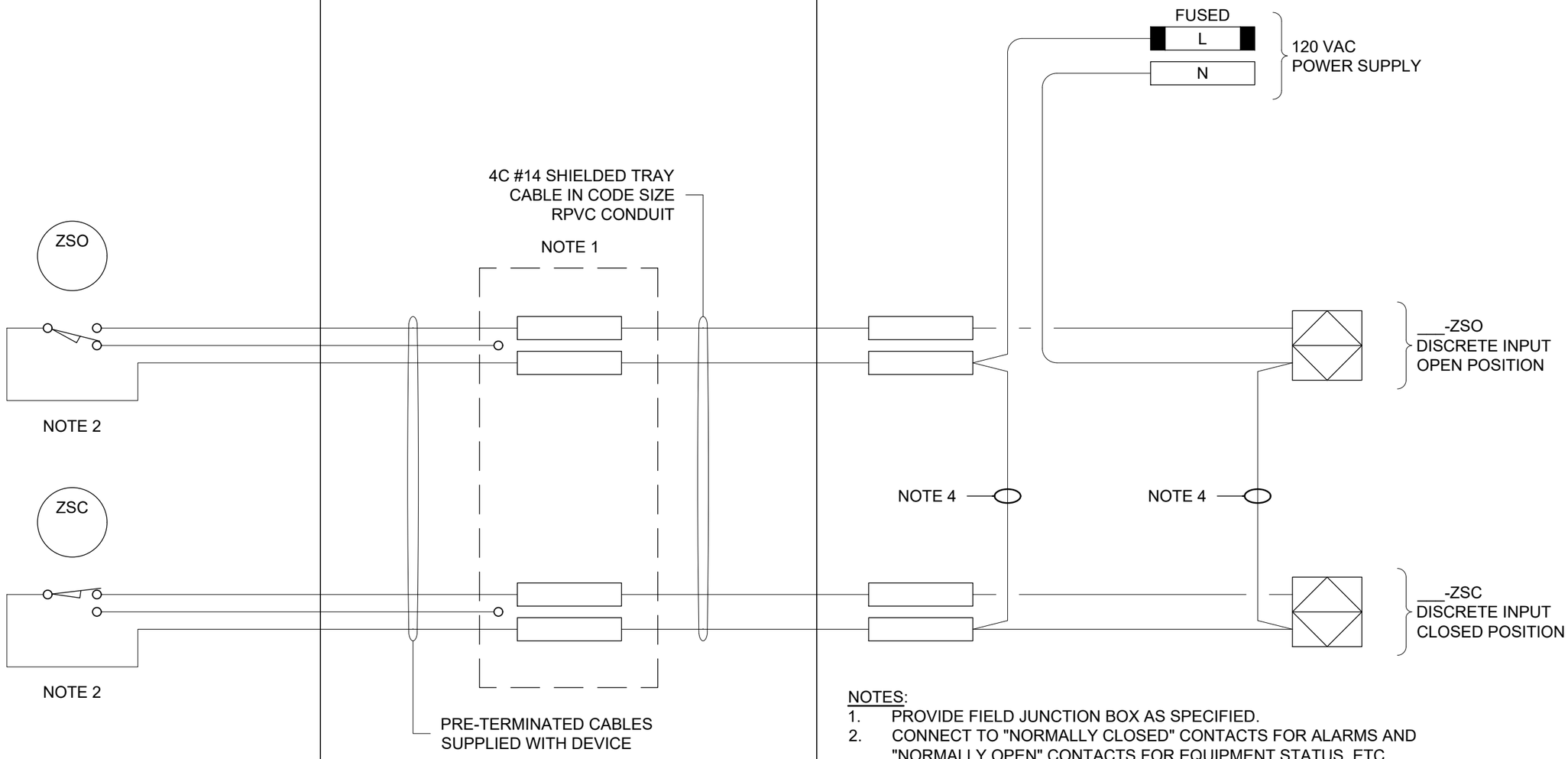
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FIELD PROCESS AREA	FIELD JUNCTION BOX	PLC CONTROL PANEL



NOTES:
1. PROVIDE FIELD JUNCTION BOX AS SPECIFIED.
2. CONNECT TO "NORMALLY CLOSED" CONTACTS FOR ALARMS AND "NORMALLY OPEN" CONTACTS FOR EQUIPMENT STATUS, ETC.
3. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
4. BOTH POSITION SWITCHES SHOWN. IF ONLY ONE SWITCH REQUIRED, REMOVE JUMPERS AND CONNECT LINE AND NEUTRAL DIRECTLY TO ASSOCIATED TERMINALS INSTEAD.

DRAWING No.

ILD-HV.H.1AS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL LIMIT SWITCHES

REVISIONS

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LAST CONFORMED SET:

FIELD PROCESS AREA | FIELD JUNCTION BOX | PLC CONTROL PANEL

VENDOR-SUPPLIED TRANSDUCER CABLE IN RIGID PVC CONDUIT SUPPLIED BY CONTRACTOR

LE

LIT

4-20mA OUTPUT CH1

\+

\-

RELAY OUTPUT 1 FAULT

NC

C

NO

AC POWER

L

N

G

1Pr #16 TPSH CABLE IN CODE SIZE RPVC CONDUIT

NOTE 1

\+

\-

SHD

2C #14 SHIELDED TRAY CABLE IN CODE SIZE RPVC CONDUIT

NOTE 1

4C+GND #14 SHIELDED TRAY CABLE IN CODE SIZE RPVC CONDUIT

2C+GND #14 SHIELDED TRAY CABLE IN CODE SIZE RPVC CONDUIT

NOTE 3 (TYP.)

SHD

___-Lvl ANALOG INPUT LEVEL

FUSED

L

N

120 VAC POWER SUPPLY

___-Flt DISCRETE INPUT LEVEL TRANSMITTER FAULT

I&C MARSHALLING CABINET

CIRCUIT BREAKER

L

N

G

120 VAC POWER SUPPLY

NOTES:

1. PROVIDE FIELD JUNCTION BOXES AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
3. PROVIDE INTRINSICALLY SAFE BARRIER FOR UNGUIDED WAVE LEVEL TRANSMITTERS INSTALLED IN HAZARDOUS AREAS.

DRAWING No.

ILD-L.H.1BS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL UNGUIDED WAVE LEVEL METER
(ULTRASONIC OR RADAR)

REVISIONS

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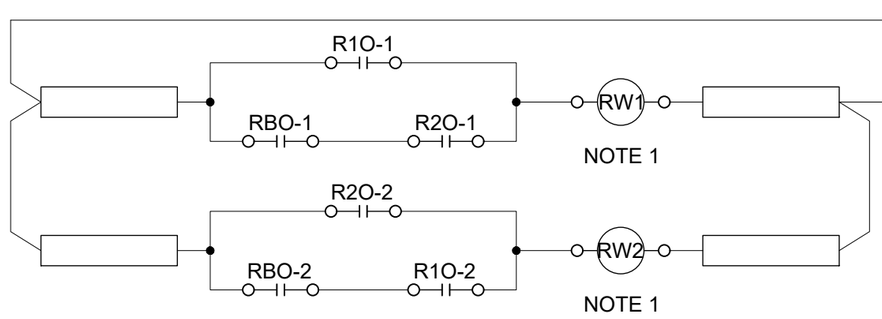
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FIELD PROCESS AREA	FIELD JUNCTION BOX	I&C MARSHALLING CABINET

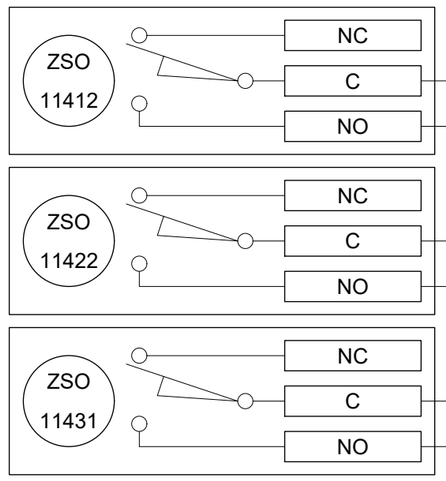
NOTES:
1. INTERPOSING RELAY. REFER TO ILD-LCP.H.6A FOR RELAY CONTACTS.
2. REFER TO DRAWING ILD-FV.H.1B FOR FULL TYPICAL TWO POSITION MOTORIZED VALVE LOOP WIRING.



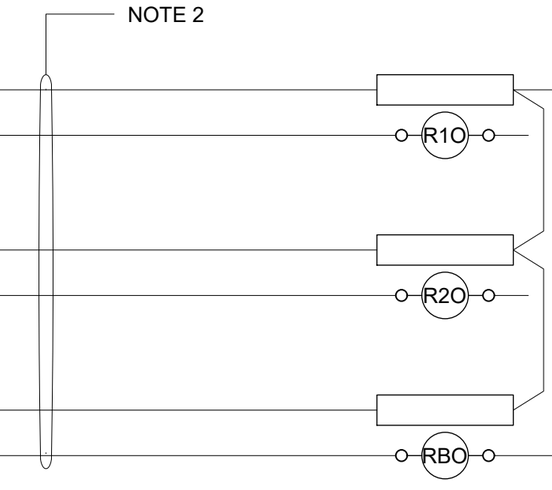


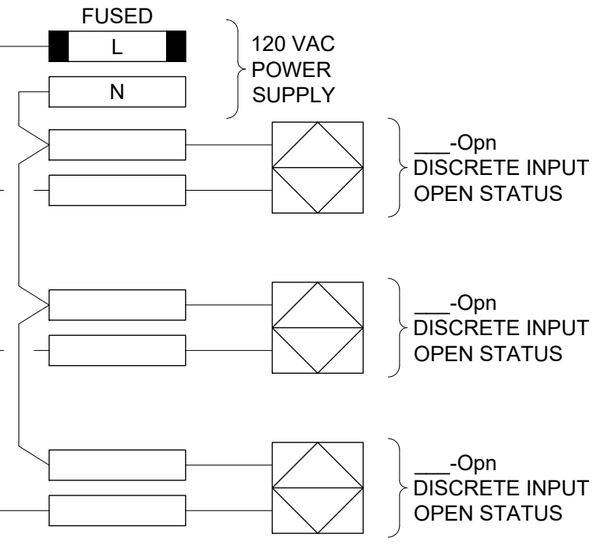
2C #14 SHIELDED TRAY CABLE IN CODE SIZE RPVC CONDUIT

PLC CONTROL PANEL



NOTE 2





DRAWING No.

ILD-LCP.H.5A

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
RELAY JUNCTION BOX

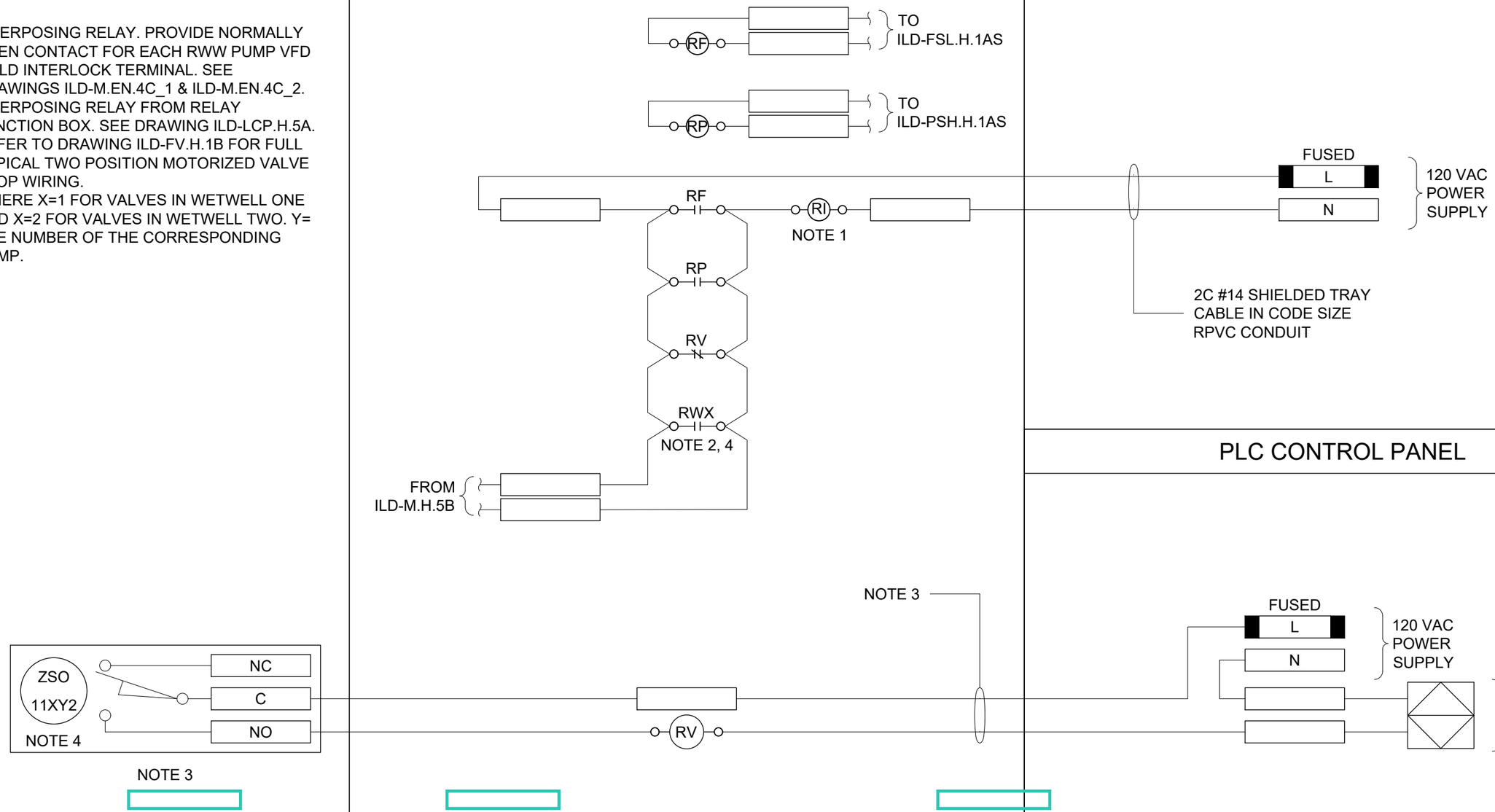
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LAST CONFORMED SET:

FIELD PROCESS AREA	FIELD JUNCTION BOX	I&C MARSHALLING CABINET

NOTES:
1. INTERPOSING RELAY. PROVIDE NORMALLY OPEN CONTACT FOR EACH RWW PUMP VFD FIELD INTERLOCK TERMINAL. SEE DRAWINGS ILD-M.EN.4C_1 & ILD-M.EN.4C_2.
2. INTERPOSING RELAY FROM RELAY JUNCTION BOX. SEE DRAWING ILD-LCP.H.5A.
3. REFER TO DRAWING ILD-FV.H.1B FOR FULL TYPICAL TWO POSITION MOTORIZED VALVE LOOP WIRING.
4. WHERE X=1 FOR VALVES IN WETWELL ONE AND X=2 FOR VALVES IN WETWELL TWO. Y= THE NUMBER OF THE CORRESPONDING PUMP.



DRAWING No.

ILD-LCP.H.6A

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
RWW PUMP INTERLOCK JUNCTION BOX

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FIELD PROCESS AREA	FIELD JUNCTION BOX	I&C MARSHALLING CABINET

NOTES:
1. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS, IP ADDRESS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
2. CONNECT TO "NORMALLY CLOSED" CONTACTS FOR ALARMS AND "NORMALLY OPEN" CONTACTS FOR EQUIPMENT STATUS, ETC.
3. REFER TO P&IDs AND PROCESS CONTROL DESCRIPTION FOR FLOAT TO VFD CONNECTIONS.
4. FOR WETWELL 1 FLOATS, X=1. FOR WETWELL 2 FLOATS, X=2.
5. WHERE FLOAT SIGNAL IS SENT TO MULTIPLE VFDs, PROVIDE AN INTERPOSING RELAY WITH A NORMALLY OPEN CONTACT FOR EACH VFD.
6. PROVIDE FIELD JUNCTION BOX AS SPECIFIED.
7. PROVIDE INTRINSICALLY SAFE BARRIER.

PRE-TERMINATED CABLES SUPPLIED WITH DEVICE

14C #14 SHIELDED TRAY CABLE IN CODE SIZE RPVC CONDUIT

NOTE 6

NOTE 7 (TYP.)

NOTE 6

FUSED
L
N
120 VAC POWER SUPPLY

LSHH 11X05
NOTE 4

LSH 11X06
NOTE 4

LSH 11X07
NOTE 4

LSL 11X08
NOTE 4

LSLL 11X04
NOTE 4

R1 R1 NOTE 5

R2 R2 NOTE 5

VFD

TO ILD-M.EN.4C_2 NOTE 3

TO ILD-M.EN.4C_2 NOTE 3

TO ILD-M.EN.4C_2 NOTE 3

TO ILD-M.EN.4C_2 NOTE 3

TO ILD-M.EN.4C_2 NOTE 3

DRAWING No.

ILD-LSLL_LSHH.H.2A

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

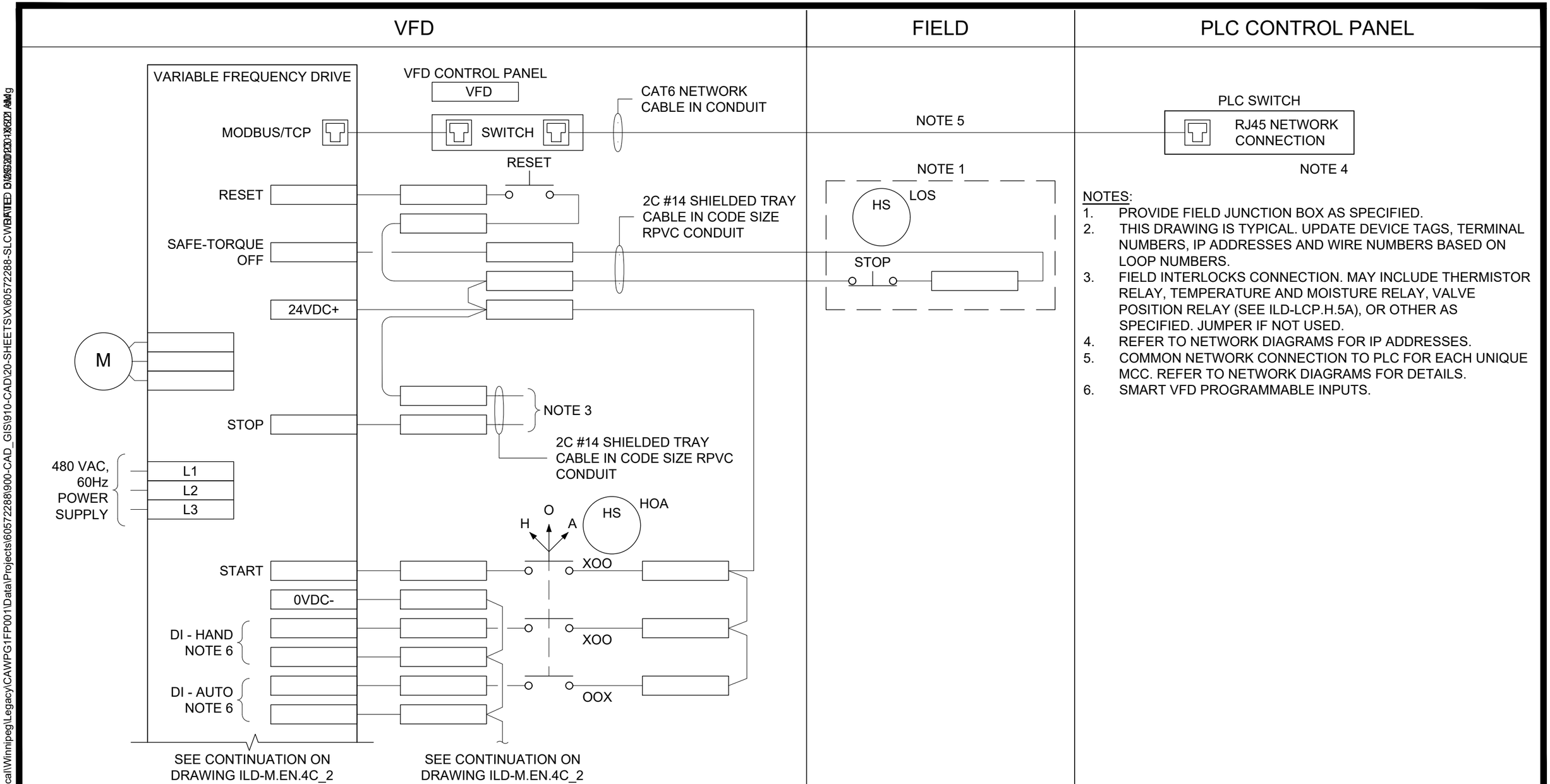
INSTRUMENT LOOP DIAGRAM
TYPICAL RWW WETWELL FLOAT SWITCH

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NOTES:

1. PROVIDE FIELD JUNCTION BOX AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS, IP ADDRESSES AND WIRE NUMBERS BASED ON LOOP NUMBERS.
3. FIELD INTERLOCKS CONNECTION. MAY INCLUDE THERMISTOR RELAY, TEMPERATURE AND MOISTURE RELAY, VALVE POSITION RELAY (SEE ILD-LCP.H.5A), OR OTHER AS SPECIFIED. JUMPER IF NOT USED.
4. REFER TO NETWORK DIAGRAMS FOR IP ADDRESSES.
5. COMMON NETWORK CONNECTION TO PLC FOR EACH UNIQUE MCC. REFER TO NETWORK DIAGRAMS FOR DETAILS.
6. SMART VFD PROGRAMMABLE INPUTS.

DRAWING No.

ILD-M.EN.4C_1

SHEET 1 OF 2

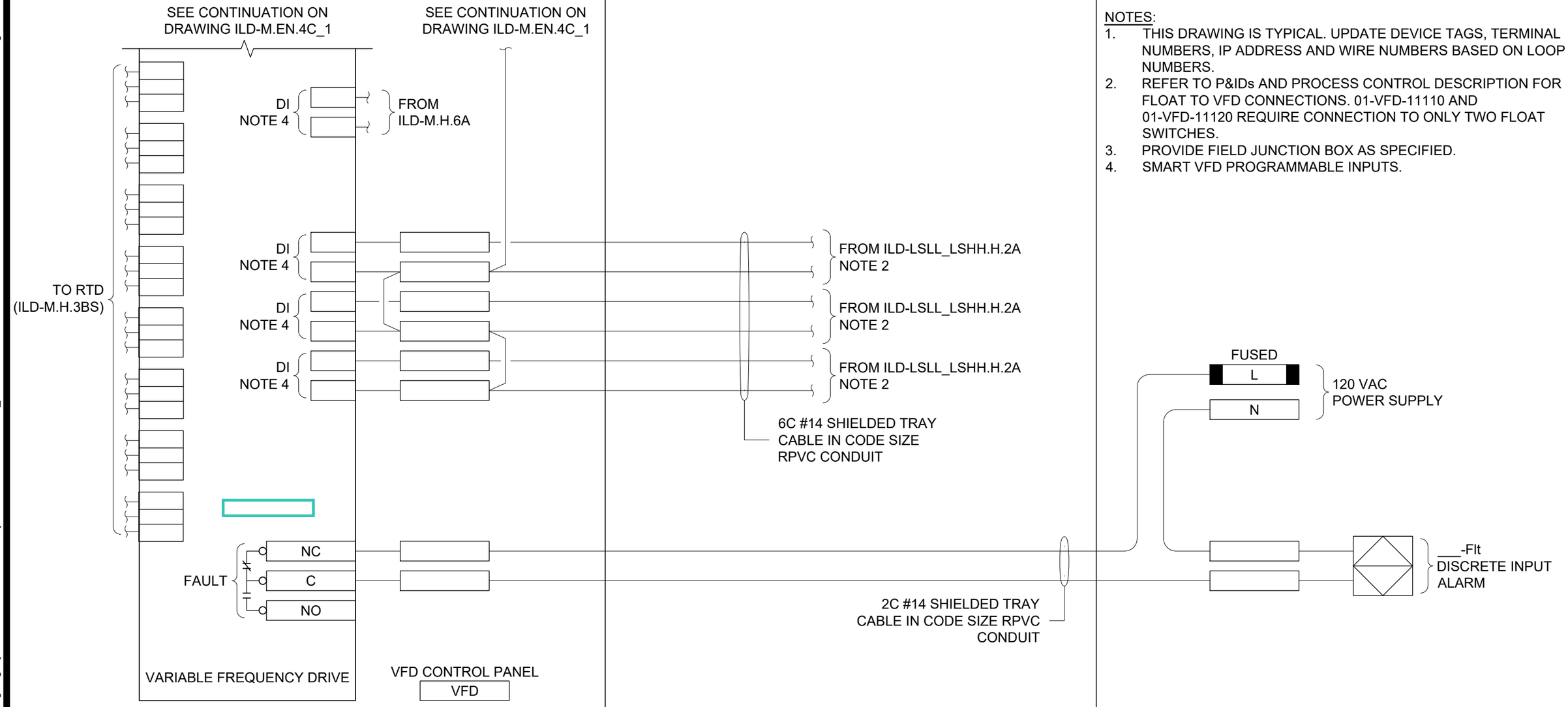
SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL RWW PUMP
SMART VARIABLE FREQUENCY DRIVE

REVISIONS

NO.	DATE		MADE BY	AUTH. BY
A	23-04-03	SW-1A: ISSUED FOR BID	JEP	CR

LAST CONFORMED SET:



NOTES:

1. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS, IP ADDRESS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
2. REFER TO P&IDs AND PROCESS CONTROL DESCRIPTION FOR FLOAT TO VFD CONNECTIONS. 01-VFD-11110 AND 01-VFD-11120 REQUIRE CONNECTION TO ONLY TWO FLOAT SWITCHES.
3. PROVIDE FIELD JUNCTION BOX AS SPECIFIED.
4. SMART VFD PROGRAMMABLE INPUTS.

DRAWING No.

ILD-M.EN.4C_2

SHEET 2 OF 2

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL RWW PUMP
SMART VARIABLE FREQUENCY DRIVE

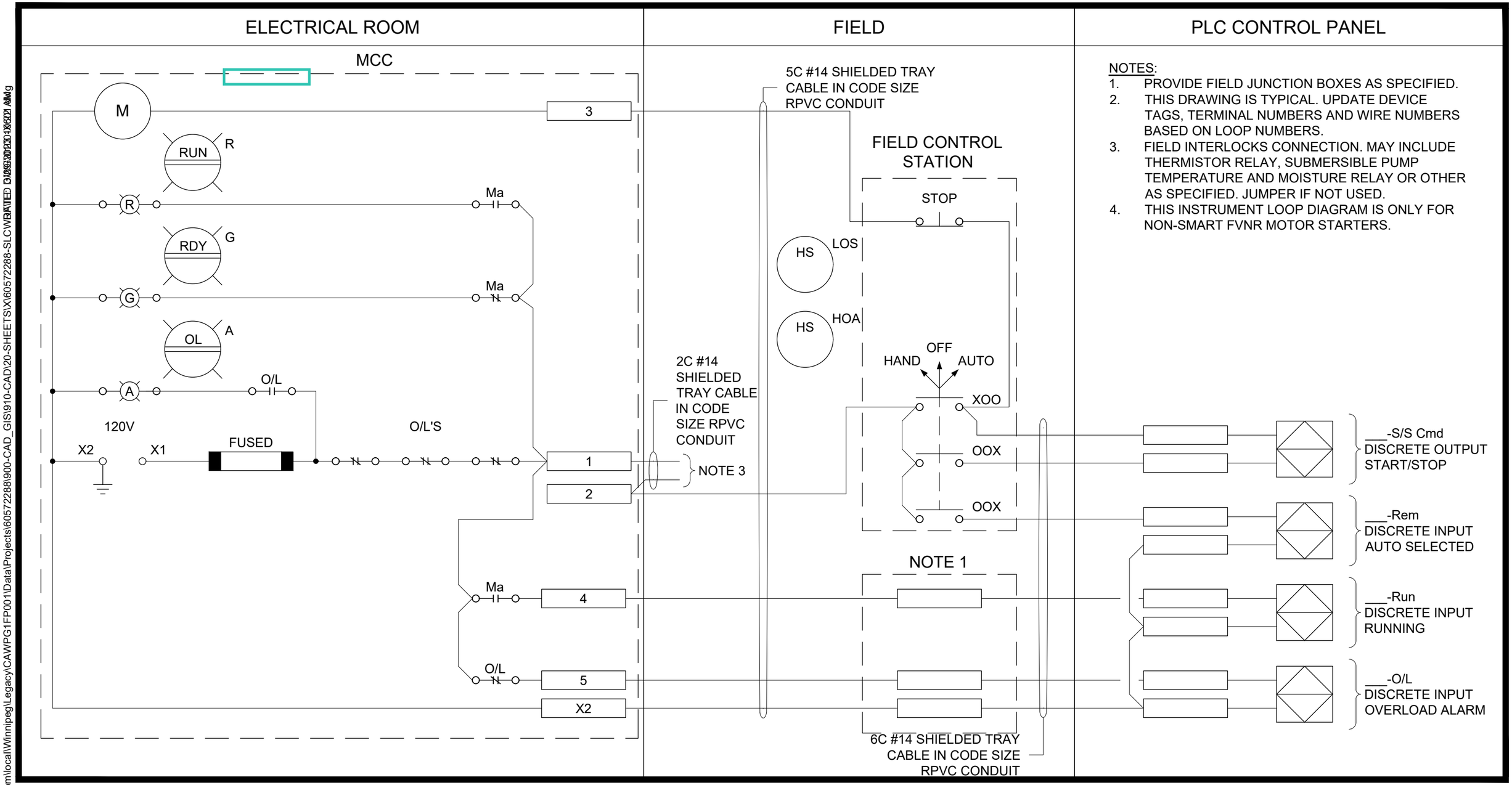
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ILD-M.H.2AS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

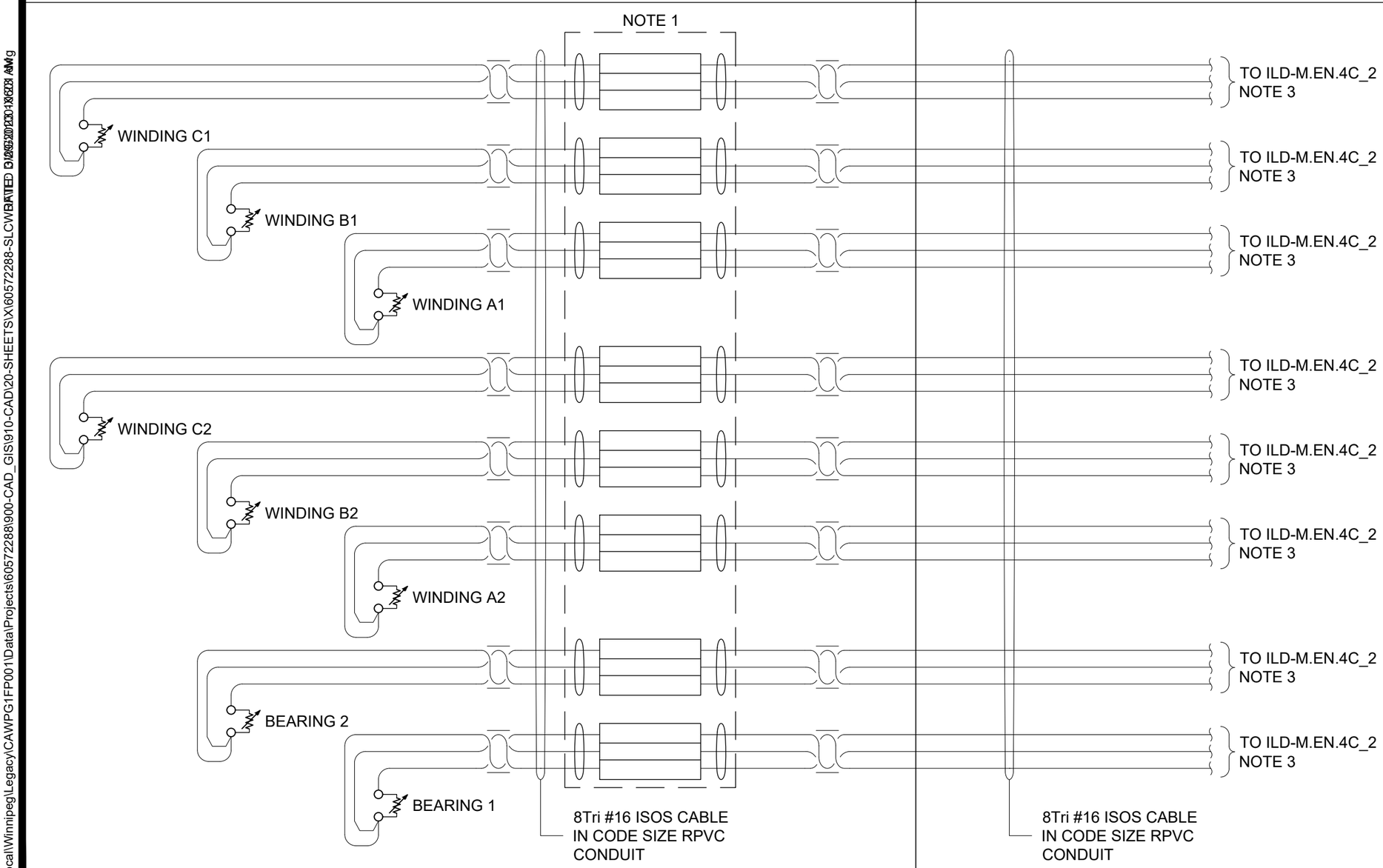
INSTRUMENT LOOP DIAGRAM
TYPICAL HARDWIRED FVNR MOTOR STARTER

REVISIONS

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NOTES:
1. PROVIDE FIELD JUNCTION BOX AS SPECIFIED.
2. THIS DRAWING IS TYPICAL FOR SEVERAL DRIVES, REFER TO INSTRUMENT INDEX FOR APPLICATIONS.
3. TERMINATE ON VFD RTD AUXILIARY CARD.

DRAWING No.

ILD-M.H.3BS

SHEET _____ OF ----

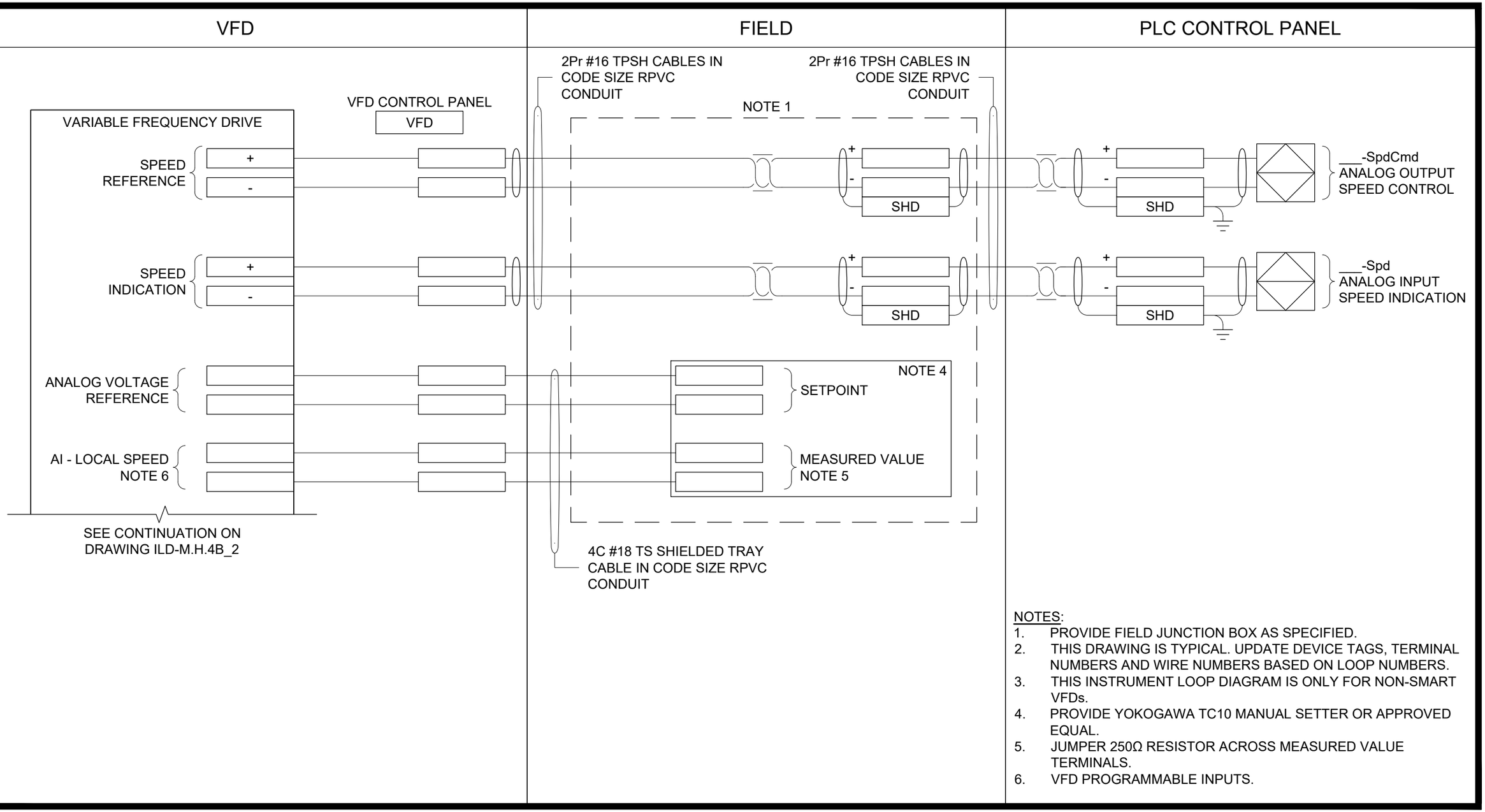
SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
RTD RELAY CONNECTION

REVISIONS

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A	23-04-03	SW-1A: ISSUED FOR BID	JEP	CR

LAST CONFORMED SET:



NOTES:

1. PROVIDE FIELD JUNCTION BOX AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
3. THIS INSTRUMENT LOOP DIAGRAM IS ONLY FOR NON-SMART VFDs.
4. PROVIDE YOKOGAWA TC10 MANUAL SETTER OR APPROVED EQUAL.
5. JUMPER 250Ω RESISTOR ACROSS MEASURED VALUE TERMINALS.
6. VFD PROGRAMMABLE INPUTS.

DRAWING No.

ILD-M.H.4B_1

SHEET 1 OF 2

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL HARDWIRED VARIABLE FREQUENCY DRIVE
SHEET 1 OF 2

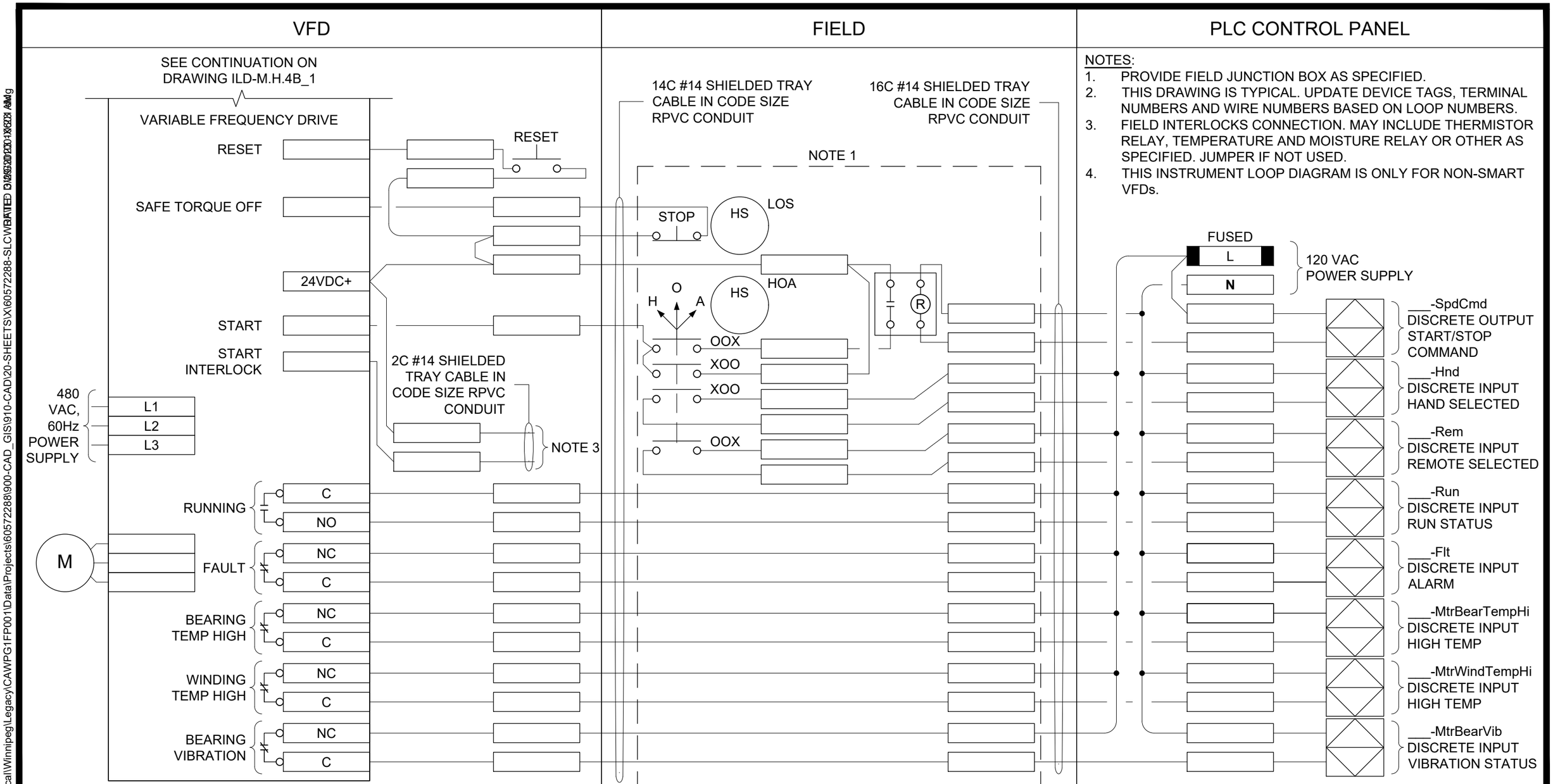
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ILD-M.H.4B_2

SHEET 1 OF 2

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

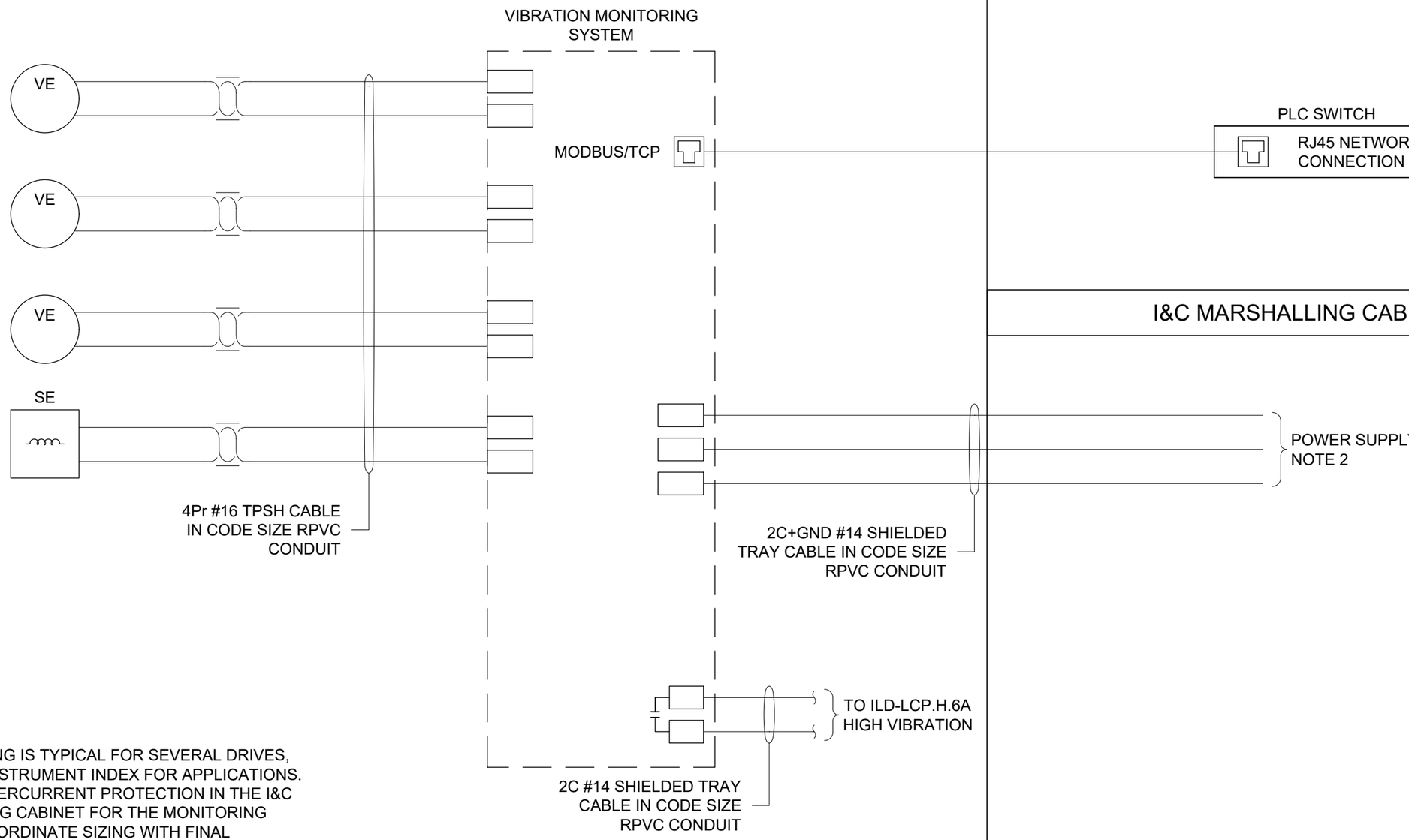
INSTRUMENT LOOP DIAGRAM
TYPICAL HARDWIRED VARIABLE FREQUENCY DRIVE
SHEET 2 OF 2

REVISIONS

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NOTES:
1. THIS DRAWING IS TYPICAL FOR SEVERAL DRIVES, REFER TO INSTRUMENT INDEX FOR APPLICATIONS.
2. PROVIDE OVERCURRENT PROTECTION IN THE I&C MARSHALLING CABINET FOR THE MONITORING SYSTEM. COORDINATE SIZING WITH FINAL SELECTED COMPONENTS.

DRAWING No.

ILD-M.H.5B

SHEET _____ OF ----

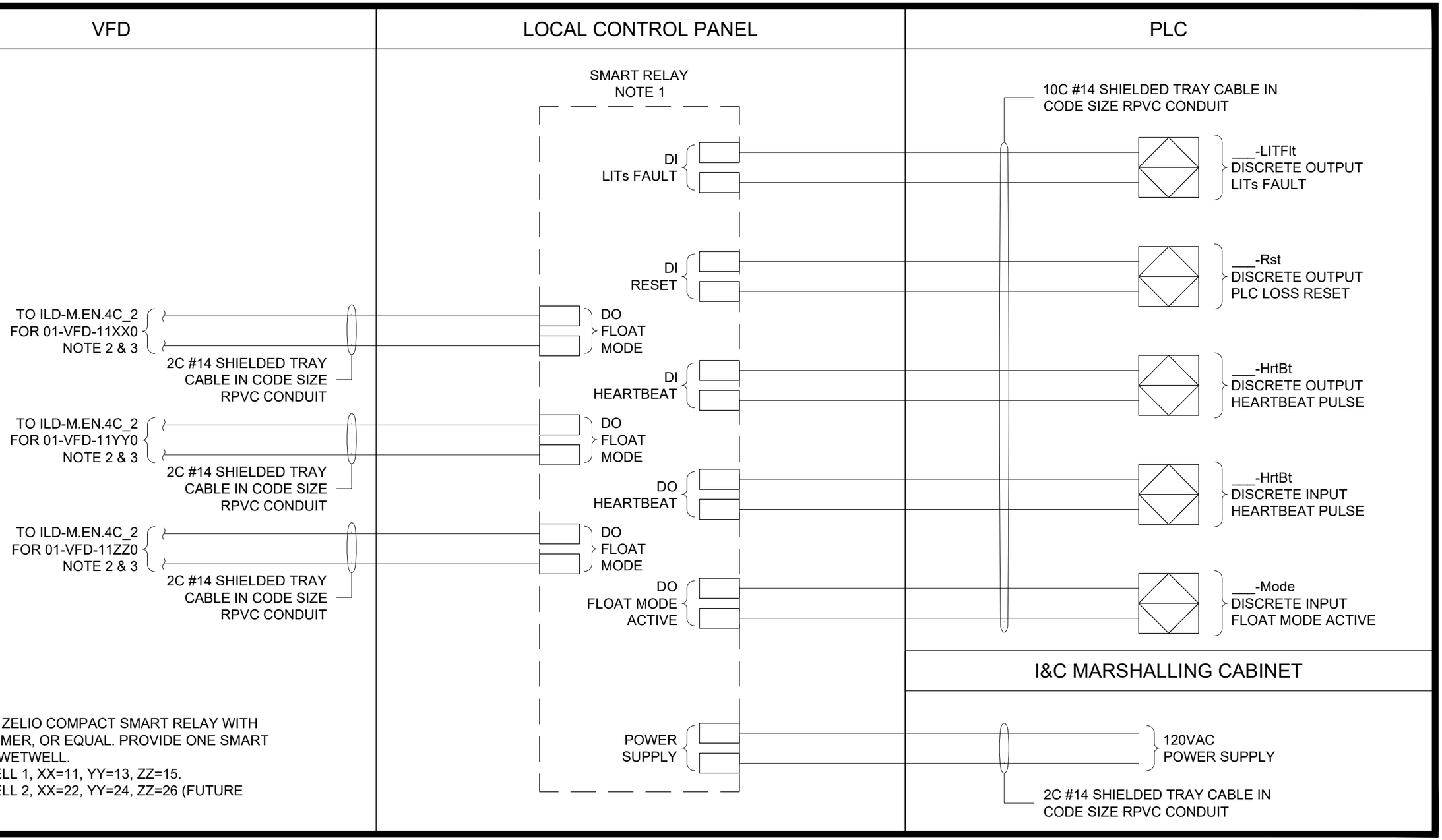
SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
VIBRATION MONITORING CONNECTION

REVISIONS

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LAST CONFORMED SET:



NOTES:
1. SCHNEIDER ZELIO COMPACT SMART RELAY WITH INTERNAL TIMER, OR EQUAL. PROVIDE ONE SMART RELAY PER WETWELL.
2. FOR WETWELL 1, XX=11, YY=13, ZZ=15.
3. FOR WETWELL 2, XX=22, YY=24, ZZ=26 (FUTURE PUMP 6).

DRAWING No.

ILD-M.H.6A

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL RWW WETWELL SMART RELAY

REVISIONS

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FIELD PROCESS AREA

TWO POSITION MOTORIZED DAMPER

MD

HS O/C

HS L/R

ZSC

ZSO

POWER SUPPLY

VREF
OPEN
VREF
CLOSE
FAULT
REMOTE SELECTED
C
NO
NC
C
NO
NC
C
NO

FIELD JUNCTION BOX

12C #14 SHIELDED TRAY CABLE IN CODE SIZE RPVC CONDUIT

NOTE 1

PLC CONTROL PANEL

___-OpnCmd
DISCRETE OUTPUT
OPEN COMMAND
NOTE 3

___-ClsCmd
DISCRETE OUTPUT
CLOSE COMMAND
NOTE 3

FUSED
L
N

120 VAC POWER SUPPLY

___-Flt
DISCRETE INPUT
FAULT

___-Rem
DISCRETE INPUT
REMOTE SELECTED

___-Cls
DISCRETE INPUT
CLOSED STATUS

___-Opn
DISCRETE INPUT
OPEN STATUS

NOTES:
1. PROVIDE FIELD JUNCTION BOXES AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
3. PROVIDE INTERPOSING RELAY IF OUTPUT CARD IS NOT A RELAY OUTPUT.

DRAWING No.

ILD-MD.H.1A

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL TWO POSITION MOTORIZED DAMPER

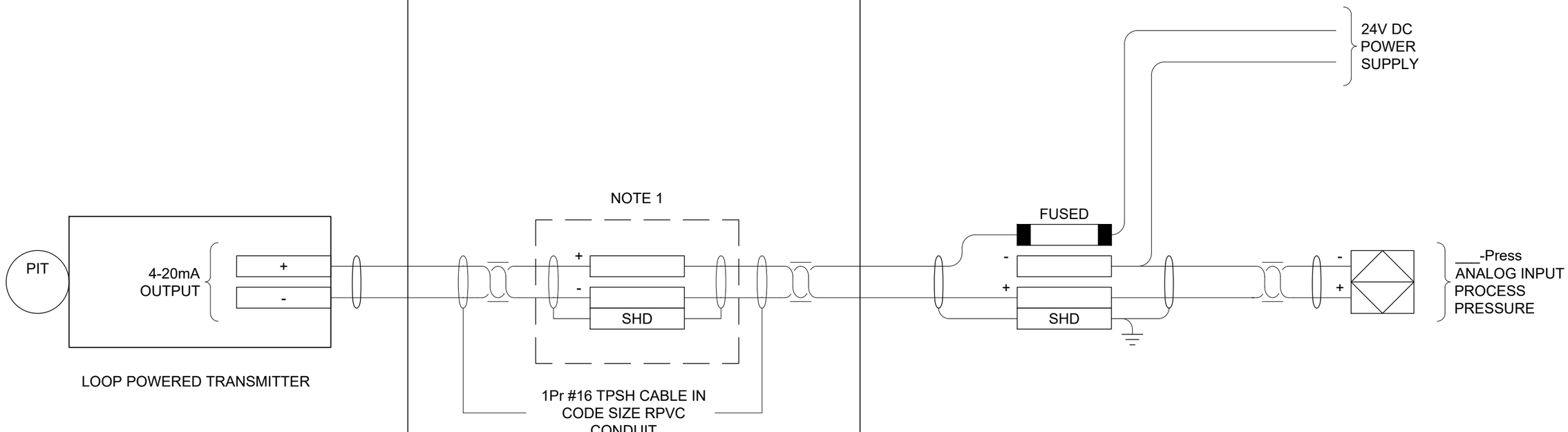
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FIELD PROCESS AREA	FIELD JUNCTION BOX	PLC CONTROL PANEL



NOTES:
1. PROVIDE FIELD JUNCTION BOX AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.

DRAWING No.

ILD-P.H.1CS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

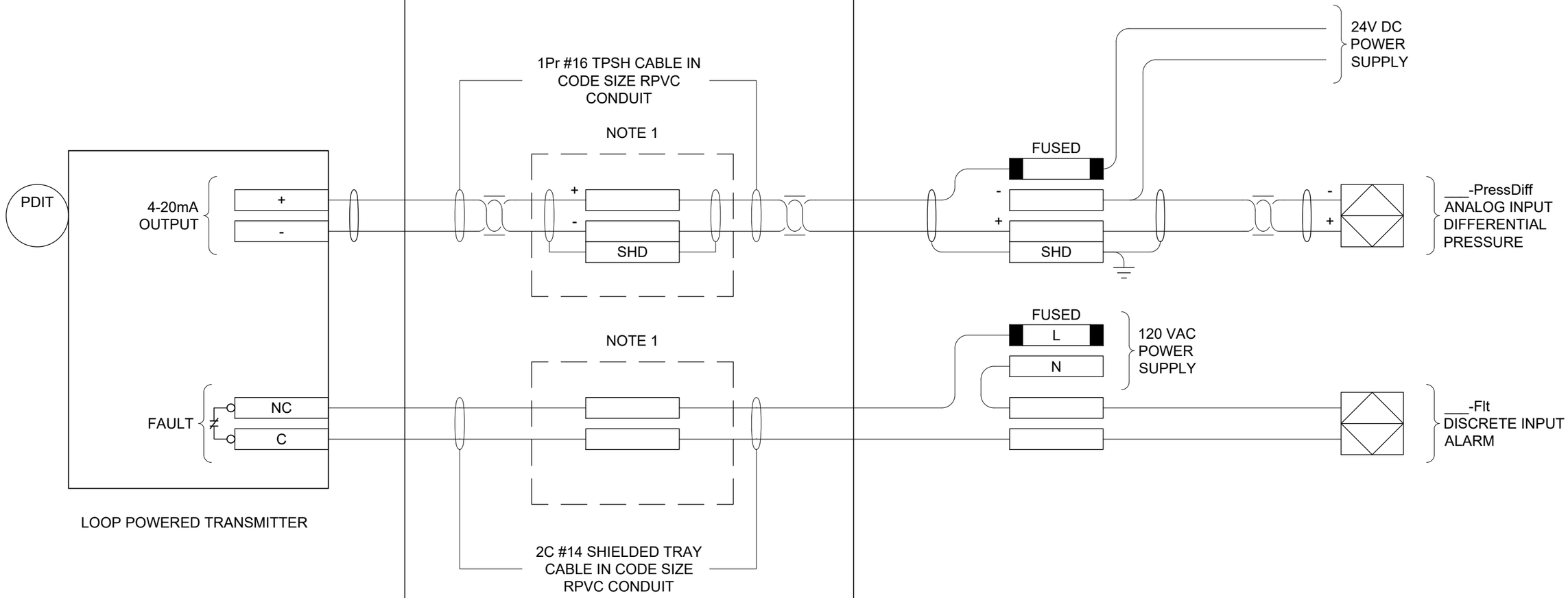
INSTRUMENT LOOP DIAGRAM
TYPICAL PRESSURE TRANSMITTER

REVISIONS

NO.	DATE		MADE BY	AUTH. BY
A	23-04-03	SW-1A: ISSUED FOR BID	JEP	CR

LAST CONFORMED SET:

FIELD PROCESS AREA | FIELD JUNCTION BOX | PLC CONTROL PANEL



NOTES:
1. PROVIDE FIELD JUNCTION BOX AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.

DRAWING No.

ILD-PD.H.1AS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL DIFFERENTIAL PRESSURE TRANSMITTER

REVISIONS

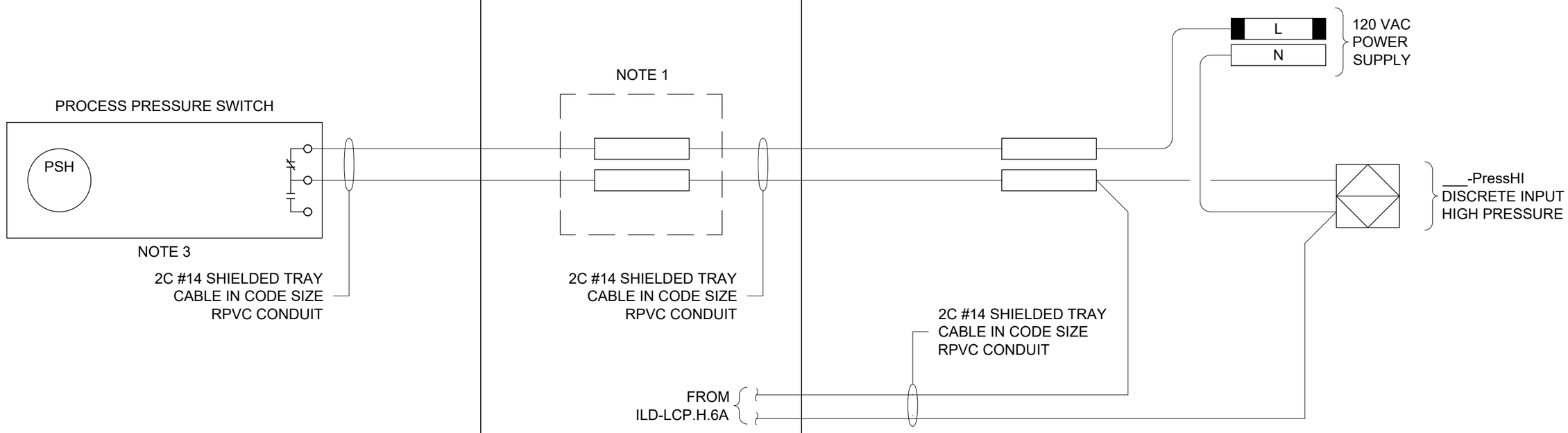
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LAST CONFORMED SET:

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FIELD PROCESS AREA	FIELD JUNCTION BOX	PLC CONTROL PANEL



NOTES:
1. PROVIDE FIELD JUNCTION BOXES AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.
3. USE FAIL-SAFE WIRING FOR PRESSURE SWITCH. CONTACTS SHALL BE CLOSED DURING NORMAL OPERATION AND OPEN TO INDICATE ALARM.

DRAWING No.

ILD-PSH.H.1CS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

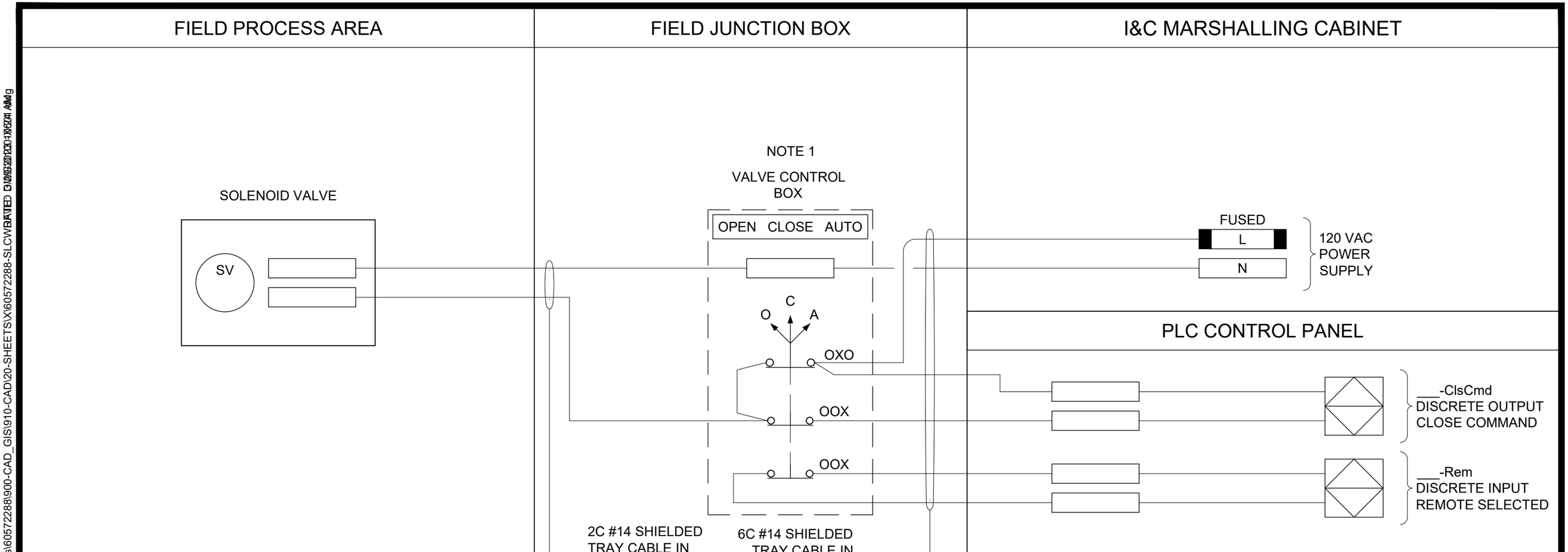
INSTRUMENT LOOP DIAGRAM
TYPICAL HIGH PRESSURE SWITCH

REVISIONS

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NOTES:
1. PROVIDE FIELD JUNCTION BOX AS SPECIFIED.
2. THIS DRAWING IS TYPICAL. UPDATE DEVICE TAGS, TERMINAL NUMBERS AND WIRE NUMBERS BASED ON LOOP NUMBERS.

DRAWING No.

ILD-SOL.H.1AS

SHEET _____ OF ----

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES
WATER RECLAMATION FACILITY

INSTRUMENT LOOP DIAGRAM
TYPICAL SOLENOID VALVE

REVISIONS

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SECTION 40 61 21

PROCESS CONTROL SYSTEM TESTING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide control system Factory Acceptance Testing (FAT) and Site Acceptance Testing as specified in this section and in compliance with the Contract Documents. The purpose of the site acceptance testing is to demonstrate the performance of the process control system by testing all components and functions of the system. The tests will be conducted in four phases:

1. Factor Acceptance Testing: This Section describes the Factory Acceptance Testing (FAT) required to demonstrate that the process control system hardware, and software are in conformance with specified requirements. The Contractor will submit a schedule of proposed FAT tests thirty (30) days after Contract award. FAT testing shall be performed on all vendor packaged control systems and the plant-wide distributed control system and SCADA equipment.

2. Component Testing: Demonstrate in manual mode that each connected component of the control system functions in accordance with specifications and manufacturer requirements. Demonstrate that field device inputs and outputs for the control system are functioning properly with correct polarity and scaling.

3. PLC Area Acceptance Testing: Demonstrate the key data acquisition, control strategies, interlocks, and alarm functions for each process area in manual, semi-automatic, and automatic control modes as applicable. Coordinate and cooperate with other divisions and simulate and/or force key process variables as required to facilitate testing activities.

4. Overall Integrated System Performance Testing: In cooperation with other contractors and divisions, participate in the Overall Integrated Performance Tests specified in the process and mechanical divisions.

1.02 REFERENCES:

A. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S5.4: Instrument Loop Diagrams

3. S7: Instrument Air

4. S12: Electrical Equipment for Hazardous Locations

5. S18.2: Alarm Management

6. S20: Instrument Specifications

7. S50: Electrical Control Signals

8. S75: Control Valve Design, Specification and Testing

9. S96: Valve Actuators

10. S99: Control System Cyber Security

11. 101: Human-Machine Interfaces

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. For Factory Acceptance Tests, include the following information in the submittal for this Section:

a. A detailed step-by-step test procedure for each test at least fifteen (15) business days in advance of each scheduled test date.

b. Confirm, in writing, times, dates and locations of Factory Acceptance Tests at least fifteen (15) business days before a test.

2. Process methodology statement stating how and what will be done by the Contractor during the acceptance testing, and what the impact on the NEW WRF will be. The methodology statement will be prepared by the Contractor with the Engineer providing reviews and input and must be approved before implementation.

3. Test schedule for each Component, Process Unit, and Process Area.

4. Process control system component test procedures.

5. Process Area control strategy test procedures.

6. Integrated System Performance Test procedures.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Within two (2) weeks following completion of any acceptance tests, submit acceptance test report to the Engineer.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.08 PROJECT/SITE CONDITIONS:

A. Coordinate all work of this Section with the Other Contractors responsible for the construction of the related work, with plant operations and the Engineer.

B. Schedule field testing which affects the NEW WRF operation or existing WRF operation through the Engineer daily.

C. Do not perform testing which may affect NEW WRF or existing WRF operation without the Engineer's approval.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Provide any additional software, tools, testing equipment, temporary configuration programs, cables, wiring, terminals and other accessories required to fully test and verify the proper connection and operation the process control system.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Meet the following conditions prior to the start of any acceptance testing.

1. Correct deficiencies noted during installation prior to commencement of testing.

2. Have on site, documentation pertinent to the equipment being tested. Provide a detailed description of the testing methodology to be used to ensure satisfactory performance of the process control system equipment.

3. Keep on site, labelled, and properly stored spare parts, expendables and test equipment pertinent to the equipment being tested.

4. Have the Engineer review acceptance test schedules and acceptance test procedures.

5. Perform the acceptance testing on a per Process Area basis. Test no more than one Process Area at any given time unless other arrangements are made with the Engineer.

6. Obtain approval from the Engineer prior to conducting any testing which may affect operations.

7. Schedule any testing which affects the system operation through the Engineer daily.

B. Provide all required plant startup and commissioning, performance testing, and reliability testing as specified in Sections 01 78 25, 01 78 26, and 01 78 27.

3.02 FACTORY ACCEPTANCE TESTING (FAT):

A. Provide all labor, materials, equipment and incidentals, specified and as may be required to perform the FAT. Conduct the FAT at the Contractor's facility at the completion of program development and before shipment, verify that the system components are functioning properly and that they meet the functional and performance requirements of the Contract Documents.

1. The process control system includes but is not necessarily limited to the PLC control panels, server computers, historian, operator workstations, application software, communication networks, and related appurtenances.

2. Submit information on FAT procedures to verify that testing shall fulfill the requirements of the Contract Documents. Submittal shall be made at least two weeks in advance of any scheduled testing and shall include dates of scheduled tests.

3. Notify the Engineer in writing at least fifteen (15) business days before expected initiation of each test. The SLCDPU and Engineer reserve the right to be present at the Contractor's facilities during operational test of system equipment, either for individual units or as an integrated system. Presence of the SLCDPU and/or Engineer during testing does not relieve the Contractor from conforming to the requirements of the Contract Documents and shall in no way imply acceptance of the equipment.

B. Hardware and Software Tests

1. Demonstrate that all system hardware has been tested and is capable of running diagnostic software without error.

2. All system components shall be tested to verify proper operation of the equipment as stand-alone units. Test shall include, but not be limited to, the following:

3. AC/DC power checks.

4. Power fail/restart tests.

5. Diagnostics checks.

6. Functional test of all PLC I/O from the field terminal blocks to the processor.

7. Functional test of Hot Standby PLC processor switchover.

8. Functional tests of all power supplies, circuit breakers, relays and associated panel components.

9. Functional demonstration of operator interface terminals and review of graphic screen layouts.

10. All system components shall be tested to verify that communication between units is working properly.

11. Demonstration of communication between PLCs and other devices connected on Ethernet networks shall be included in the Test Procedure.

12. The SLCDPU and Engineer reserve the right to be present during the tests. Log each test result and provide the Engineer with a deficiency list at the end of the testing period. Rectify any deficiencies within two weeks of completion of the FAT.

13. If a test or a portion of a test fails, it may be re-tested at the end of the FAT. Troubleshooting and repair shall not interfere with continuation of the FAT. If a test or portion of a test fails to the point where it needs to be rescheduled at a later date, tests shall be required at no additional expense of the client. Include expenses for the SLCDPU and/or Engineer, for travel, accommodations, and sustenance of the same quality used for the original test. Re-test expenses shall be for a maximum of three persons.

C. Test Duration

1. Provide FAT for Real Time Servers, Historian, Workstations, Engineering Stations, Hardware, Ethernet Communications, Software and Integrated System.

2. The FAT duration shall be proposed by the Contractor in his schedule, it is envisaged that no FAT shall take longer than five (5) business days.

D. Release of Process Control System for Shipment

1. The development of testing schedules shall be produced in conjunction with the Project Master Schedule. Prior to shipping provide the following:

a. Shipment method and the details of the insurance coverage.

b. Details of storage requirements.

c. Loading and unloading requirements.

d. Physical dimensions and weight.

e. A signed letter stating that all deficiencies noted during in-factory acceptance testing have been corrected and retested.

E. Testing Aids and Equipment

1. Provide the following documentation:

a. One copy of approved submittals applicable to the equipment to be tested.

b. One master copy of each FAT procedure.

c. A complete inventory of the equipment to be tested including make, model, and serial number.

2. Provide use of the following test equipment:

a. Off-line diagnostic and test programs.

b. Any other special test equipment that is required to demonstrate the proper operation of the system

F. Factory Test Schedule

1. General:

a. Testing will, in general, be limited to a maximum of ten (10) hours per day.

b. A meeting will be held each morning to review the day's test schedule.

c. A meeting will be held each evening to review the day's test results and to review or revise the next day's test schedule.

3.03 FIELD TESTING:

A. Organize acceptance testing sequentially by Process Area and in line with the master schedule. Include testing of all inputs/outputs (I/Os), PLC functions and communications for each Process Area.

B. Check each Process Area against drawings and database lists. Test each PLC and corresponding data communication links.

C. Check all I/O from the field components to the process control system. Include instruments, control devices, panels, termination cabinets, input/output cards, and other devices in the I/O to ensure proper operation. The applicable Other Contractor will be in attendance during I/O field checks.

D. Document the component testing and submit to the Engineer. Include the following:

1. I/O name

2. I/O description

3. Drawing reference

4. Type of test(s) performed

5. Date tested

6. Signature of tester and date

7. Signature of Engineer and date

E. Test the process control system equipment as follows:

1. Check equipment against inventory lists.

2. Certify that the equipment has been installed properly.

3. Power up the process control system equipment and run diagnostics to verify proper operation.

4. Load the application system software from backup media.

5. Verify peripheral operation and peripheral failure operation.

6. Check polling of remotes.

7. Verify that data is not lost on failover from the primary to the backup communication path.

8. Verify that operating data is not lost on failover from the primary to the standby processor.

9. Verify historical data is not lost if the system server is down for less than 72 hours.

10. Test input/output, display, control, and report generation software.

11. Test historical data collection capabilities.

12. Test trending functions.

13. Certify that the system is ready for performance testing.

14. Test operation of the Local Area Network associated with the process control system equipment.

15. Test all alarm functions and alarm history files.

16. Test system automatic backup and restore procedures.

F. Document the process control system area testing and submit to the Engineer. Include the following:

1. Description of functions tested

2. Tests performed

3. Copies of messages, displays, reports, and trends which verify operation

4. Signature of tester and date

5. Signature of the Engineer's and date

6. Problem description, if any

7. Performance Verification

8. Completed Form 102 for each component or subsystem

9. Completed Form 103 for each component or subsystem

G. After Process Area Testing and component testing have been completed, perform an Integrated System Performance Test to verify the system performance. Provide onsite personnel for the Integrated System Performance Test duration.

H. Participate in tests over a thirty (30) day period when the Influent Pump Station is operating. Any deficiencies will be promptly corrected, and the test restarted. If deficiencies remain uncorrected at the end of the test period, the test period will be

extended on a day-to-day basis at the Contractor's expense until proper operation can be demonstrated. Final Acceptance will only be achieved when the requirements of the Integrated System Performance Test has been successfully demonstrated to the Engineer's satisfaction.

3.04 DEMONSTRATION:

A. Use the communications statistics to verify and demonstrate that the average process control system equipment to PLC communications availability is greater than 99.99 percent. Failure of data communication equipment will not count as downtime.

B. Demonstrate an availability of 99.99 percent or better for the entire process control system. Availability is defined as:

1. Availability = (Test Duration - Downtime)/Test Duration.

C. The system is down if a PLC cannot be accessed from the operator station because of a hardware/software failure, an operational PLC is not polled, alarm and event reporting functions are lost, trend or historical data is lost, or operator commands cannot be carried out because of a hardware/software failure.

D. Failover to a backup device will not be counted as downtime provided the backup device assumed proper operation.

E. Make necessary operational adjustments to the system while the Influent Pump Station is operating.

F. Demonstrate the historical logging and reporting functions of the system.

G. Demonstrate system response times for operator displays and data update to or from other process areas and remote sites. Perform test reruns the Engineer may deem necessary.

3.05 PROTECTION:

A. Operate control system equipment only in areas where construction is sufficiently completed and with environmental controls in place and operational such that the manufacturer's environmental requirements are not compromised.

B. Provide dust and moisture protection for control system equipment overnight and when not in use to protect against unanticipated construction activities, painting, cleaning, etc.

C. Maintain daily backups of all program and configuration files for all control system components on removeable media. Backup files may be stored off-site or on-site provided that they are physically separated from the respective control system equipment.

3.06 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 61 93

PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST

PART 1 - GENERAL

1.01 DESCRIPTION:

A. The control system I/O indices included in this section have been provided for reference and includes all the control system input and output points shown on the P&ID diagrams and the mechanical system schematics. The control system I/O indices will be used by the control system programmers and integrators to develop the control system PLC application programs, server and historian computer configurations, and Human-Machine Interface graphics.

1.02 REFERENCES:

A. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S5.4: Instrument Loop Diagrams

3. S7: Instrument Air

4. S12: Electrical Equipment for Hazardous Locations

5. S18.2: Alarm Management

6. S20: Instrument Specifications

7. S50: Electrical Control Signals

8. S75: Control Valve Design, Specification and Testing

9. S96: Valve Actuators

10. S99: Control System Cyber Security

11. 101: Human-Machine Interfaces

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. The Input/Output indices provided in this section shall be updated by the Contractor based on the finalized Input/Output requirements for each packaged

system and piece of equipment obtained from the “No Exceptions Taken” or “Make Corrections Noted” shop drawings.

2. Submit finalized For Construction Input/Output indices for the process control system when all shop drawings have been reviewed.

3. Submit finalized Input/Output indices for the HVAC control system when all shop drawings have been reviewed.

4. Submit As-Constructed Input/Output indices for the entire control system for review when construction and commission is completed.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 GENERAL:

A. Update Input/output indices provided in this section based on the finalized Input/output requirements for each packaged system and piece of equipment obtained from the “No Exceptions Taken” or “Make Corrections Noted” shop drawings.

B. Use only updated and reviewed Input/output lists in the development of the control system PLC application programs, server and historian computer configurations, and Human-Machine Interface graphics.

C. Update the Input/output indices during construction and commissioning of the Influent Pump Station.

D. Submit the record information Input/Output indices for review by the Engineer and include copies in the project O&M manuals in both printed and soft copies on removable media.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	80001	PressLo	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	80003	Temp	0000-X650_01	BMS Network	IPS Electrical	AI	Modbus
1	81201	Temp	0000-X650_01	BMS Network	IPS Electrical	AI	Modbus
1	81210	Temp	0000-X650_01	BMS Network	IPS Electrical	AO	Modbus
1	81211	Flt	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81211	PressDiff	0000-X650_01	BMS Network	IPS Electrical	AI	Modbus
1	81320	Alarm	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81320	Clg	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81320	Htg	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81320	Run	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81320	SpdCmd	0000-X650_01	BMS Network	IPS Electrical	AO	Modbus
1	81321	Flt	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81321	PressDiff	0000-X650_01	BMS Network	IPS Electrical	AI	Modbus
1	81322	Flt	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81322	PressDiff	0000-X650_01	BMS Network	IPS Electrical	AI	Modbus
1	81430	S/SCmd	0000-X650_01	BMS Network	IPS Electrical	DO	Modbus
1	81440	Run	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81480	Temp	0000-X650_01	BMS Network	IPS Electrical	AO	Modbus
1	81490	S/SCmd	0000-X650_01	BMS Network	IPS Electrical	DO	Modbus
1	81491	Run	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81520	Pos	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81520	PosCmd	0000-X650_01	BMS Network	IPS Electrical	DO	Modbus
1	81530	Pos	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81530	PosCmd	0000-X650_01	BMS Network	IPS Electrical	DO	Modbus
1	81570	Pos	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81570	PosCmd	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	81590	Pos	0000-X650_01	BMS Network	IPS Electrical	AI	Modbus
1	81590	PosCmd	0000-X650_01	BMS Network	IPS Electrical	DI	Modbus
1	71101	Alarm	0000-X690_01	Fire Pump Panel	IPS Electrical	DI	Ethernet
1	71101	Sup	0000-X690_01	Fire Pump Panel	IPS Electrical	DI	Ethernet
1	71101	Tbl	0000-X690_01	Fire Pump Panel	IPS Electrical	DI	Ethernet
1	10101	Flow	0100-X601	Maintenance Hole 3A Flow Sensor	IPS Electrical	AI	
1	10101	Flt	0100-X601	Maintenance Hole 3A Flow Sensor	IPS Electrical	DI	
1	10101	Total	0100-X601	Maintenance Hole 3A Flow Sensor	IPS Electrical	DI	
1	10201	Flow	0100-X601	Existing Metering Maintenance Hole Sensor	IPS Electrical	AI	
1	10201	Flt	0100-X601	Existing Metering Maintenance Hole Sensor	IPS Electrical	DI	

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	10201	Total	0100-X601	Existing Metering Maintenance Hole Sensor	IPS Electrical	DI	
1	10301	Flow	0100-X601	Maintenance Hole 5B Flow Sensor	IPS Electrical	AI	
1	10301	Flt	0100-X601	Maintenance Hole 5B Flow Sensor	IPS Electrical	DI	
1	10301	Total	0100-X601	Maintenance Hole 5B Flow Sensor	IPS Electrical	DI	
1	11100	Rst	0100-X602	RWW Wetwell 1 Smart Relay	IPS Electrical	DO	
1	11100	HrtBt	0100-X602	RWW Wetwell 1 Smart Relay	IPS Electrical	DO	
1	11100	HrtBt	0100-X602	RWW Wetwell 1 Smart Relay	IPS Electrical	DI	
1	11100	Mode	0100-X602	RWW Wetwell 1 Smart Relay	IPS Electrical	DI	
1	11101	Cls	0100-X602	RWW 1 Motorized Gate	IPS Electrical	DI	
1	11101	Pos	0100-X602	RWW 1 Motorized Gate	IPS Electrical	AI	
1	11101	MtrFlt	0100-X602	RWW 1 Motorized Gate	IPS Electrical	DI	
1	11101	Opn	0100-X602	RWW 1 Motorized Gate	IPS Electrical	DI	
1	11101	PosCmd	0100-X602	RWW 1 Motorized Gate	IPS Electrical	AO	
1	11101	Rem	0100-X602	RWW 1 Motorized Gate	IPS Electrical	DI	
1	11101	NotRdy	0100-X602	RWW 1 Motorized Gate	IPS Electrical	DI	
1	11101	Trq	0100-X602	RWW 1 Motorized Gate	IPS Electrical	DI	
1	11102	Flt	0100-X602	RWW 1 Ultrasonic Level	IPS Electrical	DI	
1	11102	Lvl	0100-X602	RWW 1 Ultrasonic Level	IPS Electrical	AI	
1	11103	Flt	0100-X602	RWW 1 Radar Level	IPS Electrical	DI	
1	11103	Lvl	0100-X602	RWW 1 Radar Level	IPS Electrical	AI	
1	11104	LvlLoLo	0100-X602	RWW 1 Float Switch	IPS Electrical	DI	
1	11105	LvlHiHi	0100-X602	RWW 1 Float Switch	IPS Electrical	DI	
1	11106	LvlHi	0100-X602	RWW 1 Float Switch	IPS Electrical	DI	
1	11107	LvlHi	0100-X602	RWW 1 Float Switch	IPS Electrical	DI	
1	11108	LvlLo	0100-X602	RWW 1 Float Switch	IPS Electrical	DI	
1	11110	MtrBearTemp x2	0100-X602	RWW Pump 1	IPS Electrical	AI	Ethernet
1	11110	MtrBearVib x3	0100-X602	RWW Pump 1	IPS Electrical	AI	Ethernet
1	11110	O/L	0100-X602	RWW Pump 1	IPS Electrical	DI	Ethernet
1	11110	Rem	0100-X602	RWW Pump 1	IPS Electrical	DI	Ethernet
1	11110	Run	0100-X602	RWW Pump 1	IPS Electrical	DI	Ethernet
1	11110	S/SCmd	0100-X602	RWW Pump 1	IPS Electrical	DO	Ethernet
1	11110	ShaftSpd	0100-X602	RWW Pump 1	IPS Electrical	AI	Ethernet
1	11110	Spd	0100-X602	RWW Pump 1	IPS Electrical	AI	Ethernet
1	11110	SpdCmd	0100-X602	RWW Pump 1	IPS Electrical	AO	Ethernet
1	11110	WindTemp x6	0100-X602	RWW Pump 1	IPS Electrical	AI	Ethernet
1	11112	Cls	0100-X602	RWW Pump 1 Discharge Flow Valve	IPS Electrical	DI	

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	11112	ClsCmd	0100-X602	RWW Pump 1 Discharge Flow Valve	IPS Electrical	DO	
1	11112	Opn	0100-X602	RWW Pump 1 Discharge Flow Valve	IPS Electrical	DI	
1	11112	Rem	0100-X602	RWW Pump 1 Discharge Flow Valve	IPS Electrical	DI	
1	11113	Press	0100-X602	RWW Pump 1 Discharge Pressure	IPS Electrical	AI	
1	11114	PressHi	0100-X602	RWW Pump 1 Discharge Pressure Switch	IPS Electrical	DI	
1	11130	MtrBearTemp x2	0100-X602	RWW Pump 3	IPS Electrical	AI	Ethernet
1	11130	MtrBearVib x3	0100-X602	RWW Pump 3	IPS Electrical	AI	Ethernet
1	11130	O/L	0100-X602	RWW Pump 3	IPS Electrical	DI	Ethernet
1	11130	Rem	0100-X602	RWW Pump 3	IPS Electrical	DI	Ethernet
1	11130	Run	0100-X602	RWW Pump 3	IPS Electrical	DI	Ethernet
1	11130	S/SCmd	0100-X602	RWW Pump 3	IPS Electrical	DO	Ethernet
1	11130	ShaftSpd	0100-X602	RWW Pump 3	IPS Electrical	AI	Ethernet
1	11130	Spd	0100-X602	RWW Pump 3	IPS Electrical	AI	Ethernet
1	11130	SpdCmd	0100-X602	RWW Pump 3	IPS Electrical	AO	Ethernet
1	11130	WindTemp x6	0100-X602	RWW Pump 3	IPS Electrical	AI	Ethernet
1	11132	Cls	0100-X602	RWW Pump 3 Discharge Flow Valve	IPS Electrical	DI	
1	11132	ClsCmd	0100-X602	RWW Pump 3 Discharge Flow Valve	IPS Electrical	DO	
1	11132	Opn	0100-X602	RWW Pump 3 Discharge Flow Valve	IPS Electrical	DI	
1	11132	Rem	0100-X602	RWW Pump 3 Discharge Flow Valve	IPS Electrical	DI	
1	11133	Press	0100-X602	RWW Pump 3 Discharge Pressure	IPS Electrical	AI	
1	11134	PressHi	0100-X602	RWW Pump 3 Discharge Pressure Switch	IPS Electrical	DI	
1	11150	MtrBearTemp x2	0100-X602	RWW Pump 5	IPS Electrical	AI	Ethernet
1	11150	MtrBearVib x3	0100-X602	RWW Pump 5	IPS Electrical	AI	Ethernet
1	11150	O/L	0100-X602	RWW Pump 5	IPS Electrical	DI	Ethernet
1	11150	Rem	0100-X602	RWW Pump 5	IPS Electrical	DI	Ethernet
1	11150	Run	0100-X602	RWW Pump 5	IPS Electrical	DI	Ethernet
1	11150	S/SCmd	0100-X602	RWW Pump 5	IPS Electrical	DO	Ethernet
1	11150	ShaftSpd	0100-X602	RWW Pump 5	IPS Electrical	AI	Ethernet
1	11150	Spd	0100-X602	RWW Pump 5	IPS Electrical	AI	Ethernet
1	11150	SpdCmd	0100-X602	RWW Pump 5	IPS Electrical	AO	Ethernet
1	11150	WindTemp x6	0100-X602	RWW Pump 5	IPS Electrical	AI	Ethernet
1	11152	Cls	0100-X602	RWW Pump 5 Discharge Flow Valve	IPS Electrical	DI	
1	11152	ClsCmd	0100-X602	RWW Pump 5 Discharge Flow Valve	IPS Electrical	DO	
1	11152	Opn	0100-X602	RWW Pump 5 Discharge Flow Valve	IPS Electrical	DI	
1	11152	Rem	0100-X602	RWW Pump 5 Discharge Flow Valve	IPS Electrical	DI	
1	11153	Press	0100-X602	RWW Pump 5 Discharge Pressure	IPS Electrical	AI	

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	11154	PressHi	0100-X602	RWW Pump 5 Discharge Pressure Switch	IPS Electrical	DI	
1	11311	ClsCmd	0100-X602	RWW Pump 1 Seal Water Solenoid	IPS Electrical	DO	
1	11311	Rem	0100-X602	RWW Pump 1 Seal Water Solenoid	IPS Electrical	DI	
1	11312	FlowLo	0100-X602	RWW Pump 1 Seal Water Flow	IPS Electrical	DI	
1	11331	ClsCmd	0100-X602	RWW Pump 3 Seal Water Solenoid	IPS Electrical	DO	
1	11331	Rem	0100-X602	RWW Pump 3 Seal Water Solenoid	IPS Electrical	DI	
1	11332	FlowLo	0100-X602	RWW Pump 3 Seal Water Flow	IPS Electrical	DI	
1	11351	ClsCmd	0100-X602	RWW Pump 5 Seal Water Solenoid	IPS Electrical	DO	
1	11351	Rem	0100-X602	RWW Pump 5 Seal Water Solenoid	IPS Electrical	DI	
1	11352	FlowLo	0100-X602	RWW Pump 5 Seal Water Flow	IPS Electrical	DI	
1	80001	Alarm	0100-X602	IPS H2S Gas Alarm	IPS Electrical	DI	
1	80001	AnH2S	0100-X602	IPS H2S Gas Sensor	IPS Electrical	AI	
1	80001	AnH2S	0100-X602	IPS H2S Gas Sensor	IPS Electrical	AI	
1	80001	Flt	0100-X602	IPS H2S Gas Fault	IPS Electrical	DI	
1	80001	Warn	0100-X602	IPS H2S Gas Warning	IPS Electrical	DI	
1	1111A	Cls	0100-X602	RWW Pump 1 Check Valve Closed Limit Switch	IPS Electrical	DI	
1	1111A	Opn	0100-X602	RWW Pump 1 Check Valve Open Limit Switch	IPS Electrical	DI	
1	1113A	Cls	0100-X602	RWW Pump 3 Check Valve Closed Limit Switch	IPS Electrical	DI	
1	1113A	Opn	0100-X602	RWW Pump 3 Check Valve Open Limit Switch	IPS Electrical	DI	
1	1115A	Cls	0100-X602	RWW Pump 5 Check Valve Open Limit Switch	IPS Electrical	DI	
1	1115A	Opn	0100-X602	RWW Pump 5 Check Valve Closed Limit Switch	IPS Electrical	DI	
1	11200	Rst	0100-X603	RWW Wetwell 2 Smart Relay	IPS Electrical	DO	
1	11200	HrtBt	0100-X603	RWW Wetwell 2 Smart Relay	IPS Electrical	DO	
1	11200	HrtBt	0100-X603	RWW Wetwell 2 Smart Relay	IPS Electrical	DI	
1	11200	Mode	0100-X603	RWW Wetwell 2 Smart Relay	IPS Electrical	DI	
1	11201	Cls	0100-X603	RWW 2 Motorized Gate	IPS Electrical	DI	
1	11201	Pos	0100-X603	RWW 2 Motorized Gate	IPS Electrical	AI	
1	11201	MtrFlt	0100-X603	RWW 2 Motorized Gate	IPS Electrical	DI	
1	11201	Opn	0100-X603	RWW 2 Motorized Gate	IPS Electrical	DI	
1	11201	PosCmd	0100-X603	RWW 2 Motorized Gate	IPS Electrical	AO	
1	11201	Rem	0100-X603	RWW 2 Motorized Gate	IPS Electrical	DI	
1	11201	NotRdy	0100-X603	RWW 2 Motorized Gate	IPS Electrical	DI	
1	11201	Trq	0100-X603	RWW 2 Motorized Gate	IPS Electrical	DI	
1	11202	Flt	0100-X603	RWW 2 Ultrasonic Level	IPS Electrical	DI	
1	11202	Lvl	0100-X603	RWW 2 Ultrasonic Level	IPS Electrical	AI	
1	11203	Flt	0100-X603	RWW 2 Radar Level	IPS Electrical	DI	

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	11203	Lvl	0100-X603	RWW 2 Radar Level	IPS Electrical	AI	
1	11204	LvlLoLo	0100-X603	RWW 2 Float Switch	IPS Electrical	DI	
1	11206	LvlHi	0100-X603	RWW 2 Float Switch	IPS Electrical	DI	
1	11207	LvlHi	0100-X603	RWW 2 Float Switch	IPS Electrical	DI	
1	11208	LvlLo	0100-X603	RWW 2 Float Switch	IPS Electrical	DI	
1	11220	MtrBearTemp x2	0100-X603	RWW Pump 2	IPS Electrical	AI	Ethernet
1	11220	MtrBearVib x3	0100-X603	RWW Pump 2	IPS Electrical	AI	Ethernet
1	11220	O/L	0100-X603	RWW Pump 2	IPS Electrical	DI	Ethernet
1	11220	Rem	0100-X603	RWW Pump 2	IPS Electrical	DI	Ethernet
1	11220	Run	0100-X603	RWW Pump 2	IPS Electrical	DI	Ethernet
1	11220	S/SCmd	0100-X603	RWW Pump 2	IPS Electrical	DO	Ethernet
1	11220	ShaftSpd	0100-X603	RWW Pump 2	IPS Electrical	AI	Ethernet
1	11220	Spd	0100-X603	RWW Pump 2	IPS Electrical	AI	Ethernet
1	11220	SpdCmd	0100-X603	RWW Pump 2	IPS Electrical	AO	Ethernet
1	11220	WindTemp x6	0100-X603	RWW Pump 2	IPS Electrical	AI	Ethernet
1	11222	Cls	0100-X603	RWW Pump 2 Discharge Flow Valve	IPS Electrical	DI	
1	11222	ClsCmd	0100-X603	RWW Pump 2 Discharge Flow Valve	IPS Electrical	DO	
1	11222	Opn	0100-X603	RWW Pump 2 Discharge Flow Valve	IPS Electrical	DI	
1	11222	Rem	0100-X603	RWW Pump 2 Discharge Flow Valve	IPS Electrical	DI	
1	11223	Press	0100-X603	RWW Pump 2 Discharge Pressure	IPS Electrical	AI	
1	11224	PressHi	0100-X603	RWW Pump 2 Discharge Pressure Switch	IPS Electrical	DI	
1	11240	MtrBearTemp x2	0100-X603	RWW Pump 4	IPS Electrical	AI	Ethernet
1	11240	MtrBearVib x3	0100-X603	RWW Pump 4	IPS Electrical	AI	Ethernet
1	11240	O/L	0100-X603	RWW Pump 4	IPS Electrical	DI	Ethernet
1	11240	Rem	0100-X603	RWW Pump 4	IPS Electrical	DI	Ethernet
1	11240	Run	0100-X603	RWW Pump 4	IPS Electrical	DI	Ethernet
1	11240	S/SCmd	0100-X603	RWW Pump 4	IPS Electrical	DO	Ethernet
1	11240	ShaftSpd	0100-X603	RWW Pump 4	IPS Electrical	AI	Ethernet
1	11240	Spd	0100-X603	RWW Pump 4	IPS Electrical	AI	Ethernet
1	11240	SpdCmd	0100-X603	RWW Pump 4	IPS Electrical	AO	Ethernet
1	11240	WindTemp x6	0100-X603	RWW Pump 4	IPS Electrical	AI	Ethernet
1	11242	Cls	0100-X603	RWW Pump 4 Discharge Flow Valve	IPS Electrical	DI	
1	11242	ClsCmd	0100-X603	RWW Pump 4 Discharge Flow Valve	IPS Electrical	DO	
1	11242	Opn	0100-X603	RWW Pump 4 Discharge Flow Valve	IPS Electrical	DI	
1	11242	Rem	0100-X603	RWW Pump 4 Discharge Flow Valve	IPS Electrical	DI	
1	11243	Press	0100-X603	RWW Pump 4 Discharge Pressure	IPS Electrical	AI	

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	11244	PressHi	0100-X603	RWW Pump 4 Discharge Pressure Switch	IPS Electrical	DI	
1	11321	ClsCmd	0100-X603	RWW Pump 2 Seal Water Solenoid	IPS Electrical	DO	
1	11321	Rem	0100-X603	RWW Pump 2 Seal Water Solenoid	IPS Electrical	DI	
1	11322	FlowLo	0100-X603	RWW Pump 2 Seal Water Flow	IPS Electrical	DI	
1	11341	ClsCmd	0100-X603	RWW Pump 4 Seal Water Solenoid	IPS Electrical	DO	
1	11341	Rem	0100-X603	RWW Pump 4 Seal Water Solenoid	IPS Electrical	DI	
1	11342	FlowLo	0100-X603	RWW Pump 4 Seal Water Flow	IPS Electrical	DI	
1	1122A	Cls	0100-X603	RWW Pump 2 Check Valve Open Limit Switch	IPS Electrical	DI	
1	1122A	Opn	0100-X603	RWW Pump 2 Check Valve Closed Limit Switch	IPS Electrical	DI	
1	1124A	Cls	0100-X603	RWW Pump 4 Check Valve Open Limit Switch	IPS Electrical	DI	
1	1124A	Opn	0100-X603	RWW Pump 4 Check Valve Closed Limit Switch	IPS Electrical	DI	
1	11411	Flow	0100-X604	RWW 1 Flowmeter	IPS Electrical	AI	
1	11411	Total	0100-X604	RWW 1 Flowmeter	IPS Electrical	DI	
1	11412	Cls	0100-X604	RWW Header 1 Valve	IPS Electrical	DI	
1	11412	ClsCmd	0100-X604	RWW Header 1 Valve	IPS Electrical	DO	
1	11412	Opn	0100-X604	RWW Header 1 Valve	IPS Electrical	DI	
1	11412	Rem	0100-X604	RWW Header 1 Valve	IPS Electrical	DI	
1	11413	Cls	0100-X604	RWW 1 Header Drain Valve	IPS Electrical	DI	
1	11413	Opn	0100-X604	RWW 1 Header Drain Valve	IPS Electrical	DI	
1	11413	OpnCmd	0100-X604	RWW 1 Header Drain Valve	IPS Electrical	DO	
1	11413	Rem	0100-X604	RWW 1 Header Drain Valve	IPS Electrical	DI	
1	11421	Flow	0100-X604	RWW 2 Flowmeter	IPS Electrical	AI	
1	11421	Total	0100-X604	RWW 2 Flowmeter	IPS Electrical	DI	
1	11422	Cls	0100-X604	RWW Header 2 Valve	IPS Electrical	DI	
1	11422	ClsCmd	0100-X604	RWW Header 2 Valve	IPS Electrical	DO	
1	11422	Opn	0100-X604	RWW Header 2 Valve	IPS Electrical	DI	
1	11422	Rem	0100-X604	RWW Header 2 Valve	IPS Electrical	DI	
1	11423	Cls	0100-X604	RWW 2 Header Drain Valve	IPS Electrical	DI	
1	11423	Opn	0100-X604	RWW 2 Header Drain Valve	IPS Electrical	DI	
1	11423	OpnCmd	0100-X604	RWW 2 Header Drain Valve	IPS Electrical	DO	
1	11423	Rem	0100-X604	RWW 2 Header Drain Valve	IPS Electrical	DI	
1	11431	Cls	0100-X604	RWW Bypass Valve	IPS Electrical	DI	
1	11431	Opn	0100-X604	RWW Bypass Valve	IPS Electrical	DI	
1	11431	OpnCmd	0100-X604	RWW Bypass Valve	IPS Electrical	DO	
1	11431	Rem	0100-X604	RWW Bypass Valve	IPS Electrical	DI	
1	40006	Press	0100-X605	Odor control influent air pressure transmitter	IPS Electrical	AI	

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	40101	Cls	0100-X605	Odor control influent air motorized damper	IPS Electrical	DI	
1	40101	ClsCmd	0100-X605	Odor control influent air motorized damper	IPS Electrical	DO	
1	40101	Flt	0100-X605	Odor control influent air motorized damper	IPS Electrical	DI	
1	40101	Opn	0100-X605	Odor control influent air motorized damper	IPS Electrical	DI	
1	40101	OpnCmd	0100-X605	Odor control influent air motorized damper	IPS Electrical	DO	
1	40101	Rem	0100-X605	Odor control influent air motorized damper	IPS Electrical	DI	
1	40102	Flt	0100-X605	Odor control influent damper pressure transmitter	IPS Electrical	DI	
1	40102	PressDiff	0100-X605	Odor control influent damper pressure transmitter	IPS Electrical	AI	
1	40103	Temp	0100-X605	Odor Control System Panel	IPS Electrical	AI	
1	40104	Flt	0100-X605	Odor Control System Panel	IPS Electrical	DI	
1	40104	PressDiff	0100-X605	Odor Control System Panel	IPS Electrical	AI	
1	40105	LvlLo	0100-X605	Odor Control System Panel	IPS Electrical	DI	
1	40106	LvlHi	0100-X605	Odor Control System Panel	IPS Electrical	DI	
1	40107	LvlHiHi	0100-X605	Odor Control System Panel	IPS Electrical	DI	
1	40108	ClsCmd	0100-X605	Odor Control System Panel	IPS Electrical	DO	
1	40108	OpnCmd	0100-X605	Odor Control System Panel	IPS Electrical	DO	
1	40108	Rem	0100-X605	Odor Control System Panel	IPS Electrical	DI	
1	40110	O/L	0100-X605	Odor Control System Panel	IPS Electrical	DI	
1	40110	Rem	0100-X605	Odor Control System Panel	IPS Electrical	DI	
1	40110	Run	0100-X605	Odor Control System Panel	IPS Electrical	DI	
1	40110	S/SCmd	0100-X605	Odor Control System Panel	IPS Electrical	DO	
1	40120	HiLmt	0100-X605	W2 Water Heater	Dewatering HVAC	DI	
1	40120	OnCmd	0100-X605	W2 Water Heater	Dewatering HVAC	DO	
1	40131	Press	0100-X605	Odor Control System Panel	IPS Electrical	AI	
1	40132	Flow	0100-X605	Odor Control System Panel	IPS Electrical	AI	
1	40132	Total	0100-X605	Odor Control System Panel	IPS Electrical	DI	
1	40141	Temp	0100-X606	Odor Control System Panel	IPS Electrical	AI	
1	40142	Flt	0100-X606	Odor Control System Panel	IPS Electrical	DI	
1	40142	PressDiff	0100-X606	Odor Control System Panel	IPS Electrical	AI	
1	40143	FlowLo	0100-X606	Odor Control System Panel	IPS Electrical	DI	
1	40144	ClsCmd	0100-X606	Odor Control System Panel	IPS Electrical	DO	
1	40144	OpnCmd	0100-X606	Odor Control System Panel	IPS Electrical	DO	
1	40144	Rem	0100-X606	Odor Control System Panel	IPS Electrical	DI	
1	40150	Flt	0100-X607	FOA Fan	IPS Electrical	DI	
1	40150	MtrBearTempHi	0100-X607	FOA Fan	IPS Electrical	DI	
1	40150	MtrBearVib	0100-X607	FOA Fan	IPS Electrical	DI	

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	40150	MtrWindTempHi	0100-X607	FOA Fan	IPS Electrical	DI	
1	40150	Rem	0100-X607	FOA Fan	IPS Electrical	DI	
1	40150	Run	0100-X607	FOA Fan	IPS Electrical	DI	
1	40150	S/S	0100-X607	FOA Fan	IPS Electrical	DO	
1	40150	Spd	0100-X607	FOA Fan	IPS Electrical	AI	
1	40150	SpdCmd	0100-X607	FOA Fan	IPS Electrical	AO	
1	40152	Press	0100-X607	FOA Fan Suction Pressure Transmitter	IPS Electrical	AI	
1	40153	Cls	0100-X607	FOA Fan Discharge Motorized Damper	IPS Electrical	DI	
1	40153	ClsCmd	0100-X607	FOA Fan Discharge Motorized Damper	IPS Electrical	DO	
1	40153	Flt	0100-X607	FOA Fan Discharge Motorized Damper	IPS Electrical	DI	
1	40153	Opn	0100-X607	FOA Fan Discharge Motorized Damper	IPS Electrical	DI	
1	40153	OpnCmd	0100-X607	FOA Fan Discharge Motorized Damper	IPS Electrical	DO	
1	40153	Rem	0100-X607	FOA Fan Discharge Motorized Damper	IPS Electrical	DI	
1	71010	Flow	0100-X631	Break Tank W1 Flowmeter	IPS Electrical	AI	
1	71010	O/L	0100-X631	W2 Pump 1	Dewatering HVAC	DI	
1	71010	Rem	0100-X631	W2 Pump 1	Dewatering HVAC	DI	
1	71010	Run	0100-X631	W2 Pump 1	Dewatering HVAC	DI	
1	71010	S/SCmd	0100-X631	W2 Pump 1	Dewatering HVAC	DO	
1	71010	Total	0100-X631	Break Tank W1 Flowmeter	IPS Electrical	DI	
1	71020	O/L	0100-X631	W2 Pump 2	Dewatering HVAC	DI	
1	71020	Rem	0100-X631	W2 Pump 2	Dewatering HVAC	DI	
1	71020	Run	0100-X631	W2 Pump 2	Dewatering HVAC	DI	
1	71020	S/SCmd	0100-X631	W2 Pump 2	Dewatering HVAC	DO	
1	71020	Flow	0100-X632	W3CW Distribution Flowmeter 1	IPS Electrical	AI	
1	71020	Total	0100-X632	W3CW Distribution Flowmeter 1	IPS Electrical	DI	
1	71030	Flow	0100-X632	W3CW Distribution Flowmeter 2	IPS Electrical	AI	
1	71030	Total	0100-X632	W3CW Distribution Flowmeter 2	IPS Electrical	DI	
1	71040	Flow	0100-X632	W1 Distribution Flowmeter	IPS Electrical	AI	
1	71040	Total	0100-X632	W1 Distribution Flowmeter	IPS Electrical	DI	
1	80001	Flt	0100-X651	Room Pressure	IPS Electrical	DI	
1	80001	PressDiff	0100-X651	Room Pressure	IPS Electrical	AI	BacNet
1	80003	Temp	0100-X651	Electrical Room Supply Air Temperature	IPS Electrical	AI	BacNet
1	81410	Flt	0100-X651	Pump Room Supply Fan	IPS Electrical	DI	
1	81410	Rem	0100-X651	Pump Room Supply Fan	IPS Electrical	DI	Ethernet
1	81410	Run	0100-X651	Pump Room Supply Fan	IPS Electrical	DI	Ethernet
1	81410	S/SCmd	0100-X651	Pump Room Supply Fan	IPS Electrical	DO	Ethernet

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	81410	Spd	0100-X651	Pump Room Supply Fan	IPS Electrical	AI	Ethernet
1	81410	SpdCmd	0100-X651	Pump Room Supply Fan	IPS Electrical	AO	Ethernet
1	81411	Flt	0100-X651	Pump Room Supply Fan Filter	IPS Electrical	DI	
1	81411	PressDiff	0100-X651	Pump Room Supply Fan Filter	IPS Electrical	AI	
1	81420	Flt	0100-X651	Pump Room Exhaust Fan	IPS Electrical	DI	
1	81420	Rem	0100-X651	Pump Room Exhaust Fan	IPS Electrical	DI	Ethernet
1	81420	Run	0100-X651	Pump Room Exhaust Fan	IPS Electrical	DI	Ethernet
1	81420	S/SCmd	0100-X651	Pump Room Exhaust Fan	IPS Electrical	DO	Ethernet
1	81420	Spd	0100-X651	Pump Room Exhaust Fan	IPS Electrical	AI	Ethernet
1	81420	SpdCmd	0100-X651	Pump Room Exhaust Fan	IPS Electrical	AO	Ethernet
1	81550	Cls	0100-X651	ERV 1 Suction Motorized Damper	IPS Electrical	DI	BacNet
1	81550	OpnCmd	0100-X651	ERV 1 Suction Motorized Damper	IPS Electrical	DO	BacNet
1	81560	Cls	0100-X651	ERV 1 Suction Motorized Damper	IPS Electrical	DI	BacNet
1	81560	OpnCmd	0100-X651	ERV 1 Suction Motorized Damper	IPS Electrical	DO	BacNet
1	11001	5%	0100-X652	Gas Detection	IPS Electrical	DI	
1	11001	10%	0100-X652	Gas Detection	IPS Electrical	DI	
1	11001	AnLEL	0100-X652	Gas Detection	IPS Electrical	AI	
1	11001	Flt	0100-X652	Gas Detection	IPS Electrical	DI	
1	80003	Temp	0100-X652	Electrical Room Supply Air Temperature	IPS Electrical	AI	BacNet
1	81201	Temp	0100-X652	ERV 1 Discharge Temperature Sensor	IPS Electrical	AI	BacNet
1	81210	Temp	0100-X652	Gas Burner Section	IPS Electrical	AO	
1	81211	Flt	0100-X652	AHU-81210 Filter Pressure Sensor	IPS Electrical	DI	BacNet
1	81211	PressDiff	0100-X652	AHU-81210 Filter Pressure Sensor	IPS Electrical	AI	BacNet
1	81430	S/SCmd	0100-X652	MAU 1 Supply Fan	Dewatering HVAC	DO	BacNet
1	81440	Run	0100-X652	MAU 1 Supply Fan	Dewatering HVAC	DI	BacNet
1	81570	Pos	0100-X652	Isolation Damper	IPS Electrical	AI	BacNet
1	81570	PosCmd	0100-X652	Isolation Damper	IPS Electrical	AI	BacNet
1	80001	Temp	0100-X653	Outdoor Air Temperature	IPS Electrical	AI	BacNet
1	80002	Temp	0100-X653	Electrical Room Supply Air Temperature	IPS Electrical	AI	BacNet
1	81310	Alarm	0100-X653	Compressor	IPS Electrical	DI	
1	81310	Clg	0100-X653	Compressor	IPS Electrical	DI	
1	81310	Htg	0100-X653	Compressor	IPS Electrical	DI	
1	81310	Run	0100-X653	Compressor	IPS Electrical	DI	
1	81310	SpdCtl	0100-X653	Compressor	IPS Electrical	AO	
1	81311	Flt	0100-X653	AHU 1 Summer Filter	IPS Electrical	DI	BacNet
1	81311	PressDiff	0100-X653	AHU 1 Summer Filter	IPS Electrical	AI	BacNet

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	81312	Flt	0100-X653	AHU 1 Winter Filter	IPS Electrical	DI	BacNet
1	81312	PressDiff	0100-X653	AHU 1 Winter Filter	IPS Electrical	AI	BacNet
1	81450	Temp	0100-X653	SCR	IPS Electrical	AO	
1	81460	S/SCmd	0100-X653	MAU 1 Supply Fan	IPS Electrical	DO	BacNet
1	81470	Run	0100-X653	MAU 1 Supply Fan	Dewatering HVAC	DI	BacNet
1	81510	Pos	0100-X653	Electrical Room Supply Isolation Damper	IPS Electrical	DI	BacNet
1	81510	PosCmd	0100-X653	Electrical Room Supply Isolation Damper	IPS Electrical	DO	BacNet
1	81540	Pos	0100-X653	Electrical Room Relief Air Isolation Damper	IPS Electrical	DI	BacNet
1	81540	PosCmd	0100-X653	Electrical Room Relief Air Isolation Damper	IPS Electrical	DO	BacNet
1	81580	Pos	0100-X653	Return Air Modulating Damper	IPS Electrical	AI	
1	81580	PosCmd	0100-X653	Return Air Modulating Damper	IPS Electrical	AO	
1	80003	Temp	0100-X654	Electrical Room Supply Air Temperature	IPS Electrical	AI	BacNet
1	81320	Alarm	0100-X654	Compressor	IPS Electrical	DI	
1	81320	Clg	0100-X654	Compressor	IPS Electrical	DI	
1	81320	Htg	0100-X654	Compressor	IPS Electrical	DI	
1	81320	Run	0100-X654	Compressor	IPS Electrical	DI	
1	81320	SpdCmd	0100-X654	SCR	IPS Electrical	AO	
1	81321	Flt	0100-X654	AHU 1 Summer Filter	IPS Electrical	DI	BacNet
1	81321	PressDiff	0100-X654	AHU 1 Summer Filter	IPS Electrical	AI	BacNet
1	81322	Flt	0100-X654	AHU 1 Winter Filter	IPS Electrical	DI	BacNet
1	81322	PressDiff	0100-X654	AHU 1 Winter Filter	IPS Electrical	AI	BacNet
1	81480	Temp	0100-X654	Compressor	IPS Electrical	AO	
1	81490	S/SCmd	0100-X654	MAU 1 Supply Fan	IPS Electrical	DO	BacNet
1	81491	Run	0100-X654	MAU 1 Supply Fan	Dewatering HVAC	DI	BacNet
1	81520	Pos	0100-X654	Electrical Room Relief Air Isolation Damper	IPS Electrical	DI	BacNet
1	81520	PosCmd	0100-X654	Electrical Room Relief Air Isolation Damper	IPS Electrical	DO	BacNet
1	81530	Pos	0100-X654	Electrical Room Supply Isolation Damper	IPS Electrical	DI	BacNet
1	81530	PosCmd	0100-X654	Electrical Room Supply Isolation Damper	IPS Electrical	DO	BacNet
1	81590	Pos	0100-X654	Return Air Modulating Damper	IPS Electrical	AI	
1	81590	PosCmd	0100-X654	Return Air Modulating Damper	IPS Electrical	AO	
1	81115	O/L	0100-X655	FSC Skid 1	IPS Electrical	DI	
1	81115	Rem	0100-X655	FSC Skid 1	IPS Electrical	DI	
1	81115	Run	0100-X655	FSC Skid 1	IPS Electrical	DI	
1	81115	S/SCmd	0100-X655	FSC Skid 1	IPS Electrical	DO	
1	81117	PressHi	0100-X655	FSC Skid 1	IPS Electrical	DI	
1	81118	FlowHi	0100-X655	FSC Skid 1	IPS Electrical	DI	

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	81125	O/L	0100-X655	FSC Skid 2	IPS Electrical	DI	
1	81125	Rem	0100-X655	FSC Skid 2	IPS Electrical	DI	
1	81125	Run	0100-X655	FSC Skid 2	IPS Electrical	DI	
1	81125	S/SCmd	0100-X655	FSC Skid 2	IPS Electrical	DO	
1	81127	PressHi	0100-X655	FSC Skid 2	IPS Electrical	DI	
1	81128	FlowHi	0100-X655	FSC Skid 2	IPS Electrical	DI	
1	90000	Alarm	0100-X655	Fuel System Master Controller	IPS Electrical	DI	Ethernet
1	90000	Alarm	0100-X655	Fuel System Master Controller	IPS Electrical	DI	Ethernet
1	90000	FAL	0100-X655	Fuel System Master Controller	IPS Electrical	DI	Ethernet
1	90000	LvlLo	0100-X655	Fuel System Master Controller	IPS Electrical	DI	Ethernet
1	90000	LvlLo	0100-X655	Fuel System Master Controller	IPS Electrical	DI	Ethernet
1	90000	LvlLo	0100-X655	Fuel System Master Controller	IPS Electrical	DI	Ethernet
1	90000	LvlLo	0100-X655	Fuel System Master Controller	IPS Electrical	DI	Ethernet
1	90000	PressHi	0100-X655	Fuel System Master Controller	IPS Electrical	DI	Ethernet
1	90000	VacHi	0100-X655	Fuel System Master Controller	IPS Electrical	DI	Ethernet
1	81130	O/L	0100-X656	FTS Skid	IPS Electrical	DI	
1	81130	Rem	0100-X656	FTS Skid	IPS Electrical	DI	
1	81130	Run	0100-X656	FTS Skid	IPS Electrical	DI	
1	81130	S/SCmd	0100-X656	FTS Skid	IPS Electrical	DO	
1	81132	PressHi	0100-X656	FTS Skid	IPS Electrical	DI	
1	81140	O/L	0100-X656	FTS Skid	IPS Electrical	DI	
1	81140	Rem	0100-X656	FTS Skid	IPS Electrical	DI	
1	81140	Run	0100-X656	FTS Skid	IPS Electrical	DI	
1	81140	S/SCmd	0100-X656	FTS Skid	IPS Electrical	DO	
1	81142	PressHi	0100-X656	FTS Skid	IPS Electrical	DI	
1	81150	FlowHi	0100-X656	FTS Skid	IPS Electrical	DI	
1	99124	PressHi	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DI	
1	99125	PressHi	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DI	
1	99210	O/L	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DI	
1	99210	Rem	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DI	
1	99210	Run	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DI	
1	99210	S/SCmd	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DO	
1	99211	O/L	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DI	
1	99211	Rem	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DI	
1	99211	Run	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DI	
1	99211	S/SCmd	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DO	

Area	Loop Number	Function	Drawing Number	Associated Equipment	PLC Panel	Signal Type	Communication
1	99216	FlowHi	0100-X657	Return Fuel Pump Skid 1	IPS Electrical	DI	
1	99220	O/L	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DI	
1	99220	Rem	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DI	
1	99220	Run	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DI	
1	99220	S/SCmd	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DO	
1	99221	O/L	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DI	
1	99221	Rem	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DI	
1	99221	Run	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DI	
1	99221	S/SCmd	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DO	
1	99224	PressHi	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DI	
1	99225	PressHi	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DI	
1	99226	FlowHi	0100-X657	Return Fuel Pump Skid 2	IPS Electrical	DI	
1	99230	O/L	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DI	
1	99230	Rem	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DI	
1	99230	Run	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DI	
1	99230	S/SCmd	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DO	
1	99231	O/L	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DI	
1	99231	Rem	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DI	
1	99231	Run	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DI	
1	99231	S/SCmd	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DO	
1	99234	PressHi	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DI	
1	99235	PressHi	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DI	
1	99236	FlowHi	0100-X658	Return Fuel Pump Skid 3	IPS Electrical	DI	

SECTION 40 61 96

PROCESS CONTROL DESCRIPTIONS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide control system programming and configuration services to achieve the operational functionality generally as described in the control descriptions provided in this section and in compliance with Contract Documents.

1. This Section outlines the proposed operation and control strategies for the Influent Pump Station (IPS).

2. It should be noted that these control descriptions are provided as a guide to the intent of the main control strategies for the Influent Pump Station and do not purport to describe every detail and nuance of the completed programs. The control system integrator and Contractor must study contract documents and take into consideration the Salt Lake City standard practices for PLC program design, graphics objects characteristics, screen layouts, and operator interface features.

3. All aspects of the new control sequences, operator interface, and remote monitoring must be thoroughly tested in cooperation with the City and the Engineer to demonstrate correct functioning of all control system features and to verify that all interlocks and alarms are functioning properly.

1.02 REFERENCES:

A. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S5.4: Instrument Loop Diagrams

3. S7: Instrument Air

4. S12: Electrical Equipment for Hazardous Locations

5. S18.2: Alarm Management

6. S20: Instrument Specifications

7. S50: Electrical Control Signals

8. S75: Control Valve Design, Specification and Testing

9. S96: Valve Actuators

10. S99: Control System Cyber Security

11. 101: Human-Machine Interfaces

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

PART 2 - PRODUCTS

2.01 GENERAL:

A. All package equipment status points will be monitored by the SCADA, recorded by the historian, and available to be trended. Important operating measurements will be visible directly on the process's HMI screen. All package equipment available control inputs will be integrated with the SCADA.

B. All equipment will be able to be run manually by the operators from the SCADA. All equipment not in automatic mode from a physical Hand/Off/Auto switch will raise the alarm "Not in Auto".

C. All pumps will have a fail to start alarm if the run feedback does not show the pump is running after 30 seconds from being called to start.

D. All wet wells with level monitoring will have a high level alarm, a high high level alarm, a low level alarm, and a low low level alarm.

E. All equipment will raise alarms when a fault is generated, or abnormal operating conditions are detected. See equipment specifications and manufacturer's ratings for operating condition limits.

F. Operators shall be able to toggle the preferred operating control mode in SCADA. Selections include:

1. Averaging of analog sensors,

2. Automatically select lowest reading analog sensor,

3. Automatically select highest reading analog sensor, or

4. Control via floats only.

2.02 INFLUENT PUMP STATION (IPS) SEE P&ID DRAWINGS (0100-X602, 603, 604)

A. General:

1. The influent pumping station (IPS), comprised of two wet wells with a total of five raw wastewater (RWW) pumps, is designed for a maximum peak hour flow (PHF) of 105 millions of gallons per day (MGD) at Phase 1. This control narrative is valid up to and including Phase 1 flows only.

2. Three pumps are located in Wet Well 1 and two pumps are located in Wet Well 2 with space for a future sixth pump. The pumps discharge to a common header for each wet well. The two discharge headers exit the pump station building and are cross connected on a valve pad to deliver flow through two 48" force mains (FM) to the Headworks. A stub out is provided for a future third FM. Valves on the pad allow flow to be controlled from Wet Well 1,2, or both through either or both force mains.

3. A self-cleaning maintenance cycle will occur at a frequency set by the operator or by manual initiation during low flow conditions. A self-cleaning cycle will pump one wet well to a level low enough such that the Cleanout Pump (01-P-11110, 01-P-11120) will pump floatable and spherical solids up to 6 inches in diameter to the Headworks. Initially, one wet well will be cleaned at a time due to limited fluid volumes. The influent gate (01-FCV 11101, 01-FCV 11201) shall be closed so that all flow is directed to the wet well being cleaned.

4. Once per annum, or as necessary, the inside of each of the wet wells will be washed down manually using a supplied water cannon.

5. A FM scour maintenance cycle will occur at a frequency set by the operator or by manual initiation. A FM scour cycle will use the duty pumps to increase flow into the active FMs such that the velocity shall exceed 6 feet per second (fps). The FM scour cycle should only be performed during peak flows to maintain fluid levels and minimize air entrainment. Initially, only one FM should be scoured at a time, until there is substantial and sufficient flow to achieve the desired velocities in both FMs.

6. In the event of PLC failure, the pumps are capable of running in staged fashion independently.

7. The PLC shall send a heartbeat signal to the smart relay. If the heartbeat fails, or the relay receives a level transmitter failure signal from the PLC, the relay switches the pumps over to local float control and shall send a "float mode" status signal to

the PLC. To switch back to PLC operation, the operator must press a reset signal on the HMI.

B. Equipment Control Description

1. Variable Frequency Drives, Level Sensors, and Electrically Actuated Valves

a. All instruments and P&ID loops that provide pump monitoring and control shall include:

(1) Operator adjustable set points.

(2) Low, Low Low, High, and High High level alarms.

(3) PID pop up displays for control of the PID loop.

(4) Valve position indication for all valves in the pump station building and exterior valves. All valves will default to normally open and normally closed as shown on P&IDs.

b. The SCADA screen displays the actual status (% speed, etc.) when the controller is in AUTOMATIC mode and displays manual position when in MANUAL mode.

2. Raw Influent Feed:

a. The influent sewers that combine in this area, do so at the IPS Junction Wye. The symmetry of the wye will allow the flow to split evenly to each of the two wet wells or be conveyed to just one of the wet wells if the influent slide gate (01-FCV 11101, 01-FCV 11201) on the other is closed.

b. Electric motor-actuated slide gates (01-FCV 11101, 01-FCV 11201) allow each wet well to be isolated and taken out of service.

c. Stop logs (01-SL-11100, 01-SL-11200) allow the influent slide gates to be taken out of service.

d. Totalized influent flow measurement is obtained by summing three influent flow meters (01-FT-10101, 01-FT-10201, 01-FT-10301)

3. IPS Pumps Normal Operation:

a. Wet Well 1 includes three raw wastewater (RWW) pumps and Wet Well 2 includes two RWW pumps for a total of four duty pumps and one standby pump. Each pump is rated for a pumping capacity of 26.25 MGD. The four duty pumps provide a firm capacity of 105 MGD.

(1) Space in the IPS is allotted for the installation of one additional pump in Wet Well 2 for a buildout configuration of five duty pumps and one standby pump with a firm capacity of 131.25 MGD.

b. Two analog level instruments and five float level sensors in each wet well provide fluid level indication to the plant SCADA.

c. SCADA will compare the signals and choose the higher value of the two for each wet well as the operational signal for fluid level control in that wetwell.

d. When a pump is called to run, it shall operate for a minimum of 15 minutes in order to ensure the pumps do not violate their manufacturer-recommended maximum number of starts per hour.

e. The lead pump shall operate continuously to maintain the Level Setpoint and shall not shut down unless the wet well is taken offline or the pump position is changed.

(1) The lead pump speed shall vary between 68% and 100% to maintain the Level Setpoint.

(2) Additional pumps (lag) shall come online to maintain the Level Setpoint according to Table 3.

f. Pumps are controlled by the Level Setpoint as indicated by the level sensors in each wet well.

(1) Operator shall input the user-adjustable desired operating Level Setpoint that applies to each of Wet Well 1 and Wet Well 2. The recommended Level Setpoint is 14’8” above the Lower Level as shown on the plans, or at an elevation of 4191.7’.

(2) Beginning with one pump in operation, the pump speed will increase or decrease to maintain the liquid level in the wet well at the Level Setpoint.

(3) When all pumps in operation are running at 100 percent speed and the wet well level has been above the Level Setpoint by 6 inches for the length of time indicated by the user adjustable Time Delay setting, an additional pump is turned on. All pumps in operation will run at the

same speed. The Time Delay setting will be adjustable from 0-300 seconds, with a default setting of 90 seconds.

(4) The pumps will not drop below 68 percent speed, unless a manual override by an Operator is performed. If the pumps are running at 68 percent speed and the level has been below the Level Setpoint by 6 inches for the length of time indicated by the Time Delay setting, the most recent pump to turn on will be turned off. The Time Delay setting will be adjustable from 0-300 seconds, with a default setting of 90 seconds.

(5) SCADA shall compare the readings of the ultrasonic and radar level sensors for each well (LIT-11102 and LIT-11103 in Wetwell 1, and LIT-11202 and LIT-11203 in Wetwell 2). A discrepancy of more than 20% between the two values for more than 15s, will trigger a LEVEL SENSOR MISMATCH alarm for the associated wetwell. The alarm shall clear once the discrepancy is less than 10% for 60s.

g. The pump in duty position 1 will always be turned on first, followed by position 2, and so forth. If a pump is set to OFF when the control indicates that it needs to be turned on, it is skipped and the next pump in the sequence is turned on instead. After a cleaning cycle in either wetwell, the duty position number for each pump is reduced by one. An example is shown in Table 1 and 2 below.

Table 1

Pump	Initial Position	Position After Wet Well 1 Cleaning
RWW Pump 1 (Wetwell 1 Cleanout Pump)	1	3
RWW Pump 3	2	1
RWW Pump 5	3	2

For Buildout Conditions when the future sixth pump is added to the IPS, the pump will be controlled in a similar fashion. An example of how the rotation of pump position might look after buildout for Wet Well 2 is shown in Table 2 below.

Table 2

Pump	Initial Position	Position After Wet Well 2 Cleaning
RWW Pump 2 (Wetwell 2 Cleanout Pump)	1	6
RWW Pump 4	2	2
RWW Pump 6 (Future)	3	4

h. Table 3 below provides a recommended alarm level and associated actions for the wet wells in normal operation. When the IPS is in a maintenance cycle, these set points do not apply. The Operator shall adjust these initial normal operation setpoints based upon operating experience. The Operator shall input the user-adjustable Low Level Alarm, Low Low Level Alarm, High Level Alarm, and High High Level Alarm for the system in SCADA. The levels will apply to both wet wells if they are both in operation. All alarms clear and control is returned to normal operation when the level reaches the Level Setpoint. Care should be taken to select a High High Level Alarm that prevents the influent sewer from surcharging and causing trapped foul air to be released from the upstream maintenance hole.

Table 3

Setting Name	Action Taken	Alarm Clearing Condition	Default depth (ft) above the "10 LOWER LEVEL" as shown on contract drawings	Elevation (ft)
Low Low Level Alarm	On falling level, alarm appears on SCADA and all pumps but the lead pump turns off and speed is reduced to 68%	Alarm clears when the fluid level rises above the Low Level Alarm setpoint for 30 seconds.	14.2	4191.0
Low Level Alarm	Alarm appears on SCADA and lead pump returns to 100% speed	Alarm clears when the fluid level reaches the Level Setpoint.	14.5	4191.5
High Level Alarm	Alarm appears on SCADA and one additional pump turns on at 100%. If a cleaning cycle is running, it is terminated.	Alarm clears when the fluid level descends below the Level Setpoint.	17.2	4194.0
High High Level Alarm	Alarm appears on SCADA and all additional pumps turn on and are set to 100% speed.	Alarm clears when the fluid level descends below the High Level setpoint.	20.2	4197

i. Operators will be able to advance the duty position of all pumps via SCADA. The action will advance all pumps simultaneously. Individually advancing or setting the position of a single pump is not permitted.

j. Each wet well can be selected as IN-SERVICE or OUT-OF-SERVICE through the plant SCADA.

(1) When a wet well is selected as OUT-OF-SERVICE:

(a) The associated slide gate is closed (01-FCV 11101, 01-FCV 11201).

(b) The associated level sensor alarms are disabled.

(c) The other pumps inside the wet well are OFF and locked out.

(d) The cleanout pump is turned on and run at default 68% speed until the associated header flow meter (01-FI-11411, 01-FI-11421) reads zero. The cleanout pump is then OFF and locked out.

(e) An alarm is displayed on SCADA and HMI: "WARNING: WETWELL STILL CONTAINS HAZARDOUS GASES WITH EXPLOSION POTENTIAL, PLEASE CLEAR GASES FROM WETWELL PRIOR TO SERVICE ACCORDING TO THE O&M MANUAL."

(2) When a wet well is returned to IN-SERVICE:

(a) The associated slide gate is opened (01-FCV 11101, 01-FCV 11201).

(b) The associated level sensor alarms are enabled.

(c) The pumps inside the wet well are set to AUTO.

k. Each pump can be selected to AUTO, MANUAL, or OFF mode through the plant SCADA.

(1) When a pump is in AUTO mode, the pump is controlled as described in Section 2.22.B.3 IPS Pumps Normal Operation.

(2) When a pump is in MANUAL mode, the pump is controlled with a '%' speed input in the plant SCADA, minimum value of 68%, maximum of 100%.

(3) When the pump is placed in OFF or is otherwise out of service, SCADA will not include this pump and associated control devices (isolation valves, etc.) as part of the normal operation control loop.

l. Local Pump Control

(1) Each pump can be selected as LOCAL using the pump local control panel. The pump will be considered OFF and will not respond to SCADA inputs and control until the local control panel returns the pump to AUTO control.

(2) Each pump includes an E-Stop on the local control panel.

m. Each pump isolation valve (01-FV-11112, 01-FV-11132, 01-FV-11152, 01-FV-11222, 01-FV-11242) is normally open and cannot be closed unless the associated pump is set to OFF. The status of a pump cannot be changed from OFF if the associated pump control valve is closed.

n. Force Main to Wet Well 1 Isolation Valve (01-FV 11412) is normally open and cannot be closed unless Wet Well 1 is OUT-OF SERVICE or the Cross Connect Valve (01-FV 11431) is open. Wet Well 1 status cannot be changed to IN-SERVICE unless the Force Main 1 Isolation Valve (01-FV 11412) or the Cross Connect Valve (01-FV 11431) is open and Operator clears Warning to verify the wet well is not occupied.

o. Force Main to Wet Well 2 Isolation Valve (01-FV 11422) is normally open and cannot be closed unless Wet Well 2 is OUT-OF SERVICE or the Cross Connect Valve (01-FV 11431) is open. Wet Well 2 status cannot be changed to IN-SERVICE unless the Force Main 2 Isolation Valve (01-FV 11422) or the Cross Connect Valve (01-FV 11431) is open and Operator clears Warning to verify the wet well is not occupied.

p. RWW Pump 1, 3, and 5 cannot be turned on if Force Main to Wet Well 1 Isolation Valve (01-FV 11412) is closed, unless the Cross Connect Valve (01-FV 11431) and isolation valve (01-FV 11422) are open.

q. RWW Pump 2 and 4, and future 6, cannot be turned on if Force Main to Wet Well 2 Isolation Valve (01-FV 11422) is closed, unless the Cross Connect Valve (01-FV 11431) and isolation valve (01-FV 11412) are open.

4. IPS Wet Well Cleaning Cycle

a. Only one wet well shall be cleaned at a time. During a cleaning cycle the status of the wet well being cleaned shows as CLEANING and displays TIMER.

b. A cleaning cycle can be initiated automatically as programmed, or manually for each wet well by an Operator.

c. During the wet well cleaning cycle, certain normal operation setpoints and alarms are suspended or modified. Once the cycle is complete, normal operational setpoints and alarms are restored.

d. A cleaning cycle cannot be initiated if any of the following conditions exist:

(1) The wet well is set to OUT-OF-SERVICE (OOS),

(2) the Cleanout pump (01-P-11110, 01-P-11120) is set to OFF or OOS, or,

(3) the flow meter (01-FI-11411, 01-FI-11421) associated with the wet well reads a flow greater than 23 MGD.

e. A cleaning cycle should be initiated when the flow in the wet well to be cleaned is approximately 12 MGD.

f. If the flow is greater than 12 MGD but less than 23 MGD when a cleaning cycle begins, the pump speed will be set to 100% until the low low level alarm is triggered.

g. When the flow reaches 12 MGD, the wet well level sensor alarms are disabled for that wet well and the Cleanout pump mode is changed to Fixed, operating at 68% speed, pumping to an operational FM.

h. Cleanout flow is pumped to the Headworks via the operating FMs.

i. The cleaning cycle ends when the wet well flow meter reads 0 MGD flow.

j. If the total cleaning cycle time exceeds a user-adjustable maximum cleaning cycle time, the cleaning cycle ends and a CLEANING CYCLE TIME alarm is triggered. The default time setting is 15 minutes. The cleaning cycle time is operator adjustable; however, care should be taken to minimize the time the pump runs without fluid.

k. When the cleaning cycle ends, the IPS returns to operation as described in Section 2.02B.3 IPS Pumps Normal Operation. Level control alarm is restored in the wet well.

5. IPS Force Main Cleaning Cycle

a. Only one FM shall be cleaned at a time until daily flows are above 80 MGD. During a cleaning cycle the status of the FM being cleaned shows as CLEANING and displays TIMER.

(1) The TIMER shall be operator adjustable. The default value is 1800 seconds and begins once the flow meters (01-FI-11411, 01-FI-11421) read a combined flow equivalent to 6 feet per second velocity in the

FM. Once the TIMER expires, the IPS shall be returned to normal operation.

b. A cleaning cycle can be initiated automatically as programmed (monthly), or manually for each wet well by an Operator through SCADA.

c. A cleaning cycle cannot be initiated if a any of the following conditions exist:

(1) The wet well is set to OUT-OF-SERVICE (OOS),

(2) The Cleanout pump (01-P-11110, 01-P-11120) is set to OFF or OOS,

(3) The flow meters (01-FI-11411, 01-FI-11421) read a combined flow less than 40 MGD under normal operating conditions,

(4) The low level alarm is active, or

(5) The low low level alarm is active.

d. For low flow conditions, one FM should be OUT-OF-SERVICE (OOS), during cleaning to achieve the desired velocities.

e. If the low low level alarm is activated, the FM cleaning cycle is aborted and the IPS is returned to normal operating conditions.

f. A FM scour cycle will use the duty pumps to increase flow into the active FMs such that the velocity shall exceed 6 feet per second (fps) as measured by the discharge flow meter (01-FI-11411, 01-FI-11421).

C. Emergency Start-Up Operations

1. Start-Up Following Emergency or Unscheduled Shutdown

a. In case of a power outage, backup power will be supplied to the pumps by the onsite standby generators, and the IPS will continue operating with the programmed sequence prior to the outage.

b. Initially, the pumps in position 1 and 2 in the wet wells will be restarted first at 100% speed. Additional pumps will be brought online every 35 seconds sequentially to restore the operational sequence prior to power loss as needed by the Level Setpoint.

c. The pumps are equipped with non-reverse ratchet setups so that the pumps can be started up immediately, instead of waiting for a complete pump spin down.

D. Loss of PLC

1. This operational sequence applies only to pumps and wet wells that are in service.

2. Priority of control sources shall be that ethernet control will be considered default operation. Local inputs to the VFD will be the secondary control source.

3. While in AUTO, the backup controller shall exchange a heartbeat signal between the PLCs and the backup controller. The heartbeat exchange shall repeat every ten seconds.

    a. If the PLC fails to receive two consecutive heartbeat signals from the backup controller, it will generate a fault and display an alarm on the HMI.

    b. If the backup controller fails to receive two consecutive heartbeat signals, it will activate the backup control mode.

4. If, while in AUTO, the VFD for a pump loses connectivity from the PLC, all VFDs in the associated well shall automatically default to their secondary control source.

5. While in backup control mode, the backup controller shall send a IN BACKUP MODE signal to the PLC. An IN BACKUP CONTROL MODE warning shall appear on the HMI.

6. If while operating on the backup control source, communications is restored, the VFD will not resume accepting commands from the PLC until a reset button is pressed on the HMI. Only then will the pumps resume PLC-controlled operation and ignore commands from the backup control source.

7. The secondary control source consists of:

    a. Start signals from the associated wet well level floats. The VFD shall receive these signals via discrete inputs directly onboard the VFD.

    b. Pre-programmed speed settings and step-based logic within the VFD.

8. As the level in the wet well rises, each pump will be called to run as its start setpoint is crossed for greater than 60 seconds. Pumps will start and then increase speeds in a stepped fashion as shown in Tables 4 and 5 below.

    a. For example, as water rises past LSH-1106, Pump 1 remains running at 100%, Pump 3 increases its speed from 68% to 100%, and Pump 5 starts and runs at 68%. Conversely, on falling water level, Pump 5 will stop, Pump 3 will slow down to 68%, and Pump 1 will remain running at 100%.

9. A setpoint that triggers a speed change must maintain that state for ten minutes prior to the pump changing its speed.

10. When the water level drops below the low level setpoint, LSL-11108 and LSL-11208 shall act as a low level cutout and shut down any running pumps except Pumps 1 and 2. Pumps 1 and 2 shall have a minimum speed as listed below and will not shut off during backup control mode.

11. Any pump that is called to start must run for a minimum of 15 minutes to avoid violating the maximum of 4 starts per hour required by the pumps.

12. During PLC Communication Failure – Wet Well 1 Setpoints and Behavior are as follows in the table below:

Table 4

Level Switch	Pump 1	Pump 3	Pump 5
Level below LSLL-11104	MINIMUM, ON: ~40%	OFF	OFF
Level at/above LSLL-11104	ON: 68%	OFF	OFF
Level at/above LSL-11108	ON: 100%	OFF	OFF
Level at/above LSH-11107	ON: 100%	ON: 68%	OFF
Level at/above LSH-11106	ON: 100%	ON: 100%	ON: 68%
Level at/above LSHH-11105	ON: 100%	ON: 100%	ON: 100%

13. During PLC Communication Failure – Wet Well 2 Setpoints and Behavior are as follows in Table 5 below:

Table 5

Level Switch	Pump 2	Pump 4	Pump 6
Level below LSLL-11204	MINIMUM, ON: ~40%	OFF	OFF
Level at/above LSLL-11204	ON: 68%	OFF	OFF

Table 5			
Level Switch	**Pump 2**	**Pump 4**	**Pump 6**
Level at/above LSL-11208	ON: 100%	OFF	OFF
Level at/above LSH-11207	ON: 100%	ON: 68%	OFF
Level at/above LSH-11206	ON: 100%	ON: 100%	ON: 68%
Level at/above LSHH-11205	ON: 100%	ON: 100%	ON: 100%

14. General VFD Control Source Matrix

    a. Each VFD shall have three control sources, each defined by a start source and a speed source.

Table 6		
Control Source	**Start Source**	**Speed Source**
1	Ethernet	Ethernet
2	Float	Preset onboard frequencies
3	VFD Faceplate	VFD Faceplate

15. Control Source Matrix

Pump	Start Source 1	Speed Source 1	Start Source 2	Speed Source 2	Start Source 3	Speed Source 3
Pump 1	Ethernet	Ethernet	LSLL-11104	68	LSL-11108	100
Pump 3	Ethernet	Ethernet	LSH-11107	68	LSH-11106	100
Pump 5	Ethernet	Ethernet	LSH-11106	68	LSHH-11105	100
Pump 2	Ethernet	Ethernet	LSLL-11204	68	LSL-11208	100

Pump	Start Source 1	Speed Source 1	Start Source 2	Speed Source 2	Start Source 3	Speed Source 3
Pump 4	Ethernet	Ethernet	LSH-11207	68	LSH-11206	100
Pump 6 (future)	Ethernet	Ethernet	LSH-11206	68	LSHH-11205	100

E. SCADA System:

1. SCADA Screens:

a. The following input, display, and trending parameters are provided on each Influent Pump Station's SCADA screen:

Input, Display, Trending Parameters		
Equipment or Instrument	**Interaction (1)**	**Parameter**
Influent Pump Station		
Wet Well 1 Flow	D, T	Flow (MGD)
Wet Well 2 Flow	D, T	Flow (MGD)
Wet Well 1 Level	D, T	Level (ft)
Wet Well 2 Level	D, T	Level (ft)
Level Setpoint	I	LEVEL SETPOINT [ft]
Wet Well 1 High Alarm	I	HIGH ALARM [ft]
Wet Well 1 Low Alarm	I	LOW ALARM [ft]
Wet Well 1 High High Alarm	I	HIGH HIGH ALARM [ft]
Wet Well 1 Low Low Alarm	I	LOW LOW ALARM [ft]
Wet Well 2 High Alarm	I	HIGH ALARM [ft]
Wet Well 2 Low Alarm	I	LOW ALARM [ft]

Input, Display, Trending Parameters		
Equipment or Instrument	**Interaction [1]**	**Parameter**
Wet Well 2 High High Alarm	I	HIGH HIGH ALARM [ft]
Wet Well 2 Low Low Alarm	I	LOW LOW ALARM [ft]
Time Delay	I	Time Delay Input (sec, 0-300)
Wet Well 1 Status	I	IN-SERVICE/OUT-OF-SERVICE/CLEANING STATUS
Wet Well 2 Status	I	IN-SERVICE/OUT-OF-SERVICE/CLEANING STATUS
RWW Pump 1-2 Status	I, D	AUTO/CLEANING/MANUAL/LOCAL/OFF STATUS
RWW Pump 3-6 Status	I, D	AUTO/MANUAL/LOCAL/OFF STATUS
RWW Pump 1-6 Health Status	D	Winding and Bearing Temperature (˚F) and Vibration (Hz)
RWW Pump 1-6 Speed	I, D	VFD SPEED (%)
RWW Pump 1-6 Seal Water Flow	D, T	Flow (gpm)
RWW Pump 1-6 Discharge Pressure	D, T	Pressure (psi)
RWW Pump 1-6 Control Valve	I, D	OPEN/CLOSED STATUS
Force Main 1-2 Control Valve	I, D	OPEN/CLOSED STATUS
Cross Connect Valve	I, D	OPEN/CLOSED STATUS
[1] Legend: I = Operator Input; D = Display of actual or calculated value; T = Trend		

2. Interlocks:

a. PCS Interlocks

(1) RWW pumps are interlocked with respective discharge pressure transmitters (01-PIT-11153, 01-PIT-11133, 01-PIT-11113, 01-PIT-11243, 01-PIT-11223). At high pressure setpoint (default is 60 psi), RWW pumps' speed shall ramp down to 68%.

b. Hardwired Interlocks:

(1) Pumps are disabled by high motor vibration or high bearing temperature reading provided with each pump.

(2) Pumps are disabled by low/no seal water intake flow.

(3) Pumps are disabled by high discharge pressure switch reading of greater than 65 psi.

(4) Respective pump is disabled by closed discharge valve (01-FV-11112, 01-FV-11132, 01-FV-11152, 01-FV-11222, 01-FV-11242).

(5) Pumps are disabled by two closed FM isolation valves (01-FV-11412, 01-FV-11422).

(6) The slide gates are disabled by limit switches provided with each gate.

(7) The pumps are interlocked with relay logic to the valve positions on the discharge header (01-FV-11412, 01-FV-11422, 01-FV-11431). The pumps will not run unless the valves are configured such that there is a valid pumping path.

(8) All Pumps are disabled by low level floats (01-LSL-11108, 01-LSL-11208), except during a wet well cleaning cycle where Pumps 1 and 2 will remain operational (01-P-11110, 01-P-11220).

PART 3 - EXECUTION

3.01 FIELD TESTING:

A. Comply with the requirements specified in Section 40 61 21.

3.02 DEMONSTRATION:

A. Comply with the requirements specified in Section 40 61 21.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 62 00

COMPUTER SYSTEM HARDWARE AND ANCILLARIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide Computer System Hardware and Ancillaries as specified in this section and in compliance with the Contract Documents.

1.02 DEFINITIONS:

A. HDMI: High-Definition Multimedia Interface – an audio/video display interface used to connect a video source to a display device.

B. DP: DisplayPort – an audio/video display interface used to connect a video source to a display device.

C. OSI: Owner's System Integrator.

D. USB: Universal Serial Bus.

E. VESA: Flat Display Mounting Interface also known as VESA Mounting Interface Standard is a family of standards by the Video Electronics Standards Association.

F. CPU: Central Processing Unit

G. CAL: Client Access License

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.08 PROJECT/SITE CONDITIONS:

A. Coordinate all work of this Section with the Other Contractors responsible for the construction of the related work, with plant operations and the Contract Administrator.

1.09 WARRANTY:

A. Provide a three (3) year warranty on all computers and monitors.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Provide any software, tools, cables, wiring, terminals and other accessories required to provide a complete and operable computer system.

2.02 SERVER COMPUTERS:

A. No servers will be required for the Influent Pump Station.

2.03 OPERATOR WORKSTATION COMPUTERS:

A. Provide operator workstations to allow operators to perform their daily tasks. Provide the following workstations:

Tag	Description	Location	Notes
01-WS-90451	SCADA Workstation	0101 IPS	Single 27” Monitor
01-WS-90452	Business Workstation	0101 IPS	Single 27” Monitor
01-WS-90453	SCADA Workstation	0104 IPS Electrical Building	Single 27” Monitor
01-WS-90454	Business Workstation	0104 IPS Electrical Building	Single 27” Monitor

B. Workstations shall consist of a mini-computer, 27 inch monitor, wireless keyboard and wireless mouse. The mini-computer mounts to the VESA mounting holes on the back of the monitor. Provide a 3-foot DisplayPort cable for connection between the computer and the monitor.

C. The computer shall have the following minimum specifications:

1. Windows 10 Pro Operating System
2. 9th Generation Intel Core i7 Processor
3. 16 GB memory; 512 GB SSD storage
4. Intel UHD Graphics 630
5. Integrated Intel Gigabit Ethernet Network Interface
6. Intel Wi-Fi 6 AX200 (2x2)
7. Bluetooth M.2
8. 2 DisplayPort 1.2 video ports
9. 2 SuperSpeed USB 10 Gbps; 2 SuperSpeed USB 5Gbps
10. Audio jacks with headset and headphone front ports (3.5 mm)
11. Mini form factor
12. VESA mounting bracket

D. The computer shall be the HP EliteDesk 800 G5.

E. Prior to installation, deliver the computer to SLCDPU for initial OS configuration.

F. Provide a 27 inch monitor with the following minimum specifications:

1. 27 inch Full High Definition (FHD, 1920 x 1080) LED monitor
2. VESA mounting (100 mm x 100 mm)
3. Built-in Speaker System
4. HDMI, DisplayPort and VGA video inputs
5. Provide the Asus VS278Q-P

G. Provide a wireless keyboard and mouse combination for each workstation with the following minimum specifications:

1. Comfortable full-size keyboard and easy-to-carry sculpted mouse with snap-on wireless transceiver (2.4 GHz).
2. Long-life battery system

3. Provide the Logitech MK320

PART 3 - EXECUTION

3.01 PREPARATION:

A. The following tasks will be executed by the OSI:

1. Following delivery of the computer equipment to the SLC IMS department by the Contractor, the OSI will coordinate the installation of the operating system with the SLC IMS department. The OSI will take possession of the equipment and install the necessary software and program files.

2. Upon completion of computer equipment setup, the OSI will deliver the computer equipment back to the Contractor to be installed in racks and enclosures in preparation for factory acceptance testing (FAT) at the Contractor's panel shop. All FAT activities shall be with the actual computer hardware to be utilized for the project.

3. The OSI, with guidance from the SLC IMS department, will setup the computer domains, network configurations, firewall rules, virus protection, and software configurations.

B. Coordinate the installation of the workstations and industrial PCs with other trades. Only install these systems after construction of the facility has been completed so as to minimize dust and construction debris getting into the equipment housings.

C. Coordinate the installation of the computer operating system with SLCDPU. Computers shall be delivered to SLCDPU for initial configuration prior to installation on site.

3.02 INSTALLATION:

A. Install the workstations and industrial PCs according to the manufacturer's recommendations and as shown on the Contract Drawings. Final locations for workstations on desks shall be coordinated with the Owner.

B. Test each workstation for proper functionality. Work with the OSI to verify connectivity to the plant SCADA system or facility business network.

C. Ensure that all appropriate cables, mounts, fasteners, etc. are properly installed and rated for the area in which it is being located.

D. Calibrate industrial touch screen monitors for accurate mouse movement by touch.

3.03 PROGRAMMING:

A. Once each computer has been physically installed after a successful FAT, final setup and configuration shall be implemented and tested by the OSI.

B. Each computer shall be connected to its appropriate network and network configuration loaded and tested.

C. The OSI shall verify that the operating system is functioning properly, verify that the computer name and domain is correct, verify that the firewall rules are correct and functional and verify that virus software is operating normally.

D. The OSI shall verify that the historian servers are setup properly for redundancy and failover and that databases are setup appropriately. Verify that the databases are properly being backed up to the NAS device.

E. The OSI shall setup and verify the SCADA servers are operating properly and redundancy/failover is functioning. Setup and verify all communications drivers, OPC servers and connections to client computers.

3.04 TESTING:

A. Initial computer testing and demonstration shall occur at the FAT at the panel shop. The OSI shall demonstrate that each computer has its operating system installed and operating properly, that the network is setup correctly, software has been installed, configured and is functioning properly.

B. Final testing and demonstration shall be repeated after the equipment has been installed on site.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 40 66 00

NETWORK AND COMMUNICATION EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide network and communication equipment as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society for Testing and Materials (ASTM)

B. Institute of Electrical and Electronic Engineers (IEEE)

C. International Standards Organization/International Electrotechnical Commission (ISO/IEC):

1. 11801: Information Technology – Generic cabling for customer premises

D. National Electrical Manufacturers Association (NEMA)

E. National Electric Code (NEC)

F. Telecommunications Industry Association / Electronic Industries Association (TIA/EIA):

1. 568B: Commercial Building Telecommunications Cabling Standards

2. 569B: Commercial Building Standard for Telecommunications Pathways and Spaces

G. Underwriters Laboratories Inc. (UL).

1.03 DEFINITIONS:

A. The following definitions may be used throughout this section and subsections:

1. CTC: Communications termination cabinet

2. HMI: Human machine interface

3. LAN: Local area network

4. LCP: Local control panel

5. IP: Internet Protocol

6. MIMO: Multiple-input and multiple-output

7. OIT: Operator interface terminal

8. OSP: Outside Plant

9. PC: Personal computer

10. PLC: Programmable logic controller

11. PoE: Power over Ethernet

12. SCADA: Supervisory control and data acquisition

13. SCS: Structured Cabling System

14. UPS: Uninterruptible power supply

15. VOIP: Voice over IP

16. WAN: Wide area network

17. WAP: Wireless Access Point

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. For each CTC cabinet supplied.

B. Submit on product data for each type of product in accordance with Section 01 33 00.

C. Submit network drawings for physical connections between all network hardware.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.07 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Hardware and software to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of, equipment

furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

C. Examine the Contract Documents and verify that network and communications equipment and software being provided is compatible with the requirements. Provide all necessary accessories for a complete and operable system.

1.08 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.09 PROJECT/SITE CONDITIONS:

A. Classification of Plant Areas:

1. Refer to Division 26 and Contract Drawings.

1.10 WARRANTY:

A. The Contractor shall provide a three (3) year warranty on structured cabling systems. This includes all copper and fiber cabling, patch panels, patch cables and CTC assemblies (excluding UPS and other electronic devices).

PART 2 - PRODUCTS

2.01 GENERAL:

A. Refer to the requirements of Division 01.

B. Selected Products:

1. Provide products and materials that are new and free from all defects.

2. Products and materials called for on the drawings or in the specifications by trade names, manufacturer's name and catalogue reference are to be used as the basis for the bid submission.

3. The design has been based on the use of the first named product where multiple products have been listed.

C. Quality of Products:

1. All Products provided to be NEC and UL approved where applicable.

2. If Products specified are not NEC and UL approved, obtain approval of the relevant State regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

3. Refer to Division 01 of this specification for further information.

D. Uniformity of Manufacture:

1. Unless otherwise specifically called for in the specification, uniformity of manufacture to be maintained for similar products throughout the work.

E. Product Finishes:

1. Contractor to specify proposed finishes to be used for Contract Administrator's review.

F. Use of Products During Construction:

1. Any equipment used for temporary or construction purposes is to be approved by the Contract Administrator and in accordance with Division 01 of this specification. Clean and restore to "as new" condition all equipment prior to the time of substantial completion.

2.02 NETWORK SWITCHES:

A. Manufacturers:

1. Cisco

B. Layer 2 Rack Mounted Switches:

1. Provide layer 2 managed switches as shown on the Contract Drawings. Layer 2 switches shall have the following features:

a. 48 Gigabit Ethernet ports with line-rated forwarding performance

b. Four 1/10 gigabit Ethernet SFP+ ports

c. Cisco LAN Lite operating system.

d. Redundant Power Supplies

e. Full IEEE 802.at (PoE+) with 30W power on copper ports

f. Device management with web user interface, over-the-air access via Bluetooth and Command-Line Interface (CLI).

g. Provide the Cisco C9200L-48P-4X switch with redundant 1KW power supplies.

2. Layer 2 Panel Mounted Switches:

   a. The switch shall be built for harsh environments and temperature ranges (-40 degrees C to +75 degrees C)

   b. Fanless, convection-cooled with no moving parts.

   c. Hardened for vibration, shock and surge, and electrical noise immunity.

   d. Switch shall have all Gigabit ports with 2 Gigabit Small Form-Factor Pluggable (SFP) uplinks plus 8x1 Gigabit copper RJ45 downlink ports in a small form-factor base system.

   e. Expandable to 26 ports of Gigabit Ethernet by attaching one of 7 compatible modules (copper, PoE, fiber options).

   f. Supports multiple rings and redundant ring topologies for new network configurations.

   g. Cisco Network Essentials operating system.

   h. Redundant 24VDC Power Supplies.

   i. Device management with web user interface, over-the-air access via Bluetooth and Command-Line Interface (CLI).

   j. For switches where PoE is not required, provide the Cisco IE-3300-8T2S-E switch with option module if required.

   k. For switches where PoE is required, provide the Cisco IE-3300-8P2S-E switch with option module if required.

C. Switch Accessories:

1. Small Form Pluggable (SFP) modules for switches:

   a. For 10Gbps fiber links, provide the Cisco SFP-10G-LR (for rack-mount switches) and the Cisco SFP-10G-LRX (for industrial switches).

   b. For 1Gbps fiber links, provide the Cisco GLC-LH-SM (for rack-mounted switches) and the Cisco GLC-LH-SMD (for industrial switches).

   c. For 1Gbps copper links, provide the Cisco GLC-T (for rack-mounted switches) and the Cisco GLC-TE (for industrial switches).

2. Secure Digital (SD) memory card – All Cisco panel mount switches shall be provided with SD cards for locally storing the switch configuration.

2.03 MEDIA CONVERTERS:

A. General: Standalone media converters shall not be allowed except for use with wireless access points. All other fiber connections shall occur at the managed switch level utilizing SFP ports and modules.

2.04 VOIP PHONES:

A. All VOIP phones will be provided and installed by the Salt Lake City Information Management Systems (IMS) group. The Contractor shall coordinate the final location of each phone and associated wall jack with the Owner.

2.05 WIRELESS ACCESS POINTS:

A. Manufacturers:

1. Cisco Meraki

B. Clean Room Access Points:

1. Support for IEEE 802.11n, ac, ax

2. Integrated antennas at 2.4GHz and 5GHz (4x4 MIMO)

3. Powered over PoE 802.3at/802.3af

4. For non-corrosive and dry areas, provide a ceiling mounted Cisco Meraki MR46 access point

C. Process Room Access Points:

1. Support for IEEE 802.11n, ac, ax

2. Four external antennas at 2.4GHz and 5GHz (4x4 MIMO)

3. Powered over PoE 802.3at/802.3af

4. For corrosive or wet areas, provide the Cisco Meraki MR86 series access point with four Cisco Meraki MA-ANT-20 Dual-band Omni-Antennas

D. Outdoor Access Points:

1. Support for IEEE 802.11n, ac, ax

2. Four external antennas at 2.4GHz) and 5GHz (4x4 MIMO)

3. Powered over PoE 802.3at/802.3af

4. For outdoor locations, provide the Cisco Meraki 86 series access point with four Cisco Meraki MA-ANT-20 Dual-band Omni-Antennas

E. Coordinate installation locations of the wireless access points with the Salt Lake City Information Management Systems (IMS) group.

F. The Contractor shall provide the following quantities of indoor and outdoor wireless access points for each facility.

Building Number	Description	Indoor Access Points
0101	IPS	5
0104	IPS Electrical Building	5

Building Number	Description	Outdoor Access Points
0101	IPS	1
0104	IPS Electrical Building	1

2.06 COMMUNICATIONS TERMINATION CABINETS (CTC):

A. Comply with requirements in Section 27 11 16 for communication racks.

B. CTCs shall be 19-inch rack type systems that shall be able to support and organize electronic equipment, cross-connection and/or termination hardware for fiber optic cabling, station cabling, riser cabling, or building entrance cabling as may be required by design. The rack face shall have a conventional equipment mounting width of 19 inches.

C. The rack must be designed for cable and jumper management and have hardware to organize and support cabling and patch cords in the vertical and horizontal planes. The rack system shall be equipped for electrical grounding to meet EIA/TIA 606 Standards. The fastening system for the equipment shall facilitate easy installation with roll-formed threads in the screw holes for greater strength and durability. The mounting screws shall have pilot points.

D. For NEMA 1 enclosures, all rack components shall be charcoal black in color and made of lightweight 6061-T6 extruded aluminum. For NEMA 4X enclosures the enclosure shall be 304 stainless steel.

E. The rack shall be shipped with all necessary hardware to assemble the included frame. It shall be packed in cartons with suitable shipping inserts such that no damage occurs to the rack finish. The finish shall not be scratched, chipped or marred.

F. Each CTC cabinet shall be supplied with two dedicated 120VAC circuits with associated receptacles mounted in the back of the cabinet.

G. Each CTC shall be equipped with vertical and horizontal cable management systems that allow for neatly routing cables throughout the cabinet.

H. Each CTC shall have conduits routed directly to it or overhead cable management systems installed to neatly route structured cabling into the CTC cabinet.

I. Free Standing Rack Specifications:

1. Self-Supported Rack Framework:

a. The self-supporting equipment rack shall be inside the CTC. Standard grade frames shall be capable of supporting equipment to be mounted inside the CTC.

b. Dimensions: As required to fit in CTC with 19-inch center mounting and a minimum of 67 inches of usable vertical space. Base Footprint of 20.25 inches wide by 36 inches deep.

c. Hole Pattern: EIA310-D 3/8 inch square hole. Provide with a minimum of eighty (80) 12-24 Cage nuts and eighty (80) 12-24 x 3/8 inch screws.

d. Materials: 6061-T6 high strength aluminum.

e. Flanges: Flange edge to edge internal measurement is 17.75 inches.

2. Racks shall be mounted inside NEMA 1 Enclosures with front and rear access doors.

3. Enclosures shall have glass front doors and solid vented rear doors.

4. Approved ground lug and #6 AWG jacketed green ground wire.

5. CTC shall be installed with at least 36 inches clear working space in front and behind cabinet.

6. Minimum 84 inches tall free-standing enclosures.

7. Equipped with a slide-out shelf suitable for a laptop computer to be placed on it for system configuration/programming. The shelf shall be vented.

8. Equipped with a vertical power strip installed with a minimum of 16 outlets rated at 20 amps. The vertical power strip shall be surge protected.

9. Approved Manufacturers:

a. Great Lakes

b. CommScope, Inc.

c. Hammond Manufacturing

d. Leviton Manufacturing Co., Inc.

J. NEMA 1 Wall Mount Rack Specifications

1. Self-Supported Rack Framework:

a. The self-supporting equipment rack shall be inside the CTC. Standard grade frames shall be capable of supporting equipment to be mounted inside the CTC.

b. Dimensions: As required to fit in CTC with 19-inch center mounting. Base Footprint of 20.25 inches wide by 24 inches deep.

c. Hole Pattern: EIA310-D 3/8 inch square hole. Provide with a minimum of forty (40) 12-24 Cage nuts and forty (40) 12-24 x 3/8 inch screws.

d. Materials: 6061-T6 high strength aluminum.

e. Flanges: Flange edge to edge internal measurement is 17.75 inches.

2. Racks shall be mounted inside NEMA 1 Wall Mount Enclosures with a double hinge system allowing front and rear access.

3. Enclosures shall have glass or plexiglass front doors and solid vented rear doors.

4. Approved ground lug and #6 AWG jacketed green ground wire.

5. CTC shall be installed with at least 36 inches clear working space in front and 36 inches on the hinge side of the cabinet to allow access to the rear.

6. Panel mounting height shall be such that the top of the wall mount CTC does not exceed 80” above the finished floor.

7. Approved Manufacturers:

a. Great Lakes

b. APC

c. CPI

K. NEMA 4X Wall Mount Rack Specifications:

1. Self-Supported Rack Framework:

a. The self-supporting equipment rack shall be inside the CTC. Standard grade frames shall be capable of supporting equipment to be mounted inside the CTC.

b. Dimensions: As required to fit in CTC with 19-inch center mounting. Base Footprint of 20.25 inches wide by 24 inches deep.

c. Hole Pattern: EIA310-D 3/8 inch square hole. Provide with a minimum of forty (40) 12-24 Cage nuts and forty (40) 12-24 x 3/8 inch screws.

d. Materials: 6061-T6 high strength aluminum.

e. Flanges: Flange edge to edge internal measurement is 17.75 inches.

2. Racks shall be mounted inside NEMA 4X Wall Mount Enclosures with a double hinge system allowing front and rear access.

3. Enclosures shall have a glass or plexiglass front door.

4. Provide HVAC equipment to properly cool the enclosure while maintaining the NEMA 4X rating.

5. Approved ground lug and #6 AWG jacketed green ground wire.

6. CTC shall be installed with at least 36 inches clear working space in front and 36 inches on the hinge side of the cabinet to allow access to the rear.

7. Panel mounting height shall be such that the top of the wall mount CTC does not exceed 80” above the finished floor.

8. Approved Manufacturers:

a. Hoffman Protek Series

2.07 CTC HVAC EQUIPMENT:

A. All CTC cabinets shall be properly designed to maintain the inner temperatures of the enclosure within the 60 to 80 degrees F.

B. Any HVAC equipment shall maintain the NEMA rating of the CTC assembly.

C. Preferably, fans, air-to-air exchangers and AC units are mounted on the top of each CTC.

2.08 FIBER PATCH PANELS:

A. Provide 19 inch rack-mount fiber optic patch panels for CTC cabinets and wall-mount patch panels for industrial control panels.

B. Provide patch panel adapter plates with duplex LC connectors for single mode fiber. Each plate shall accommodate six duplex connectors.

C. Ensure that the number of fiber ports is as required per the network drawings.

D. The patch panel shall provide protection for all fiber terminations and cable strain relief. The patch panel shall protect and conceal patch cord connections.

E. Fiber patch panels shall be the Panduit FMD series for 19 inch racks and the FWME series for wall-mounted panels.

2.09 CAT 6 PATCH PANELS:

A. Each CTC cabinet shall be supplied with a 19 inch rack mountable 110 punch down to RJ45 jack patch panel. The panel shall be rated for CAT6 cabling.

B. The 110 punch blocks shall support wiring and be labeled for both T568A and T568B standards. The patch panel shall have at a minimum 24 RJ45 ports and at least 12 spare ports. Each RJ45 port shall have a plastic label holder for custom labels.

C. CAT 6 patch panels shall be as manufactured by Panduit or Leviton.

2.10 WALL JACKS AND PLATES:

A. Jacks shall be TIA/EIA Category 6 Compliant and shall support wiring and be labeled for both T568A and T568B standards. Plates shall be constructed of high-impact, flame-retardant, UL 94V-0 thermoplastic. Plates shall be available in single gang with 1-4 ports and double gang with 8 ports. Color of jacks and plates shall be determined by and coordinated with the Owner.

2.11 AC UNINTERRUPTIBLE POWER SUPPLY (UPS):

A. All CTC's shall have a UPS system installed for surge protection and battery backup of critical network equipment. Provide the following UPS equipment to be mounted within the 19 inch racks. (Note: UPS's that are located in electrical rooms are specified in Division 26).

Tag	Description	Location	Size	Load	Duration
01-UPS-91012	Influent Pump Station UPS 1	01-CTC-90302	2KVA	1.5KVA	30 MIN
01-UPS-91013	Influent Pump Station UPS 2	01-CTC-90302	2KVA	1.5KVA	30 MIN

Tag	Description	Location	Size	Load	Duration
01-UPS-91011	IPS Electrical Building UPS	01-CTC-90301	3KVA	2.25KVA	30 MIN

B. The AC UPS shall be 19 inch rack mountable and shall be mounted with sliding rails where possible. The AC UPS shall be a double-conversion system.

C. Each UPS shall be capable of running the connected load for a minimum of 30 minutes.

D. AC UPS Electrical Input Specifications (refer to Section 26 33 53 for electrical room UPS requirements).

1. Nominal Voltage: 120VAC (for 1 to 3KVA UPS's), 120VAC/208VAC for 5-10KVA UPS's)

2. Voltage Range (@120VAC): 80-144VAC

3. Input Power Factor: > 0.95

4. Frequency: 60 Hertz +/- 3 Hertz

E. AC UPS Electrical Output Specifications

1. Voltage Regulation: +/- 3 percent of Nominal

2. Efficiency: > 85 percent

3. Frequency Regulation: +/- 3 Hertz on utility, +/- 1 Hertz on battery

F. AC UPS Communications Specifications:

1. A USB port shall be available for monitoring and configuring the UPS. An appropriate cable shall be supplied to connect to the UPS with a PC.

2. An Ethernet port shall be available with the ability to monitor the UPS utilizing the SNMP protocol.

G. AC UPS Battery Specifications:

1. All batteries shall be sealed, lead-acid batteries and shall be maintenance free. Batteries shall be hot-swappable. The UPS will indicate when the battery is weak and needs to be replaced.

2. The UPS shall be able to accept additional battery modules to extend the runtime of the UPS.

H. Acceptable Manufacturers:

1. Powerware 5 or 9 Series

2. Liebert GTX Series

3. APC Smart-UPS Series

2.12 DC UNINTERRUPTIBLE POWER SUPPLY (UPS):

A. Each CTC that contains DC powered network switches shall have a 24VDC UPS installed in it for surge protection and battery backup of critical network equipment.

B. Provide the following UPS equipment to be mounted on the panel backplane. (Note: UPS's that are located in electrical rooms are specified in Division 26).

Description	Location	Size	Load	Duration
IPS Standby Power & Fuel Storage UPS	01-CTC-90101	4AH	2A	120 MIN

C. Each DC UPS shall be din-rail mountable.

D. Each UPS shall be capable of running the connected load for a minimum of 30 minutes.

E. DC UPS Electrical Specifications

1. Input Nominal Voltage: 24VDC

2. Input Voltage Range (@24VDC): 18-30VDC

3. Output Efficiency: > 98 percent

4. UPS shall have signals available to provide alarm and battery status to controller.

F. DC UPS Battery Specifications:

1. All batteries shall be sealed, lead-acid batteries and shall be maintenance free. Batteries shall be hot-swappable. The UPS will indicate when the battery is weak and needs to be replaced.

2. The UPS shall be able to accept additional battery modules to extend the runtime of the UPS.

G. Acceptable Manufacturers:

1. Phoenix QUINT-UPS series

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Refer to the requirements of Division 01.

3.02 COORDINATION WITH OTHER DIVISIONS:

A. Examine the drawings and specifications of all divisions and become fully familiar with the work. Before commencing work, obtain a ruling from the Contract Administrator on any conflicting issues between divisions. No compensation will be made for any costs arising from conflict not identified before work has commenced.

B. Coordinate the work to be performed under this section of the specification with all divisions installing equipment to ensure that there are no conflicts.

C. Lay out the work and equipment with due regard to architectural, structural, and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors, and equipment.

D. Examine previously constructed work and notify the Contract Administrator of any conditions which prejudice the proper completion of this work.

3.03 PRODUCT HANDLING:

A. Use all means necessary to protect the products included in this division before, during and after installation, and to protect products and installed work of all other trades.

B. Any damage to the products and/or installed work shall be repaired or replaced to the approval of the Contract Administrator by the Contractor at no additional cost to the City.

C. Remove advertising labels from all products installed that have such labels attached. Identification, NEC, and UL labels are not to be removed.

D. Remove dirt, rubbish, grease, etc. resulting from work performed under this section of the contract from all surfaces.

3.04 NETWORK PROGRAMMING

A. All network switches and wireless access points shall be programmed by the Salt Lake City Information Management Systems (IMS) group. Programming for vendor supplied network switches shall be performed by the vendor but shall be coordinated with the Engineer utilizing SLCDPU's standard programming templates. Programs for vendor supplied switches shall be turned over to the Owner.

B. The Contractor shall deliver all network switches and wireless access points to the IMS group for programming. The Contractor shall allow a period of six (6) months for the

IMS group to complete the programming. Once completed, the Contractor shall take possession of the switches and install them in their designated locations.

C. Business VLANS (such as VLANs for workstations, printers, WiFi, Security, etc.) shall be setup on the Business network switches such that all traffic between VLANs is controlled by firewall rules. Similarly, Control Network VLANs (SCADA, BMS, Power) shall be setup on the SCADA network switches such that all traffic between VLANs is also controlled by Firewall rules. By default, ports are disabled and not assigned to any VLAN until physical connections are made to the port and the IMS team then programs the port to the appropriate VLAN.

3.05 INSTALLATION:

A. Refer to the requirements of Division 01 for additional requirements.

B. The Contractor shall utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies which it provides. The Contractor shall employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies it provides.

C. All components of the SCS shall be the installation responsibility of the Contractor unless specifically noted otherwise. After the installation of the SCS is completed, the installation shall be inspected jointly by the Contractor and the Equipment Manufacturer's representatives. Any problems shall be corrected, and when both are satisfied with the installation, a written certification of the installation shall be delivered to the Engineer. The certification shall state that all cabling and terminations have been inspected and are installed in accordance with the manufacturer's guidelines.

D. Miscellaneous Equipment. The Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire molding, and support hardware, etc., necessary to facilitate the installation of the CTCs within the SCS. All metal fasteners and straps in corrosive or wet areas shall be 316SS.

E. Special Equipment and Tools. It shall be the responsibility of the Contractor to furnish any special installation equipment or tools necessary to properly complete the SCS. This may include, but is not limited to, tools for terminating cables, testing and splicing equipment for copper/fiber cables, communication devices, jack stands for cable reels, or cable wrenches.

F. Penetrations of Walls, Floors, and Ceilings. The Contractor shall make no penetration of existing walls, floors and/or ceilings without the prior consent of the Owner. Where penetrations through acoustical walls, fire-rated doors or other walls for cableways are to be installed, such penetrations shall be sealed by the Contractor in compliance with applicable code requirements.

G. The CTCs and all components of the system shall be installed in a neat, workmanlike manner. Wiring color codes shall be strictly observed and terminations shall be uniform

throughout the system. Identification markings and systems shall be uniform. TIA/EIA 568B wiring codes as shown on the drawings shall standardize all SCS wiring. The CTC shall be level and plumb.

3.06 TESTING & COMMISSIONING:

A. Commissioning of network and communication systems is to include but not be limited to the following:

1. Verify installation of components, power and network connections.

2. Supervise network cable testing.

3.07 TRAINING:

A. Provide training, described in detail in Division 01, as required by the plant's personnel to become fully competent in the proper operation and maintenance of all network and communication equipment described under this section of the specifications.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 66 33

METALLIC AND FIBER OPTIC COMMUNICATION CABLING AND CONNECTORS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide metallic and fiber optic communication cabling and connectors as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society for Testing and Materials (ASTM)

B. Institute of Electrical and Electronic Engineers (IEEE)

C. International Standards Organization/International Electrotechnical Commission (ISO/IEC):

1. 11801: Information Technology – Generic cabling for customer premises

D. National Electrical Manufacturers Association (NEMA)

E. National Electric Code (NEC)

F. Telecommunications Industry Association / Electronic Industries Association (TIA/EIA):

1. 568B: Commercial Building Telecommunications Cabling Standards

2. 569B: Commercial Building Standard for Telecommunications Pathways and Spaces

G. Underwriters Laboratories Inc. (UL)

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit product data in accordance with Division 26.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.07 INSPECTION:

A. Provide adequate notice to the Contract Administrator so that all cable installations can be inspected prior to energizing equipment.

1.08 WARRANTY:

A. Provide a five (5) year warranty on all metallic and fiber optic communication cabling and connectors.

PART 2 - PRODUCTS

2.01 TWISTED PAIR SHIELDED CABLES (TPSH):

A. TPSH shall be constructed as follows:

1. Two (2) copper conductors, stranded, minimum #18 AWG, PVC insulated, twisted in nominal intervals of 2 inches.

2. Insulated for 600 V, 194 degrees F.

3. 100 percent coverage aluminum foil or tape shield.

4. Separate bare stranded copper drain wire, minimum #18 AWG.

5. Overall flame-retardant PVC jacket to NEC. NEC and UL approved.

6. The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.

7. Interlocked aluminum armor and outer PVC jacket.

8. Belden 9341.

B. Where multi-conductor TPSH cables are called for, each pair shall be individually shielded, continuous number coded, and the cable assembly shall have an overall shield and overall flame retardant PVC jacket.

2.02 RTD AND MULTI CONDUCTOR SHIELDED CABLE:

A. RTD cables shall be UL approved and shall be constructed as follows:

1. Three or more copper conductors, stranded, minimum # 18 AWG.

2. PVC insulated for 600 V.

3. 100 percent coverage aluminum foil or tape shield.

4. Separate bare stranded copper drain wire.

5. Interlocked aluminum armor and outer PVC jacket.

6. Overall flame-retardant PVC jacket to NEC. NEC and UL approved.

2.03 CABLE TRAYS:

A. As specified in Section 26 05 36.

2.04 CONDUIT

A. As specified in Division 26.

2.05 WIRE:

A. As specified in Division 26.

2.06 CATEGORY 6 COMMUNICATION CABLE:

A. Comply with requirements in Section 27 15 13.

B. Category 6 cable shall be NEC approved and constructed as follows:

1. 4 bonded pairs, solid stranded, #23 AWG

2. Rip cord

3. PVC inner and outer jackets

4. UL verified to CAT 6

5. The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.

6. Insulated for 300 V for typical installations. Insulated and shielded for 600 V when installed in industrial control panels, motor control centers and any other location where the cable will be in the presence of other 480V cabling.

7. 300V Cable, Unshielded: Belden 7940A.

8. 600V Cable, shielded: Belden 7953A.

2.07 FIBER OPTIC CABLE:

A. Comply with requirements in Division 27.

B. Fiber optic cabling shall be provided between facilities and furnished with the quantity of fibers as designated on the Contract Drawings.

C. All fiber in a cable run shall be from the same manufacturer and shall be the same type. A mix of fibers from different manufacturers may not be used without written permission from the Engineer.

D. Fiber optic cabling exposed to the elements or in underground raceways shall be an armored type fiber optic cable.

E. No fiber splicing or closures are allowed except to replace existing splices.

F. Single Mode Fiber:

1. All single mode fiber optic cables within the premises shall use graded-index fibers with 9 micron cores only.

2. Optical Specifications:

a. Fibers shall have dual wavelength capability at 1310nm and 1550nm

b. Attenuation: ≤ 0.4 dB/km at 1310nm and 0.3 dB/km at 1550nm

c. Bandwidth: Operation of 10 Gigabit Ethernet at 10,000 meters at 1310nm and 30,000 meters at 1550nm

d. Numerical Aperture: 0.14

3. All fibers shall be color coded to facilitate individual fiber identification. Fibers shall have CPC® or approved equivalent color coatings that resist color degradation, minimize micro-bending losses and improve handling. The coating shall be mechanically strippable.

4. Dimensional Specifications:

a. Core Diameter: 8.2 µm

b. Cladding Diameter: 125.0 +/- 0.7 µm

c. Core-Clad Concentricity: ≤ 0.5 µm

d. Cladding Non-Circularity: ≤ 0.7 percent

e. Coating Diameter: 242 +/- 5 µm

f. Coating-Cladding Concentricity: < 12 µm

5. Environmental Specifications:

a. Operating Temperature: -40 degrees C to +70 degrees C

b. Cable shall be UV resistant, waterproof and corrosion resistant.

6. Mechanical Specifications:

a. Minimum tensile strength: 100,000 psi

b. Fiber Minimum Bending Radius: 0.75 inches

c. Cable Minimum Bending Radius (During Installation): 20 times cable diameter

d. Cable Minimum Bending Radius (After Installation): 10 times cable diameter

e. Cable shall be rated for Underground, Buried and Aerial, OSP

f. Cable shall bear OFNP (Plenum Rated), OFNR (Riser Rated) and/or appropriate markings for the environment in which they are installed.

g. Cable shall be a tight-buffer indoor/outdoor distribution cable with 900 µm color coded buffered fibers which are surrounded by water-swellable aramid strength members with a ripcord, under an overall UV-resistant, flame-retardant black jacket.

7. Fiber Cabling shall contain the number of fibers specified in the Drawings.

8. Acceptable Manufacturers:

a. Corning

G. Inner Duct:

1. Inner duct shall be used for fiber optic installations in conduit 2 inches and larger.

2. Inner duct shall be minimum 1 inch and shall be sized properly for the fiber optic cable.

3. Inner duct shall be orange, ribbed, riser rated and UL listed.

4. Acceptable Manufacturer:

   a. Carlon

H. Fiber Optic Connectors:

1. Fiber Optic Connectors shall be of ceramic construction and shall have a loss ≤ 0.5 dB. They shall be made specifically for the type of fiber being connected to and required bandwidth. The connector shall have no metal parts.

2. Fiber Optic Connectors shall utilize the LC type connector.

3. Acceptable Manufacturer:

   a. Panduit Opticam Series

I. Fiber Patch Cords:

1. The fiber patch cord shall be duplex and consist of buffered, graded-index fiber with a 125 µm cladding. The fiber cladding shall be covered by aramid yarn and a jacket of flame-retardant PVC.

2. The fiber patch cord shall be rated for 10 Gigabit Ethernet.

3. For single mode, the cords shall be Yellow in color.

PART 3 - EXECUTION

3.01 ANALOG SIGNALS:

A. Use TPSH cable for all low level analog signals such as 4-20 mA, pulse type circuits 24 VDC and under, and other signals of a similar nature.

B. Use RTD cable for connections between RTDs and transmitters or control system RTD inputs.

3.02 DIGITAL SIGNALS:

A. Use TPSH cable for all low level input (24 V and below) and output signals to the control system.

3.03 INSTRUMENT POWER:

A. Use tray type instrumentation cable in conduit in accordance with Division 26 for power to instruments, for 120 V signals other than those mentioned above and as otherwise indicated on the Drawings. Use stranded wire and cable to supply power to instruments.

3.04 INSTALLATION:

A. The Contractor shall utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies which it provides. The Contractor shall employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies it provides.

B. All components of the cabling system shall be the installation responsibility of the Contractor unless specifically noted otherwise. After the installation is completed, the installation shall be inspected jointly by the Contractor and the Equipment Manufacturer's representatives. Any problems shall be corrected, and when both are satisfied with the installation, a written certification of the installation shall be delivered to the Engineer. The certification shall state that all cabling and terminations have been inspected and are installed in accordance with the manufacturer's guidelines.

C. All installations shall be done in conformance with EIA/TIA 568B standards and with the manufacturer's installation requirements. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the failure. All damage to the cables during the construction of this project is the sole responsibility of the Contractor.

D. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 12 inches

   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 24 inches

   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 48 inches

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 6 inches

   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches

   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: 3 inches

   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches

   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches

5. Separation between Cables and Electrical Motors and Transformers: A minimum of 48 inches

6. Separation between Cables and Fluorescent Fixtures: A minimum of 6 inches

E. Install instrumentation cables in conduit systems or in cable trays. Use a minimum of 12 inches and a maximum of 40 inches length of liquid tight flexible conduit to connect the field sensors to the conduit.

F. Where non-armored instrumentation cables are installed in cable trays, provide barriers in the tray to separate instrumentation cables from power cables.

G. At each end of the run leave enough cable length for termination.

H. Do not make splices in any of the instrumentation cable runs.

I. Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.

J. Ground cable shields at one end only. Unless otherwise specified, ground the shields at the marshalling panel.

K. Protect all conductors against moisture during and after installation.

3.05 CAT 6 INSTALLATION:

A. Always follow the Manufacturer's guidelines for minimum bend radius and tension.

B. All installations and terminations shall be performed by personnel experienced in CAT 6 cable installation.

C. Perform cable testing with time domain reflectometer instrument and provide complete detailed test report. Test all runs upon completion of permanent terminations, using

instrumentation acceptable to the Engineer. Before commencing testing, submit sample test data sheets and information with respect to test instrumentation to be used.

1. Test for the following:

    a. Continuity

    b. Pair placement and polarity

    c. DC resistance

    d. Characteristics at highest contemplated frequency:

        (1) Attenuation - data cable

        (2) Mutual Capacitance - data cable

        (3) Near-end crosstalk (NEXT) - data cable

    e. Run length

2. Tests to be conducted to CAT 6 standards.

3. Reconnect or re-install and retest as necessary to correct excessive variations.

3.06 FIBER OPTIC INSTALLATION:

A. Always follow the Manufacturer's guidelines for minimum bend radius and tension.

B. All installations and terminations shall be performed by personnel experienced in fiber optic cable installation and testing.

C. Perform cable testing with optical time domain reflectometer (OTDR) instrument and provide complete detailed test report. Test all runs upon completion of permanent terminations, using instrumentation (calibrated within 12 months of test being performed) acceptable to the Engineer. Before commencing testing, submit sample test data sheets and information with respect to test instrumentation to be used.

1. All fiber testing shall be performed on all fibers in the completed end to end system. There shall be no splices unless approved in writing by the Engineer. Testing shall consist of a bidirectional end to end OTDR trace performed per EIA/TIA 455-61. All tests shall be conducted using 200 foot launch cables. The system loss measurements shall be provided at 1310nm and 1550 nm for single mode fibers. The final test results must fall within Corning’s recommended range for the installed cable.

2. The Contractor shall test all fiber optic cable prior to the installation of the cable. The Contractor shall assume all liability for the replacement of the cable should it be found defective later during installation.

3. Loss Budget: Fiber links shall have a maximum loss of:

   a. (3.0 dB loss/km)*(km of fiber in link) + (0.5dB) * (number of connectors)

   b. Note that a mated connector to connector interface is defined as a single connector for the loss calculation.

   c. Any link not meeting the requirements of the standard shall be brought into compliance by the Contractor, at no charge to the Owner.

4. Documentation of all fiber optic cabling tests shall be provided in both hard and electronic copies to the Engineer.

3.07 CONDUCTOR TERMINATIONS:

A. All equipment supplied shall be equipped with terminal blocks to accept conductor connections.

B. Instrumentation conductors, where terminated at equipment terminals other than clamping type terminal blocks, shall be equipped with self-insulated, locking type terminators, sized as required to fit conductors and screw terminals.

3.08 FIELD TESTING:

A. Test all conductors for opens, shorts, or grounds. Resistance values shall not be less than those recommended by the cable manufacturer.

3.09 IDENTIFICATION:

A. Identify all instrumentation cables.

B. Identify each conductor with wire numbers using a machine printed heat shrink wire marker.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 67 00

CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide control system equipment panels and racks as indicated and in compliance with Contract Documents.

B. Local control stations shall be supplied to house local control switches, push buttons and indictor lights associated with field devices (valves, drives, etc.). The control stations shall be located in close proximity to their associated devices. Where a group of devices are located within close proximity to each other, the local controls may be combined into a single common local control panel. Line of site must be maintained between all devices and the respective local controls.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Delegated Design Submittals: For each control panel, marshalling panel, equipment rack, or appurtenance thereto, provide written certification from Professional Engineer licensed in the State of Utah stating that supports, systems and anchorage for equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

1.03 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Unless otherwise specified, provide outside finishes on all enclosures in ANSI 61 Grey.

B. The enclosures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors without any warpage.

2.02 ENCLOSURES:

A. Provide NEMA Type 1A gasketed enclosures in ordinary locations without process equipment.

B. Provide NEMA Type 4 enclosures in ordinary locations with process equipment.

C. Provide NEMA Type 4X 316SS enclosures for:

1. Category 1 and 2 wet and corrosive locations

2. Outdoor locations

D. Enclosures located in electrically hazardous classified areas shall bear appropriate hazardous area ratings based on the area classifications identified by Division 26.

E. Enclosures for mounting field control indicator lamps and switches in unclassified areas to be heavy duty die cast enclosures.

2.03 PANEL ENCLOSURES:

A. Fabricate panel enclosures from minimum 11 gauge steel panels complete with necessary stiffening to form a rigid free-standing line up. The structures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors. Provide removable top and bottom cable entry plates.

B. Provide panels with front access only. Doors shall be key lockable and fitted with 3-point heavy duty latching assemblies. Provide a continuous piano hinge and a pneumatic hold open device on each door.

C. Finish the interior of the enclosure with white paint. Provide a switched light fixture and 120 VAC duplex convenience receptacle inside the enclosure.

2.04 MARSHALING AND CONTROL PANELS:

A. Supply, fabricate, checkout, layout, document and deliver to Site fully equipped and functional panels.

B. Supply all components contained on or within the panels fully wired under this Section of the Specification.

C. The selection of all accessories, materials and methods for fabrication are specified in Section 26 27 17. Incidental items not covered by these Specifications, but which are necessary to complete the fabrication of the control panels, is the responsibility of the panel fabricator.

D. Fans and filters shall be installed to pressurize all control panels in non-hazardous areas thus discouraging dust accumulation and providing air purging for temperature and corrosion control.

E. Marshalling and control panels shall be adequately sized to facilitate a professional, uncluttered arrangement. Provide adequate internal and external space to accommodate a 20 percent increase in each type of component used.

F. Control and marshalling panel layouts and wiring diagrams are to be provided by the Contractor as Shop Drawings.

2.05 IPS PROCESS PLC PANEL:

A. Supply and installation of a new PLC control panel for the Influent Pump Station process systems to accommodate the extent of Input/Output points associated with the influent pump station equipment and field instruments.

1. This panel shall be equipped with a Hot-Standby PLC arrangement and will be fed from a UPS power supply specified in Section 26 33 53.

2. Requirements for the control panel and internal components are specified in Section 26 27 17.

3. This panel will be located in the IPS electrical building and shall be of NEMA 12 design and suitable for continuous operation with 90 degrees F ambient. Provide auxiliary cooling system if required to maintain internal temperature less than 95 degrees F.

4. This panel shall be free standing with provisions for secure anchorage meeting seismic restraint specification. The panel size shall be determined based on the specified features and components of the panel together with the specified quantity of PLC Inputs and Outputs defined in the facility I/O list, communication equipment, and including specified quantity of spare rack space and I/O cards.

2.06 WIRING AND ACCESSORIES:

A. Provide wiring inside the panels according to the following Specifications:

1. Control wiring to be a minimum of #16 AWG tinned stranded copper; insulation rated at 600 V.

2. Wiring for power distribution shall be a minimum of #14 AWG tinned stranded copper; insulation rated at 600 V.

3. Install cables in accordance with the requirements of Division 26.

B. Tag each wire at both ends with a heat shrink sleeve that is machine printed. Allow approximately 1 inch of wire insulation between the tag and the bare wire.

C. Wiring systems with different voltage levels or types shall be suitably segregated within the panel, according to relevant electrical codes.

D. Run all wiring in enclosed plastic wire troughs such as Panduit. Size all wire troughs so that the total cross sectional area of the insulated wire and cable does not exceed 40 percent of the cross sectional area of the wire way.

E. Provide a minimum clearance of 2 inches between wire trough and any point of wire termination.

F. Terminate all wiring, incoming and outgoing, at dedicated terminal strips mounted inside the panels. Identify each terminal strip with a terminal strip number, defined as follows:

1. Wire identification to use the connected field device tag name with the wire's corresponding end device terminal number appended to it.

2. Identify every joint and/or terminal of the above wire run with the same identifier until the wire meets another tagged device, at which point the wire identifier will change to use the new device name and terminal number.

3. For example, pressure transmitter S740-FIT located in the field has a 1 PR-TPSH cable connected to it. The cable runs through a junction box to a marshaling panel. The wire identifiers for the pair of wires would be S740-FIT all the way to the marshaling panel.

4. Identify spare wires by using the cable tag, wire number and an “-SP” suffix.

5. Arrange wiring on terminal blocks such that all internal panel wiring terminates on the inboard side of the terminal blocks and all external wiring terminates on the outboard side.

G. Provide a 120 VAC panel power distribution system and 24 VDC and other DC power distribution systems as required in each panel to accommodate all instrumentation systems fed from the panel. Provide a thermal magnetic circuit breaker on each main power circuit and a fused terminal block for each branched circuit off the main.

H. Provide power conditioners in each panel to power AC instrumentation and control loads. Power conditioners are Oneac Series CX or acceptable alternative.

I. Provide all DC power supplies as required for all instrument circuits. Power all circuits from the local control panels or marshalling panels. Power supplies to be equal to Hammond or G.F.C., complete with an overvoltage protection module.

J. Provide redundant configurations for power supply equipment serving more than one instrument loop, so that failure of a single unit will not disable all or any shared part of the instrumentation and communication system. Provide diode isolation for redundant direct current supply units, and ground the negative terminal of the power supply.

K. Unless otherwise required, all DC power supplies to be rated 28 VDC, adjustable plus or minus 5%, and set to provide 26.4 V on the panel direct current bus. Size the power supply for two times the connected load, minimum size is 2 A.

L. Provide disconnect type terminal blocks to isolate field wiring that is powered sourced from the panel. Provide a dedicated fused disconnect type terminal block to isolate each individual PLC input and output.

M. Provide sufficient terminals so that not more than two wires are connected under the same terminal. Provide 20 percent spare terminal capacity at each terminal block assembly.

N. Terminals shall be color coded as follows:

1. Red = positive 24 VDC

2. Black = analog signal plus

3. White = analog signal common and VAC neutral

4. Grey = 120 VAC

5. Green = ground

O. Provide nameplates for each device on or within the panels and enclosures. Nameplates shall be white laminated plastic with black lettering, a minimum of 1 inch x 3 inches in size with up to three lines of 0.25 inch lettering. Securely fasten nameplates in and situate them in a visible location.

2.07 PANEL GROUNDING:

A. Provide a ground system for the instrumentation circuits, isolated from the main power system ground to each marshaling panel.

B. Provide grounding lugs for each panel, suitable for termination of up to #2 AWG copper grounding conductor.

C. Provide in each marshaling panel an isolated grounding bus bar 0.25 x 1 x 24 inch, equipped with necessary lugs for accepting two (2) #2 AWG grounding conductors.

D. Firmly bond all panel-mounted devices on or within the panels to ground. Provide supplementary bonding conductors for backpanels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.

PART 3 - EXECUTION

3.01 MOUNTING HEIGHTS:

A. Unless otherwise specified or a conflict exists, mount all control panels:

1. 48 inches or taller such that the top of the control panel is at 78 inches above the finished floor.

2. Less than 48 inches such that the panel is centered at 48 inches above the finished floor.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 68 00

PROCESS CONTROL SOFTWARE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide Process Control Software, equipment PLC and OIT programming, as indicated and in compliance with Contract Documents. SCADA programming will be performed by OSI.

1.02 REFERENCES:

A. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S18.2: Alarm Management

3. S99: Control System Cyber Security

4. 101: Human-Machine Interfaces

1.03 DEFINITIONS:

A. FAT: Factory acceptance test

B. HMI: Human machine interface

C. I&C: Instrumentation and control for process systems

D. IS: Instrumentation supplier

E. LAN: Local area network

F. LCP: Local control panel

G. NC: Normally closed

H. NO: Normally open

I. OIT: Operator interface terminal

J. OSI: Owner's System Integrator

K. PC: Personal computer

L. PID: Control action, proportional plus integral plus derivative

M. PLC: Programmable logic controller

N. P&ID: Process and instrumentation diagram

O. RIO: Remote input/output

P. SCADA: Supervisory control and data acquisition

Q. VCP: Vendor control panel

1.04 SUBMITTALS:

A. Submittals shall meet the requirements of Section 01 33 00.

B. A minimum of four weeks prior to factory acceptance testing, submit programming files for review.

1.05 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PROCESS CONTROL SOFTWARE:

A. SLCDPU has standardized around the Modicon M340 and M580 Series PLC hardware, the Modicon Magelis OIT hardware, and the Inductive Automation Ignition HMI software. The Contractor will not be required to provide any software related to these platforms. However, if a piece of equipment has been approved and is being supplied with PLC hardware, OIT hardware or HMI software that is different than the Department's standard, the Contractor shall provide all licenses associated with the hardware or software. These licenses shall be in the Department's name and shall provide full functionality with the equipment or software that has been provided.

2.02 GENERAL PROGRAMMING REQUIREMENTS:

A. SLCDPU has developed programming standards to provide uniformity between control loops, processes and facilities. These standards should be followed by any vendor or integrator that is providing equipment and/or services for SLCDPU facilities.

B. Control Loops. A control loop is a single piece of equipment or a group of equipment that performs a specific function. Each control loop will have an associated loop number and description. Process Equipment and programming shall be divided into loops based upon their corresponding function. This allows the process to be neatly broken down into parts that are simple and logical. Multiple pieces of equipment should not have the same loop number.

C. Loop Numbers. Each control loop shall be assigned a unique number to set itself apart from all other loops.

D. Control Strategies. Each control loop shall have or be part of an associated control strategy. The control strategy is used to describe the function of each control loop in detail. Refer to Section 40 61 96 for the control strategies for this project.

E. Equipment and Instrumentation Tagging:

1. Equipment and instrumentation shall be tagged as shown on the P&IDs in the Contract Drawings. Instrumentation tagging follows the ISA-5.1-1984 standard where the tag has a functional identification letter code and then the loop number. The functional identification letter code should follow what is shown below in Table 40 68 00-1.

2. The functional identification of an instrument or its functional equivalent consists of letters from the below table and includes one first-letter (designating the measured or initiating variable) and one or more succeeding letters (identifying the functions performed).

3. The functional identification of an instrument is made according to the function and not according to the construction. Thus, a differential pressure transmitter used for flow measurement would be identified by FT and not PDT.

4. The succeeding letters of the functional identification designate one or more readout or passive functions and/or output functions. A modifying letter may be used, if required, in addition to one or more other succeeding letters. Modifying letters may modify either a first letter or succeeding letters, as applicable. Thus, TDAL contains two modifiers. The letter D changes the measured value T into a new variable, “differential temperature.” The letter L restricts the readout function A, alarm, to represent a low alarm only.

5. The sequence of identification letters begins with a first letter selected according to the table below. Readout or passive functional letters follow in any order, and output

functional letters follow these in any sequence, except that output letter C (control) precedes output letter V (valve), e.g., PCV, a self-actuated control valve. However, modifying letters, if used, are interposed so that they are placed immediately following the letters they modify.

6. The number of functional letters grouped for one instrument should be kept to a minimum according to the judgment of the user. The total number of letters within one group should not exceed four. All functional letters groups shall be reviewed by the Owner and Engineer for approval.

7. All letters of the functional identification are uppercase.

Table 40 68 00-1

Preceding Letters				Succeeding Letters		
Measured or Initiating Variable		**Modifier**		**Readout or Passive Function**	**Output Function**	**Modifier**
A	Analysis			Alarm		
B	Burner, Combustion			Emergency	User's Choice	User's Choice
C	Conductivity				Control	
D	Density or Specific Gravity	Differential				
E	Voltage			Primary Element		
F	Flow Rate	Ratio				
G	Gauge			Glass, Viewing Device		
H	Hand					High
I	Current (Electrical)			Indicate		
J	Power	Scan				
K	Time, Time Schedule	Time Rate Of Change			Control Station	
L	Level			Light		Low
M	Motor	Momentary		Moisture		Middle
N	Video			User's Choice	User's Choice	Normal
O	User's Choice			Orifice, Restriction		Open
P	Pressure, Vacuum			Point Connection		Stop
Q	Quantity	Integrate, Totalize				

Table 40 68 00-1						
Preceding Letters				**Succeeding Letters**		
Measured or Initiating Variable		**Modifier**		**Readout or Passive Function**	**Output Function**	**Modifier**
R	Radiation			Record, Print		
S	Speed, Frequency				Switch	
T	Temperature				Transmit	
U	Multivariable			Multifunction	Multifunction	Multifunction
V	Vibration, Mechanical Analysis				Valve, Louver	
W	Weight, Force			Well		
X	Unclassified	X-Axis		Unclassified	Unclassified	Unclassified
Y	Event, State, or Presence	Y-Axis			Relay, Compute, Convert	
Z	Position, Dimension	Z-Axis			Driver, Actuator, Final Control Element	

F. Process and Instrumentation Diagrams (P&IDs). P&IDs for the project are found in the Contract Drawings and should be used as a basis for developing the programming for the system.

2.03 PLC PROGRAMMING REQUIREMENTS:

A. Vendor systems with PLCs shall be programmed by the vendor and factory tested prior to delivery to the site. Vendors shall become familiar with the requirements of this section.

B. Contractor furnished PLCs (not as part of a vendor package) shall be programmed by the Owner's System Integrator (OSI).

C. PLCs shall be programmed in accordance with the standards described herein to maintain consistency throughout the facility from one PLC to another. SLCDPU has standardized around the Modicon M340 & M580 series of PLCs which is programmed with Unity Pro software. Prior to starting any programming, coordinate with SLCDPU the version of Unity Pro software to be used for the project.

D. PLC Configuration. Each PLC shall be programmed with its own project within Unity. The project name shall be the name of the PLC as shown on the Contract Documents.

1. PLC Hardware Configuration. The PLC Hardware Configuration shall be setup by showing the modules that have been designed for each slot of each rack. The

arrangement of the modules shall be in an orderly fashion with space for future expansion. Redundant controllers consist of two identical racks with redundant power supplies, processors and Ethernet communication modules.

2. Additional racks shall be installed when additional I/O modules are required.

3. PLC Logic Structure. The program is written with tasks and any new program file has a default task called "MAST" that is by default Cyclic with a watchdog at 250ms. It is preferred that all logic reside under this default task and that programming be implemented so that periodic tasks are not required.

4. Routines: All PLCs shall have three types of routines: Internal, Loop, and Communication routines. Internal routines shall contain all the logic that is not directly related to process controls and/or communication. This would include miscellaneous logic like PLC Clock manipulation that may have nothing to do with the Process. Loop routines shall contain all logic used to directly control and/or monitor control loops as described by the Process Control Descriptions provided in 40 61 96 and as depicted on the P&IDs. Communication routines would include all the logic utilized to communicate with other PLCs, HMI machines, and Operator Interfaces. The names of these routines will use the prefixes: IXXXXX, LXXXXX, and CXXXXX respectively. XXXXX represents the number of the routine (or loop number); all routines will have names that adequately describe the logic contained within. For example, a communications routine to communicate with VFD's might be called C00001_VFDs. All routines shall be ordered in a structured and logical fashion. An example is shown in Table 40 68 00-2:

Table 40 68 00-2

Routine Name	Routine Description
C0001_Messaging	Contains the messages used in SCADA communications. If there is a lot of communications being handled by the PLC, it is preferred that multiple routines be implemented
I0001_PLC	Contains all the logic associated with monitoring the status of the PLC
L11210_BSSFeedPump2	Contains all the logic associated with the monitoring and control of BSS Feed Pump 2

Unity Pro allows for logic routines to be programmed with Ladder Diagrams (LD), Structured Text (ST), Function Block Diagrams (FBD) and Sequential Function Charts (SFC). While each has its place and may be utilized, it is preferred that logic be implemented in FBD's.

Routine Structure: Each control loop routine should be structured by having logic organized into the following order:

a. Map PLC or communications inputs and outputs to tag names

b. Loop alarm logic

c. Loop control logic including permissives and interlocks logic

d. Loop auxiliary functions such as run hours or flow total calculations

e. Common logic for when there is more than one piece of equipment

E. Tag Naming. All programming shall be done utilizing tag names or "Symbolic Variables" which do not require physical memory address assignments. The following tag naming convention shall be utilized:

1. Tags when interpreted on a P&ID often will have implied dashes such as FI-01212. Because Unity Pro doesn't allow tag names with dashes, dashes should be omitted when separating a letter and number (FI01212 for example) and underscores should be used when separating two letters or two numbers.

2. Prefixes for tags are created using the ISA Instrument Identification Table. A table of common prefixes is shown below in Table 40 68 00-3. If there are ISA prefixes that a programmer would like to use that do not appear on this list, they must be first approved by the Engineer.

3. If the tag is associated with a certain piece of equipment, the corresponding loop number must follow the prefix used in the tag.

4. If the tag is associated with a group of equipment, for example three RAS pumps, then common tag to all three pumps will use the loop number of lowest numeric value and the appropriate prefix.

5. If the tag is not associated with any physical equipment the PLC name shall be used. All dashes and the prefix "PLC" shall be deleted.

6. If two tags share the same name, they shall be appended with a capital letter starting at A, going in alphabetical order to Z. If there are more tags than letters of the alphabet succeeding tags will start back at A and double the corresponding letter creating tags appended with AA, BB, etc.

7. Tag arrays used for messaging shall use the names of the point of message origination.

8. Other arrays may be used when it simplifies the programming and configuration of the process. Naming for these arrays shall use the same naming convention as described for regular tags.

Table 40 68 00-3						
ISA Prefix				**Instrument Identification**		
A	A	H		Analysis	Alarm	High	
A	A	H	H	Analysis	Alarm	High	High
A	A	L		Analysis	Alarm	Low	
A	A	L	L	Analysis	Alarm	Low	Low
A	C			Analysis	Control		
A	C	H		Analysis	Control	High	
A	C	H	H	Analysis	Control	High	High
A	C	L		Analysis	Control	Low	
A	C	L	L	Analysis	Control	Low	Low
A	I			Analysis	Indicate		
A	I	C		Analysis	Indicate	Control	
A	I	R		Analysis	Indicate	Record	
E	A			Voltage	Alarm		
E	I			Voltage	Indicate		
E	I	R		Voltage	Indicate	Record	
F	A	H		Flow	Alarm	High	
F	A	H	H	Flow	Alarm	High	High
F	A	L		Flow	Alarm	Low	
F	A	L	L	Flow	Alarm	Low	Low
F	C			Flow	Control		
F	C	H		Flow	Control	High	
F	C	H	H	Flow	Control	High	High
F	C	L		Flow	Control	Low	
F	C	L	L	Flow	Control	Low	Low
F	I	C		Flow	Indicate	Control	
F	I	R		Flow	Indicate	Remote	
F	Q	C		Flow	Total	Control	
F	Q	I		Flow	Total	Indicate	
F	Q	I	R	Flow	Total	Indicate	Record
F	Q	Y		Flow	Total	Relay	
F	Y			Flow	Compute		
H	S			Hand	Switch		
I	I			Current	Indicate		

Table 40 68 00-3							
ISA Prefix				**Instrument Identification**			
I	I	R		Current	Indicate	Record	
I	A	H		Current	Alarm	High	
I	A	H	H	Current	Alarm	High	High
I	C	H		Current	Control	High	
I	C	H	H	Current	Control	High	High
J	A	H		Torque	Alarm	High	
J	A	H	H	Torque	Alarm	High	High
K	A	C		Time	Alarm	Close	
K	A	N		Time	Alarm	Normal	
K	A	O		Time	Alarm	Open	
K	A	P		Time	Alarm	Stop	
K	A	S		Time	Alarm	Start	
K	C			Time	Control		
K	C	C		Time	Control	Close	
K	C	N		Time	Control	Normal	
K	C	O		Time	Control	Open	
K	C	P		Time	Control	Stop	
K	C	S		Time	Control	Start	
K	I			Time	Indicate		
L	A	H		Level	Alarm	High	
L	A	H	H	Level	Alarm	High	High
L	A	L		Level	Alarm	Low	
L	A	L	L	Level	Alarm	Low	Low
L	C			Level	Control		
L	C	H		Level	Control	High	
L	C	H	H	Level	Control	High	High
L	C	L		Level	Control	Low	
L	C	L	L	Level	Control	Low	Low
L	C	S		Level	Control	Start	
L	C	P		Level	Control	Stop	
L	D	A	H	Level	Differential	Alarm	High
L	D	A	L	Level	Differential	Alarm	Low
L	D	C	H	Level	Differential	Control	High
L	D	C	L	Level	Differential	Control	Low

Table 40 68 00-3							
ISA Prefix				**Instrument Identification**			
L	D	I		Level	Differential	Indicate	
L	D	I	C	Level	Differential	Indicate	Control
L	D	I	R	Level	Differential	Indicate	Record
L	I			Level	Indicate		
L	I	C		Level	Indicate	Control	
L	I	R		Level	Indication	Remote	
M	M	A		Motor	Moisture	Alarm	
P	A	H		Pressure	Alarm	High	
P	A	H	H	Pressure	Alarm	High	High
P	A	L		Pressure	Alarm	Low	
P	A	L	L	Pressure	Alarm	Low	Low
P	C			Pressure	Control		
P	C	H		Pressure	Control	High	
P	C	H	H	Pressure	Control	High	High
P	C	L		Pressure	Control	Low	
P	C	L	L	Pressure	Control	Low	Low
P	D	A	H	Pressure	Differential	Alarm	High
P	D	A	L	Pressure	Differential	Alarm	Low
P	D	C	H	Pressure	Differential	Control	High
P	D	C	L	Pressure	Differential	Control	Low
P	D	I		Pressure	Differential	Indicate	
P	D	I	C	Pressure	Differential	Indicate	Control
P	D	I	R	Pressure	Differential	Indicate	Record
P	I			Pressure	Indicate		
P	I	C		Pressure	Indicate	Control	
P	I	R		Pressure	Indication	Remote	
S	A	H		Speed	Alarm	High	
S	A	L		Speed	Alarm	Low	
S	A	N		Speed	Alarm	Normal	
S	C			Speed	Control		
S	C	H		Speed	Control	High	
S	C	L		Speed	Control	Low	
S	C	N		Speed	Control	Normal	
S	I			Speed	Indicate		

Table 40 68 00-3								
ISA Prefix				**Instrument Identification**				
S	I	C		Speed	Indicate	Control		
S	I	R		Speed	Indicate	Record		
S	K			Speed	Control Station			
T	A	H		Temperature	Alarm	High		
T	A	H	H	Temperature	Alarm	High	High	
T	A	L		Temperature	Alarm	Low		
T	A	L		Temperature	Alarm	Low	Low	
T	C			Temperature	Control			
T	C	H		Temperature	Control	High		
T	C	H	H	Temperature	Control	High	High	
T	C	L		Temperature	Control	Low		
T	C	L	L	Temperature	Control	Low	Low	
T	I			Temperature	Indicate			
T	I	C		Temperature	Indicate	Control		
T	I	R		Temperature	Indicate	Remote		
V	A	H		Vibration	Alarm	High		
V	C	H		Vibration	Control	High		
V	I			Vibration	Indicate			
V	I	R		Vibration	Indicate	Record		
W	A	H		Weight	Alarm	High		
W	A	H	H	Weight	Alarm	High	High	
W	A	L		Weight	Alarm	Low		
W	A	L	L	Weight	Alarm	Low	Low	
W	C			Weight	Control			
W	C	H		Weight	Control	High		
W	C	H	H	Weight	Control	High	High	
W	C	L		Weight	Control	Low		
W	C	L	L	Weight	Control	Low	Low	
W	I			Weight	Indicate			
W	I	C		Weight	Indicate	Control		
W	I	R		Weight	Indicate	Record		
Y	A			Event	Alarm			
Y	C			Event	Control			

Table 40 68 00-3						
ISA Prefix				**Instrument Identification**		
Y	I			Event	Indicate	
Y	L			Event	Light	
Y	Y			Event	Relay	
Z	A			Position	Alarm	
Z	A	H		Position	Alarm	High
Z	A	H	H	Position	Alarm	High High
Z	A	L		Position	Alarm	Low
Z	A	L	L	Position	Alarm	Low Low
Z	A	N		Position	Alarm	Normal
Z	C			Position	Control	
Z	C	H		Position	Control	High
Z	C	H	H	Position	Control	High High
Z	C	L		Position	Control	Low
Z	C	L	L	Position	Control	Low Low
Z	C	N		Position	Control	Normal
Z	I			Position	Indicate	
Z	I	O		Position	Indicate	Open
Z	I	C		Position	Indicate	Close
Z	I	R		Position	Indicate	Record

F. Derived Function Blocks (DFBs) should be utilized to keep PLC code simple and consistent from PLC to PLC. Example DFB's are:

1. ALRM (Alarm Block) – Generates an alarm condition if a certain condition is true for a preset amount of time. The alarm condition may be latched or self-healing.

2. RH (Run Hours) – Calculates run hours for a piece of equipment as well as last start/stop dates/times as well as number of starts and starts per hour.

G. Common Programming Procedures. The following programming methods shall be followed when developing PLC logic:

1. User Data Types: No user defined data types shall be used without approval from the Owner and Engineer. Data types shall be selected to best suit the application. Default data types shall be BOOL, DINT and REAL.

2. Documentation: The following requirements shall be met with regards to documentation:

    a. All tags that have been created in the program shall have a description associated with it that adequately describes the tag and its purpose.

    b. Rung comments shall be used to adequately describe the functions being performed.

3. Messaging: PLC to PLC communication will take place over the plant network. All PLCs will perform reads only. No PLC writes will be accepted without approval from the Engineer. Any control that requires network communications shall have associated logic for communications alarming and watchdog. In the event of a communications alarm, logic shall be written on a case-by-case basis to follow the safest and most logical consequence for that control strategy.

4. Alarming: Alarm priorities shall be set up for each alarm as indicated in the Process Control Descriptions Section 40 61 96. All alarms shall be announced on the HMI and be one of two types of alarms: latched or self-healing alarms. A latched alarm remains active even after the alarm condition clears until an operator uses the alarm reset pushbutton on the HMI. A self-healing alarm clears itself once the alarm condition clears. All alarms shall be generated in the PLC logic utilizing the ALMD function block. Process alarms for each piece of equipment shall be detailed in the corresponding loop description. In addition to process alarms each PLC will have the following alarms:

    a. AC Power Failure Alarm

    b. UPS Alarm

    c. DC Power Supply Alarms

    d. Communications Failure Alarm

    e. PLC Card Failure

    f. PLC Fault

5. Standard Logic: The following methods should be followed when writing PLC logic:

    a. Where possible, utilize derived function blocks to make programming the same between devices and to simplify the look and feel of the program.

    b. All analog inputs shall be scaled within the PLC logic to engineering units.

c. General Latched Alarms: All latched alarms will be latched through the ALRM function block and un-latched by using the appropriate Alarm Reset button on the HMI.

d. General Self-Healing Alarms: All self-healing alarms will be announced on the HMI. Once the alarm condition clears the alarm will clear itself and operation will proceed as normal. Self-Healing Alarms are most common when the operator is required to go to the equipment and reset the alarm locally.

e. Valve Fail to Open: All valves with an Open Command or Open/Close Command shall have a Valve Fail to Open alarm. This is a latched alarm.

f. Valve Fail to Close: All valves with a Close Command or Open/Close Command shall have a Valve Fail to Close alarm. This is a latched alarm.

g. Valve Position Failure: All modulating valves with position control shall have a Valve Position Failure Alarm. The position failure alarm occurs when the Position Indication and Position Control are not within a specified tolerance for a specified delay time. This is a latched alarm.

h. Fail to Start: All equipment with start commands from the PLC shall have a Fail to Start Alarm. This is a latched alarm.

i. Fail to Stop: All motors with start commands from the PLC shall have a Fail to Stop Alarm. This is a latched alarm.

j. Speed Failure: All motors with speed control shall have a speed failure alarm. The speed failure alarm condition occurs when the Speed Indication and Speed Control are not within a user specified tolerance for a user specified delay time. This is a latched alarm.

k. Equipment Ready: All equipment with Start/Stop controls shall have a ready status. The ready status is energized if and only if no alarm conditions are present and the local switch is in remote. The ready status signifies that the equipment is ready to be controlled by SCADA.

l. Equipment Interlocks: Means shall be provided for equipment that is controlled by the PLC to have software interlocks to prevent the equipment from operating. The HMI shall display if an interlock is preventing it from operating.

m. Equipment Hours & Starts: Equipment that "runs" shall have the RH function block programmed for accumulating run hours, tracking starts and start/hour and allowing the operator to see the last time the equipment was started and stopped.

6. Instrument Alarms: By default instruments that provide an analog signal to the PLC shall have Lo-Lo, Low, High and Hi-Hi alarm logic with set points that are adjustable at the HMI.

2.04 OIT PROGRAMMING REQUIREMENTS:

A. Operator Interface Terminals (OITs) are typically provided at the machine level where a local interface is required in the process area. When an OIT is required it shall be programmed as follows:

1. Develop a main page with system status, alarm status and navigation. The main page shall include the date and time and have a button to allow the operator to update the date and time.

2. The OIT shall have user security with viewer, operator and supervisor usernames and passwords. When logged in as viewer (default), the user may see all the pages but does not have any control. When logged in as operator, the user may be able to control the system and change set points that are commonly changed. When logged in as supervisor, the user may control the system and change all set points.

3. The OIT shall have an alarm page that shows current alarms. Alarms may be acknowledged and reset from this screen. The screen shall be synced with the plant HMI system so that alarm acknowledgement may occur at either location and reflect the acknowledgement on both systems. A separate page shall show an alarm history.

4. The OIT shall have additional pages for the process and equipment for which the OIT is monitoring and controlling.

5. Fonts – The font shall typically be Arial size 13 except for titles that may have larger font.

6. Colors – The following color scheme shall be followed:

a. Static text – Gray or Black

b. Status text – Blue

c. Control text – Green

d. Equipment Status – Off – Red; On – Green

e. Valve Status – Closed – Red; Open – Green; Traveling Closed – Blinks between purple and red; Traveling Open – Blinks between purple and green; not travelling and not closed or opened: Purple

f. Alarms – If an instrument or piece of equipment has an alarm condition, it should blink between its normal color and yellow.

2.05 HMI PROGRAMMING REQUIREMENTS:

A. All HMI programming will be performed by the OSI.

B. General. The SCADA system shall be developed based upon the Inductive Automation's Ignition software platform. The core of the system consists of two SCADA servers that are redundant with each other. These SCADA servers host the database and I/O drivers for gathering the tags from the PLC's throughout the Facility. Separate servers are setup as SCADA historians, which collects data from selected tags and records that data to a historical database. The historian software utilizes Microsoft SQL Server and the SCADA servers push historical data into the SQL database. That data is then used for generating trends and reports. All SCADA clients are launched from a network connection established to either of the SCADA servers.

C. Network Configuration. The SCADA network shall be physically separate from all other networks. Only workstations connected to the SCADA network shall be allowed to launch SCADA clients. A firewall separates the SCADA servers from the historian and another firewall separates the historian from the SLCDPU network. This configuration allows SLCDPU to obtain historical data through the firewall. The SCADA servers are in separate buildings with dedicated, redundant connections between each other. The SCADA network is setup as a simple workgroup and IP address assignment should be coordinated with the OSI.

D. Software Installation. Each SCADA server shall be a Windows Server (coordinate the OS version with SLCDPU) and shall have the latest version of the Java Runtime Environment (JRE) installed. Typically, the latest version of Ignition is installed as well but this should be coordinated with SLCDPU. The Historian shall have Microsoft SQL Server Standard installed (coordinate the version with SLCDPU) with licensing based upon the number of cores in the server. All SCADA computers should have their clocks synchronized and be setup with automatic backups of all pertinent files.

E. SCADA Project Setup. The Ignition servers can run multiple projects but generally only one project is required. The project should be named appropriately for the facility that it is being setup for. Each project is assigned an authentication profile, a default database and tag provider.

F. Redundancy Configuration. Ignition redundancy is setup as a Master server and a Backup server. If the Master server goes down or is disconnected the Backup should take over. Then when the Master server is back online it will take over again as the Master.

G. SCADA System Security. Each Ignition server setup shall have security installed to prevent unauthorized users to access the system. The system shall have an audit log setup that records all user transactions to SQL Server. Security shall be setup so that users may be granted access to areas with varying security levels. Areas are generally setup by process area or location. Security levels (also called roles) by default are set as level 10 – Operator; Level 20 – Supervisor; Level 30 – Administrator. Additional levels may be added on an as needed basis. For example, if a separate Operator II level is desired, this

would be assigned to Level 11. Each SCADA tag that has control functions shall be assigned a security access area and level. Each view client shall be setup to auto logout after a preset time (default shall be 10 minutes) to a view-only account called "Viewer". The "Viewer" account shall be setup to allow the operator to view all the SCADA screens but not to perform any control functions.

H. SQL Database Configuration. Ignition connects to as many SQL databases as needed for the project. The default database should be called "SQL01" in Ignition and "ignition_SQL01" in SQL Server. Additional databases would increment in number as needed. The database is setup into different tables some of which are automatically generated by the project. Tables are used for alarm history, security audit log, operator logs, equipment logs, historical data and report data.

I. Alarm Configuration. The SCADA System shall be setup to provide an alarm alerting system that alerts and displays to operators any new or acknowledged alarms. In addition, an alarm history shall allow the operator to see alarms from any chosen previous date and time. Alarms shall be categorized by area or process like the above described security areas.

J. Alarm Notification – Voice Notification. Each alarm condition that is programmed within the SCADA System shall be configurable to notify the operator via a phone call if the alarm occurs. The system shall be setup with an on-call roster and schedule so that the voice notifications are routed to the right phone numbers.

K. I/O Drivers. Ignition is setup with OPC-UA and OPC-DA servers for connecting to devices such as PLC's to monitor and control those devices. Each device shall be strategically named and shall be setup for tag name queries. For Modicon PLC's, the Modicon OPC Factory Server (OFS) shall be utilized to accomplish this. Associated with each PLC shall be a scan class for that device that determines how often the device is polled for data.

L. Tag Database Development:

1. General. SCADA System tags shall be well organized into folders for each process control loop. Parent folders shall contain the facility and process area, location or PLC. Often folders are preceded by a number so that the folders are in process order. An example path to a control loop folder might be: "BCWTP/PLC0901/L0021_ReturnClearWellLevel". Here the facility is Big Cottonwood Water Treatment Plant (BCWTP), the PLC is PLC0901 and the control loop is 0021. Each control loop folder should contain all the tags necessary to monitor and control that loop.

2. Data Types. So that similar tags are consistently the same from one loop to another, Data Types shall be utilized. A Data Type is a tag structure that may consist of one or more individual tags. Typically, the tag structures are like the PLC Derived Function Blocks (DFBs) as described in the PLC programming section. They will

include all the necessary tags from the DFB plus additional internal tags that assist in the monitoring and control of the control loop.

3. Client Tags. Client tags are used for functions that are unique to each Ignition client. Uses include custom user settings, screen settings and security settings.

4. System Tags. System tags are used to show information about the SCADA software. Use these tags to show status of the system, including communications to devices, redundancy health, system date and time, system performance, database connectivity and alarm status.

M. SCADA Screen Development:

1. General. SCADA screens are the mechanism by which operators may monitor and control the facility. It is crucial that they are accurate and therefore each component on each screen should be thoroughly tested and debugged. To maintain consistency throughout SLCDPU's facilities, the following standards for screen development should be followed.

2. Templates. To maintain consistency throughout the SCADA screens, templates shall be used. Wherever there is commonality between display components a template will allow for those components to always be displayed in the same manner. Ignition allows templates to be nested which is a very powerful feature. Templates should be developed for basic building blocks such as pumps, valves, pipes, equipment, discrete displays, numeric displays, control buttons, numeric set points, etc. The combination of these building blocks should help to build more sophisticated templates for popups such as alarm status/configuration, motor status/configuration, PID controllers, alternators, instrument display/configuration, etc. See Figure 2.4.1 for an illustration of a set of templates. This is an example popup screen that has a template for each pump that has nested templates for discrete status, motor run hour information, motor control buttons and alarm configuration. The popup also has templates for pump alternation, PID control and numeric set points. These same templates are used throughout the screens so that they provide consistency to the operator.

3. SCADA Screen Standards. The following standards shall be followed when developing the SCADA screens:

a. Screen Size – Screens shall be developed for wide screen monitors with HD resolution (1920x1080). The development of the screens shall account for the Windows menu on the bottom of the screen as well as application borders.

b. Windows shall automatically resize if the monitor's resolution is something other than 1920x1080.

c. Fonts – The font shall typically be Arial size 13 except for titles that may have larger font.

d. Colors – The following color scheme shall be followed:

(1) Static text – Gray Black

(2) Status text – Blue

(3) Control text – Green

(4) Equipment Status – Off – Red; On – Green

(5) Valve Status – Closed – Red; Open – Green; Traveling Closed – Blinks between purple and red; Traveling Open – Blinks between purple and green; not travelling and not closed or opened: Purple

(6) Alarms – If an instrument or piece of equipment has an alarm condition, it should blink between its normal color and yellow.

e. Navigation – The user shall have the ability to navigate through the SCADA screens by using the top menu and navigation tree (described below). In addition, buttons should be located on individual windows to allow for navigation to other screens and to open popups. The system shall be setup for a "viewer" mode which when the operator isn't logged in navigation is still allowed but all control functions on all screens are disabled. Each control loop within the system should have an associated popup screen (popup screens may contain information from multiple control loops). Typically, the operator would click on the equipment as it is displayed on the screen to open the popup for that equipment.

4. Windows:

a. Top Menu – Across the top of the screen shall be a top menu. This menu is always visible to the operator. The menu shall have the following functionality:

(1) The SLCDPU logo which when pressed opens the main overview screen.

(2) A back arrow that when pressed opens the previously opened window.

(3) A forward arrow that when pressed returns to the original screen that was open after the Back button was pressed.

(4) An Alarms button and symbol that flashes red if an unacknowledged alarm exists (a number should also appear indicating the number of unacknowledged alarms present). When pressed the Alarms window is opened.

(5) A Trends button and symbol that when pressed opens the Trends window.

(6) A Logs button that opens the operator log window

(7) A Reports button and symbol that when pressed opens the Reports window.

(8) A Comms button and symbol that when pressed opens the Communications window.

(9) A Login/Logout button and text that shows the current user that is logged into the system and when pressed open a popup window that allows the operator to login or logout or to switch to the viewer user.

(10) The system date and time shall be displayed on the menu.

b. Navigation Tree – Along the left side of the screen shall be a navigation tree. This tree is always visible to the operator. The tree gives the operator the ability to open all project windows for the facility. It is possible that the tree takes up all the space on the left of the screen if there are a lot of windows in the project. If there are not a lot of windows and there is some space below the tree, then key process information should be shown below the tree.

c. Overview Screen – When the Ignition Client is launched, and the operator logs in for the first time, the Menu, Navigation Tree and main Overview Screen should always be displayed. Clicking on the SLCDPU logo on the Menu will always return the operator to the Overview Screen. The Overview Screen should be a process diagram of the facility. The goal of this window is to show the operator as much information as possible about the facility's overall operation.

d. Standard Windows:

(1) Alarms – The alarms screen is where the operator goes to look at current and past alarms. The screen should be divided into five tabs as follows:

(a) Tab #1 – Active Alarms – This primary tab shows any unacknowledged alarms and acknowledged alarms that have not yet been cleared. Each alarm shall indicate if it has been acknowledged and if so by whom, it shall have the time the alarm became active, an alarm description, current state and active duration. Only operators that are logged in shall be able to acknowledge alarms. In addition, alarms may be shelved by the operator. When shelving an alarm, a dropdown will allow the operator to select for how long the alarm should be shelved for.

(b) Tab #2 – Alarm History – This tab shows a history of alarms which includes when the alarm when active, when it was acknowledged and when it was cleared. A calendar tool at the bottom of the page will allow the operator to view alarm history with specific start and stop dates and times.

(c) Tab #3 – Disables Alarms – This tab shows any alarms in the system that have been disabled by an operator.

(d) Tab #4 – Suppressed Alarms - This tab shows any alarms in the system that have been suppressed by an operator.

(e) Tab #5 – Out of Service – This tab lists any equipment that has been taken out of service by an operator.

The Alarms screen shall have a button called "Test Alarm" that allows the operator to turn on a test alarm to make sure that the alarming system is properly working.

(2) Trending – The trending screen allows operators to view custom and/or saved trends for the facility. The screen shall utilize Ignition's "Ad Hoc Trend" tool which is preconfigured with tag picking from the Historian, date/time selection and buttons with various trending tools.

(3) Communications – The communications screen allows operators to view the architecture of the SCADA system. All devices that are connected to the SCADA system with a communications link (typically an Ethernet link) shall be shown on this screen. Status of the communication of each device is shown and alarms are triggered if communications are lost with each of the devices. PLC's shall show their current state (running, stopped or faulted) and system clock. PLC clocks should automatically synchronize with the primary SCADA server's clock. If a PLC clock is not properly synchronized with the SCADA server, an alarm is triggered. Statistical information should be shown for each PLC in the system.

(4) Logs – The logs screen is a location for operators to view various logs that are being kept through the SCADA software as well as give the operator the ability to enter their own logs. The logs screen shall have a set of tabs for each log that has been configured. What is shown in the example screen is typical but additional logs may be implemented when needed. The first tab is the "Area" log. This is where operators enter logs for areas within the facility. The second tab is the "Equipment" log. This log is for each piece of equipment in the facility. When a piece of equipment is put into service or taken out of service a log entry is automatically added to this log. In addition, the operator may add custom equipment logs when needed. The third tab is the

"Audit log". This log is automatically generated by the Ignition software and reports when operators log in, log out, acknowledge alarms and make control or set point changes on the SCADA screens. The fourth tab is the preventative maintenance "SCADA PM's log. This log is a table of preventative maintenance tanks for each asset in the facility and is used to interact with the facility's asset management software.

(5) Reports – The Reports screen is where the operator goes to setup, view, print and/or obtain data related to the facility's process.

e. Project Windows – The project windows allow the operator to see how each control loop within each process of the facility is functioning and provides access to control loop popups which allow the operator to make control and set point changes. The screens shall be designed in a 2-dimensional process flow diagram manner. Wherever possible, the diagram shall also be laid out in the same orientation as the equipment is physically installed at the facility. When developing project windows, the programmer shall hold screen development workshops with the Owner and Engineer. In the initial workshop the programmer shall present his or her ideas on how the project windows should look and obtain input from the Owner and Engineer. Then the programmer will develop the first draft of all project windows as which point a subsequent workshop will be held and the screens presented. Final modifications will be implemented and then a final workshop should be held. In the final workshop the screens should be presented in a fully functional Ignition client with simulated data.

f. Popups – The programmer shall develop popups for the project so that monitoring and control of each control loop throughout the system is properly achieved. Popups may be unique or may be templates that are interchangeable. Because of the HD resolution of the monitors, popups may be small or large depending on process/system and Owner preference.

5. There shall be a plant overview HMI screen that graphically depicts the plant and allows for logical navigation to each process area through buttons.

6. Each area should generally have three layers of depth that can be clicked into for more details:

   a. Process area overview

   b. Subsystem process view

   c. Detailed view (if required)

7. Each area will have a process overview screen with main status and control available – a point should be included on the area overview generally if the point will be checked or monitored once per 4 hours.

8. Each process area subsystem or control loop should be logically grouped based on the process, functionality, and interactions in the subsystem process view screens. The process area overview screen shall have buttons near the associated process graphics to navigate to the subsystem process view screen. Most status and set points shall be able to be viewed and set from this screen. In areas with complex control loops that cannot fit on one screen with sufficient whitespace, general status and controls will be shown and a button will be provided to navigate to a further detailed view for all available status and control points.

PART 3 - EXECUTION

3.01 PREPARATION:

A. The Contractor is responsible for all factory testing in accordance with Section 40 61 13 and Section 40 61 21.

3.02 INSTALLATION:

A. Provide in accordance with Section 40 61 13.

3.03 FIELD TESTING:

A. Provide in accordance with Section 40 61 21.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 40 70 00

INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide Instrumentation for Process Systems as specified in this section and in compliance with related detailed instrumentation specification sections and Contract Documents.

B. The Work of this section includes the provision of instrument data sheets for all instruments supplied for this project. The contractor shall provide an as-constructed instrument data sheet for each instrument supplied for this project based on the ISA S20 standard for instrument specification forms.

C. Refer to Section 40 61 13 for additional requirements related to instrument specification sheets.

1.02 REFERENCES:

A. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S5.4: Instrument Loop Diagrams

3. S7: Instrument Air

4. S12: Electrical Equipment for Hazardous Locations

5. S18.2: Alarm Management

6. S20: Instrument Specifications

7. S50: Electrical Control Signals

8. S75: Control Valve Design, Specification and Testing

9. S96: Valve Actuators

10. S99: Control System Cyber Security

11. 101: Human-Machine Interfaces

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Prepare and submit Instrument Data Sheets for each instrument supplied for this project in accordance with the ISA S20 standard. Clearly indicate all pertinent data for the respective instrument on the data sheets and clearly indicate any deviations from specified requirements. The completed Instrument Data Sheets shall be submitted together with and form an integral part of the instrumentation shop drawings specified in this division.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 INSTRUMENTATION INDEX:

A. The table provided in this section is an itemized list of instrumentation to be supplied for this project. The instrumentation index provides detailed information for the tagged instrumentation devices shown on the P&ID diagrams and HVAC schematic diagrams.

B. The Instrumentation Index also provides references to the service conditions, P&ID drawing, instrumentation specification section, wiring diagrams, standard details, and location drawings.

PART 3 - EXECUTION

3.01 INSTRUMENT DATA SHEETS:

A. Contractor shall update the Instrument Data Sheets to reflect all changes in the work, and as required based on shop drawings that have been returned from the Engineer with a “No Exceptions Taken” or “Make Corrections Noted” status.

B. The as-constructed set of instrument data sheets shall be included in the O&M manual submittal.

3.02 INSTRUMENT INDEX:

A. Contractor shall update the Instrument Index to reflect all changes in the work, and as required based on shop drawings that have been returned from the Engineer with a “No Exceptions Taken” or “Make Corrections Noted” status.

B. The as-constructed Instrument Index shall be included in the O&M manual submittal.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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Area	Type	acm_Loop Number	Drawing Number	Spec	Associated Equipment	Device Type	Low Low Alarm	Low Alarm	Set Point	Set Point Adjustable Range	High Alarm	High High Alarm	Loop Wiring Diagram	Standard Detail	Location Drawing	Vendor Package
01	FIT	10101	0100-X601	40 71 00	Maintenance Hole 3A Flow Sensor	Radar Level Sensor	4192.97	4193.97	4193.57	7.2	4196.75	4200.17	ILD-FE.H.3A	0100-I701	N/A	
01	FIT	10201	0100-X601	40 71 00	Existing Manhole Flow Sensor	Radar Level Sensor	4201.5	4202.5	4204.5	6	4205.5	4207.5	ILD-FE.H.3A	0100-I701	N/A	
01	FIT	10301	0100-X601	40 71 00	Maintenance Hole 5B Flow Sensor	Radar Level Sensor	4197.39	4198.39	4198.23	1.7	4198.5	4199	ILD-FE.H.3A	0100-I701	N/A	
01	ZSO	11101	0100-X602	40 23 13.01	RWW 1 Gate	Open Position Switch							ILD-FCV.H.1A		0101-I101	
01	ZSC	11101	0100-X602	40 23 13.01	RWW 1 Gate	Closed Position Switch							ILD-FCV.H.1A		0101-I102	
01	FCV	11101	0100-X602	40 23 13.01 / 40 23 13.03	RWW 1 Gate	Modulating Valve Actuator							ILD-FCV.H.1AS	Mfr. Std.	0101-I102	
01	LE	11102	0100-X602	40 72 00	RWW 1	Ultrasonic Level Transmitter	4191	4191.5	4191.7	18.26	4194	4197	ILD-L.H.1BS	0100-I703	0101-I101	
01	LE	11103	0100-X602	40 72 00	RWW 1	Radar Level Transmitter	4191	4191.5	4191.7	18.26	4194	4197	ILD-L.H.1BS	0100-I703	0101-I101	
01	LSLL	11104	0100-X602	40 72 00	RWW Wetwell 1 Low Low Level Switch	Float Switch	4191		4191	0			ILD-LSLL_LSHH.H.2A	0100-I702	0101-I102	
01	LSHH	11105	0100-X602	40 72 00	RWW Wetwell 1 High High Level Switch	Float Switch			4197	0		4197	ILD-LSLL_LSHH.H.2A	0100-I701	0101-I102	
01	LSH	11106	0100-X602	40 72 00	RWW Wetwell 1 High Level Switch 1	Float Switch			4194		4194		ILD-LSLL_LSHH.H.2A	0100-I703	0101-I101	
01	LSH	11107	0100-X602	40 72 00	RWW Wetwell 1 High Level Switch 2	Float Switch			4191.7		4191.7		ILD-LSLL_LSHH.H.2A	0100-I703	0101-I101	
01	LSL	11108	0100-X602	40 72 00	RWW Wetwell 1 Low Level Switch	Float Switch		4191.5	4191.5				ILD-LSLL_LSHH.H.2A	0100-I703	0101-I101	
01	PG	11111	0100-X602	40 73 00	RWW Pump 1	Pressure Gauge								0100-I701	0101-I102	
01	FV	11112	0100-X602	40 23 13.01 / 40 23 13.03	RWW Pump 1 Discharge Valve	Open/Close Valve Actuator							ILD-FV.H.1B	Mfr. Std.	0101-I102	
01	PIT	11113	0100-X602	40 73 00	RWW Pump 1	Pressure Transmitter	13.85	19.05	33.33	61.14	74.89	75	ILD-P.H.1C	0100-I702	0101-I102	
01	PSH	11114	0100-X602	40 73 00	RWW Pump 1 Discharge High Pressure Switch	Pressure Switch			74.89	7.489	74.89		ILD-PSH.H.1CS	0100-I702	0101-I102	
01	PG	11131	0100-X602	40 73 00	RWW Pump 3	Pressure Gauge									0101-I102	
01	FV	11132	0100-X602	40 23 13.01 / 40 23 13.03	RWW Pump 3 Discharge Valve	Open/Close Valve Actuator							ILD-FV.H.1B	Mfr. Std.	0101-I102	
01	PIT	11133	0100-X602	40 73 00	RWW Pump 3	Pressure Transmitter	13.85	19.05	33.33	61.14	74.89	75	ILD-P.H.1C	0100-I702	0101-I102	
01	PSH	11134	0100-X602	40 73 00	RWW Pump 3 Discharge High Pressure Switch	Pressure Switch			74.89				ILD-PSH.H.1CS	0100-I702	0101-I102	
01	PG	11151	0100-X602	40 73 00	RWW Pump 5	Pressure Gauge									0101-I102	
01	FV	11152	0100-X602	40 23 13.01 / 40 23 13.03	RWW Pump 3 Discharge Valve	Open/Close Valve Actuator							ILD-FV.H.1B	Mfr. Std.	0101-I102	
01	PIT	11153	0100-X602	40 73 00	RWW Pump 5	Pressure Transmitter	13.85	19.05	33.33	61.14	74.89	75	ILD-P.H.1C	0100-I702	0101-I102	
01	PSH	11154	0100-X602	40 73 00	RWW Pump 5 Discharge High Pressure Switch	Pressure Switch			74.89				ILD-PSH.H.1CS	0100-I702	0101-I102	
01	HS	11311	0100-X602	40 78 00	RWW Pump 1 Solenoid	OCR Switch							ILD-SOL.H.1AS		0101-I102	
01	SOL	11311	0100-X602	40 23 13.01 / 40 23 13.03	RWW Pump 1 Solenoid	Solenoid Valve							ILD-SOL.H.1AS	Mfr. Std.	0101-I102	
01	FSL	11312	0100-X602	40 71 00	RWW Pump 1	Flow Switch	7750						ILD-FSL.H.1AS	0100-I701	0101-I102	
01	HS	11331	0100-X602	40 78 00	RWW Pump 3 Solenoid	OCR Switch							ILD-SOL.H.1AS		0101-I102	
01	SOL	11331	0100-X602	40 23 13.01 / 40 23 13.03	RWW Pump 3 Solenoid	Solenoid Valve							ILD-SOL.H.1AS	Mfr. Std.	0101-I102	
01	FSL	11332	0100-X602	40 71 00	RWW Pump 3	Flow Switch	7750						ILD-FSL.H.1AS	0100-I701	0101-I102	
01	HS	11351	0100-X602	40 78 00	RWW Pump 5 Solenoid	OCR Switch							ILD-SOL.H.1AS		0101-I102	
01	SOL	11351	0100-X602	40 23 13.01 / 40 23 13.03	RWW Pump 5 Solenoid	Solenoid Valve							ILD-SOL.H.1AS	Mfr. Std.	0101-I102	
01	FSL	11352	0100-X602	40 71 00	RWW Pump 5	Flow Switch	7750						ILD-FSL.H.1AS	0100-I701	0101-I102	
01	AIT	80001	0100-X602	40 76 00	Gas Detection Panel	Gas Analyzer Transmitter	2	5	5	48	20	50	ILD-A.H.4A		0101-I102	
01	HS	80003	0100-X602	40 78 00	Gas Detection Panel	Silence Pushbutton							ILD-A.H.4A		0101-I102	
01	HS	11110-1	0100-X602	40 78 00	RWW Pump 1	Lock/Off/Stop Switch							ILD-M.EN.4C		0101-I102	
01	HS	11110-2	0100-X602	40 78 00	RWW Pump 1	Hand/Off/Auto Switch							ILD-M.EN.4C		0101-I102	
01	ZSO	1111A	0100-X602	40 23 13.01	RWW Pump 1 Discharge Check Valve	Open Position Switch							ILD-HV.H.1AS		0101-I102	
01	ZSC	1111A	0100-X602	40 23 13.01	RWW Pump 1 Discharge Check Valve	Closed Position Switch							ILD-HV.H.1AS		0101-I102	
01	HS	11130-1	0100-X602	40 78 00	RWW Pump 3	Hand/Off/Auto Switch							ILD-M.EN.4C		0101-I102	
01	HS	11130-2	0100-X602	40 78 00	RWW Pump 3	Lock/Off/Stop Switch							ILD-M.EN.4C		0101-I102	
01	ZSO	1113A	0100-X602	40 23 13.01	RWW Pump 3 Discharge Check Valve	Open Position Switch							ILD-HV.H.1AS		0101-I102	
01	ZSC	1113A	0100-X602	40 23 13.01	RWW Pump 3 Discharge Check Valve	Closed Position Switch							ILD-HV.H.1AS		0101-I102	
01	HS	11150-1	0100-X602	40 78 00	RWW Pump 5	Hand/Off/Auto Switch							ILD-M.EN.4C		0101-I102	
01	HS	11150-2	0100-X602	40 78 00	RWW Pump 5	Lock/Off/Stop Switch							ILD-M.EN.4C		0101-I102	
01	ZSC	1115A	0100-X602	40 23 13.01	RWW Pump 5 Discharge Check Valve	Closed Position Switch							ILD-HV.H.1AS		0101-I102	
01	ZSO	1115A	0100-X602	40 23 13.01	RWW Pump 5 Discharge Check Valve	Open Position Switch							ILD-HV.H.1AS		0101-I102	
01	XI	80002-1	0100-X602	40 76 00	Gas Detection Panel	Indicating Light							ILD-A.H.4A		0101-I102	
01	XI	80002-2	0100-X602	40 76 00	Gas Detection Panel	Indicating Light							ILD-A.H.4A		0101-I102	
01	ZSO	11201	0100-X603	40 23 13.01	RWW 2 Gate	Open Position Switch							ILD-FCV.H.1A		0101-I01	
01	ZSC	11201	0100-X603	40 23 13.01	RWW 2 Gate	Closed Position Switch							ILD-FCV.H.1A		0101-I102	
01	FCV	11201	0100-X603	40 23 13.01 / 40 23 13.03	RWW 2 Gate	Modulating Valve Actuator							ILD-FCV.H.1AS	Mfr. Std.	0101-I102	
01	LE	11202	0100-X603	40 72 00	RWW 2	Ultrasonic Level Transmitter	4191	4191.5	4191.7	18.26	4194	4197	ILD-L.H.1BS	0100-I703	0101-I101	
01	LE	11203	0100-X603	40 72 00	RWW 2	Radar Level Transmitter	4191	4191.5	4191.7	18.26	4194	4197		0100-I703	0101-I102	
01	LSLL	11204	0100-X603	40 72 00	RWW Wetwell 2 Low Low Level Switch	Float Switch	4191		4191	0			ILD-LSLL_LSHH.H.2A	0100-I703	0101-I102	
01	LSHH	11205	0100-X603	40 72 00	RWW Wetwell 2 High High Level Switch	Float Switch			4197	0		4197	ILD-LSLL_LSHH.H.2A	0100-I703	0101-I102	
01	LSH	11206	0100-X603	40 72 00	RWW Wetwell 2 High Level Switch 1	Float Switch			4194		4194		ILD-LSLL_LSHH.H.2A	0100-I703	0101-I101	
01	LSH	11207	0100-X603	40 72 00	RWW Wetwell 2 High Level Switch 2	Float Switch			4191.7		4191.7		ILD-LSLL_LSHH.H.2A	0100-I703	0101-I101	
01	LSL	11208	0100-X603	40 72 00	RWW Wetwell 2 Low Level Switch	Float Switch		4191.5	4191.5				ILD-LSLL_LSHH.H.2A	0100-I703	0101-I101	
01	PG	11221	0100-X603	40 73 00	RWW Pump 2	Pressure Gauge							N/A			
01	FV	11222	0100-X603	40 23 13.01 / 40 23 13.03	RWW Pump 2 Discharge Valve	Open/Close Valve Actuator							ILD-FV.H.1B	Mfr. Std.	0101-I102	
01	PIT	11223	0100-X603	40 73 00	RWW Pump 2	Pressure Transmitter	13.85	19.05	33.33	61.14	74.89	75	ILD-P.H.1C	0100-I702	0101-I102	
01	PSH	11224	0100-X603	40 73 00	RWW Pump 2 Discharge High Pressure Switch	Pressure Switch			74.89	7.489	74.89	0	ILD-PSH.H.1CS	0100-I702	0101-I102	
01	PG	11241	0100-X603	40 73 00	RWW Pump 4	Pressure Gauge							N/A			
01	FV	11242	0100-X603	40 23 13.01 / 40 23 13.03	RWW Pump 4 Discharge Valve	Open/Close Valve Actuator							ILD-FV.H.1B	Mfr. Std.	0101-I102	
01	PIT	11243	0100-X603	40 73 00	RWW Pump 4	Pressure Transmitter	13.85	19.05	33.33	61.14	74.89	75	ILD-P.H.1C	0100-I702	0101-I102	

Area	Type	acm_Loop Number	Drawing Number	Spec	Associated Equipment	Device Type	Low Low Alarm	Low Alarm	Set Point	Set Point Adjustable Range	High Alarm	High High Alarm	Loop Wiring Diagram	Standard Detail	Location Drawing	Vendor Package
01	PSH	11244	0100-X603	40 73 00	RWW Pump 4 Discharge High Pressure Switch	Pressure Switch			74.89	7.489	74.89	0	ILD-PSH.H.1CS	0100-I702	0101-I102	
01	HS	11321	0100-X603	40 78 00	RWW Pump 2 Solenoid	OCR Switch							ILD-SOL.H.1AS		0101-I102	
01	SOL	11321	0100-X603	40 23 13.01 / 40 23 13.03	RWW Pump 2 Solenoid	Solenoid Valve							ILD-SOL.H.1AS	Mfr. Std.	0101-I102	
01	FSL	11322	0100-X603	40 71 00	RWW Pump 2	Flow Switch	7750						ILD-FSL.H.1AS	0100-I701	0101-I102	
01	HS	11341	0100-X603	40 78 00	RWW Pump 4 Solenoid	OCR Switch							ILD-SOL.H.1AS		0101-I102	
01	SOL	11341	0100-X603	40 23 13.01 / 40 23 13.03	RWW Pump 4 Solenoid	Solenoid Valve							ILD-SOL.H.1AS	Mfr. Std.	0101-I102	
01	FSL	11342	0100-X603	40 71 00	RWW Pump 4	Flow Switch	7750						ILD-FSL.H.1AS	0100-I701	0101-I102	
01	HS	11220-1	0100-X603	40 78 00	RWW Pump 2	Hand/Off/Auto Switch									0101-I102	
01	HS	11220-2	0100-X603	40 78 00	RWW Pump 2	Lock/Off/Stop Switch									0101-I102	
01	ZSO	1122A	0100-X603	40 23 13.01	RWW Pump 2 Discharge Check Valve	Open Position Switch							ILD-HV.H.1AS		0101-I102	
01	ZSC	1122A	0100-X603	40 23 13.01	RWW Pump 2 Discharge Check Valve	Closed Position Switch							ILD-HV.H.1AS		0101-I102	
01	HS	11240-1	0100-X603	40 78 00	RWW Pump 4	Hand/Off/Auto Switch									0101-I102	
01	HS	11240-2	0100-X603	40 78 00	RWW Pump 4	Lock/Off/Stop Switch									0101-I102	
01	ZSC	1124A	0100-X603	40 23 13.01	RWW Pump 4 Discharge Check Valve	Closed Position Switch							ILD-HV.H.1AS		0101-I102	
01	ZSO	1124A	0100-X603	40 23 13.01	RWW Pump 4 Discharge Check Valve	Open Position Switch							ILD-HV.H.1AS		0101-I102	
01	FE	11411	0100-X604	40 71 00	RWW Header 1	Flowmeter				18,056 - 54,690			ILD-FE.H.1AS	0100-I701	0101-I102	
01	FV	11412	0100-X604	40 23 13.01 / 40 23 13.03	RWW Header 1	Open/Close Valve Actuator							ILD-FV.H.1B	Mfr. Std.	0101-I102	
01	FV	11413	0100-X604	40 23 13.01 / 40 23 13.03	RWW Header 1 Drain Valve	Open/Close Valve Actuator							ILD-FV.H.1B	Mfr. Std.	0101-I102	
01	FE	11421	0100-X604	40 71 00	RWW Header 2	Flowmeter				18,056 - 54,690			ILD-FE.H.1AS	0100-I701	0101-I102	
01	FV	11422	0100-X604	40 23 13.01 / 40 23 13.03	RWW Header 2	Open/Close Valve Actuator							ILD-FV.H.1B	Mfr. Std.	0101-I102	
01	FV	11423	0100-X604	40 23 13.01 / 40 23 13.03	RWW Header 2 Drain Valve	Open/Close Valve Actuator							ILD-FV.H.1B	Mfr. Std.	0101-I102	
01	FV	11431	0100-X604	40 23 13.01 / 40 23 13.03	RWW Header Cross Connect Valve	Open/Close Valve Actuator							ILD-FV.H.1B	Mfr. Std.	0101-I102	
01	PIT	40006	0100-X605	40 73 00	IPS Odor Control Foul Air Intake Pressure Transmitter	Pressure Transmitter	-25 w.c.	-20 w.c.	-14 w.c.	-25 w.c. - 406.78 w	0 w.c.	406.78 w.c.	ILD-P.H.1C	0100-I702	0102-I101	
01	MD	40101	0100-X605	40 23 13.01 / 40 23 13.03	IPS Odor Control Damper	Open/Close Valve Actuator							ILD-MD.H.1A	Mfr. Std.	0102-I101	
01	PDIT	40102	0100-X605	40 73 00	IPS Odor Control Differential Pressure Transmitter	Differential Pressure Transmitter								0100-I702		
01	TIT	40103	0100-X605		Bioscrubber Temperature Transmitter		-40	40	65	- 40 to 100	90	100				IPS ODOR CONTROL SYSTEM
01	PDIT	40104	0100-X605	40 73 00	Bioscrubber Differential Pressure Transmitter	Differential Pressure Transmitter								0100-I702		IPS ODOR CONTROL SYSTEM
01	LSL	40105	0100-X605	40 72 00	Bioscrubber Low Level Switch	Float Switch			Per Vendor						0102-I101	IPS ODOR CONTROL SYSTEM
01	LSH	40106	0100-X605	40 72 00	Bioscrubber High Level Switch	Float Switch			Per Vendor						0102-I101	IPS ODOR CONTROL SYSTEM
01	LSHH	40107	0100-X605	40 72 00	Bioscrubber High High Level Switch	Float Switch			Per Vendor						0102-I101	IPS ODOR CONTROL SYSTEM
01	SOL	40108	0100-X605	40 23 13.01 / 40 23 13.03	W2 to Bioscrubber Solenoid Valve	Solenoid Valve							ILD-SOL.H.1AS	Mfr. Std.	0102-I101	IPS ODOR CONTROL SYSTEM
01	FE	40111	0100-X605		Odor Control System	Rotameter			55 gpm				ILD-FE.H.1A		0101-I102	IPS ODOR CONTROL SYSTEM
01	PIT	40131	0100-X605	40 73 00	Bioscrubber Sprayer Pressure Transmitter	Pressure Transmitter	-25 w.c.	-20 w.c.	-14 w.c.	-25 w.c. - 406.78 w	0 w.c.	406.78 w.c.	ILD-P.H.1C	0100-I702	0102-I101	IPS ODOR CONTROL SYSTEM
01	FE	40132	0100-X605	40 71 00	Bioscrubber Sprayer Flowmeter	Flowmeter			55 gpm				Mfg Std	0100-I701	0102-I101	IPS ODOR CONTROL SYSTEM
01	HS	40110-1	0100-X605	40 78 00	Recirc Pump	Hand/Off/Auto Switch									0102-I101	IPS ODOR CONTROL SYSTEM
01	HS	40110-2	0100-X605	40 78 00	Recirc Pump	Lock/Off/Stop Switch									0102-I101	IPS ODOR CONTROL SYSTEM
01	HS	40120-1	0100-X605	40 78 00	Nutrient Tank Mixer	Hand/Off/Auto Switch									0102-I101	IPS ODOR CONTROL SYSTEM
01	HS	40120-2	0100-X605	40 78 00	Nutrient Tank Mixer	Lock/Off/Stop Switch									0102-I101	IPS ODOR CONTROL SYSTEM
01	HS	40130-1	0100-X605	40 78 00	Metering Pump	Hand/Off/Auto Switch									0102-I101	IPS ODOR CONTROL SYSTEM
01	HS	40130-2	0100-X605	40 78 00	Metering Pump	Lock/Off/Stop Switch									0102-I101	IPS ODOR CONTROL SYSTEM
01	TIT	40141	0100-X606		Biofilter 1 Temperature Transmitter	Temperature Transmitter	-40	40	65	- 40 to 100	90	100			0102-I101	IPS ODOR CONTROL SYSTEM
01	PDIT	40142	0100-X606		Biofilter 1 Differential Pressure Transmitter	Differential Pressure Transmitter									0102-I101	IPS ODOR CONTROL SYSTEM
01	FS	40143	0100-X606		W2 to Biofilter 1 Flow Switch	Flow Switch									0102-I101	IPS ODOR CONTROL SYSTEM
01	PV	40144	0100-X606	40 23 13.01 / 40 23 13.03	W2 to Biofilter 1 Pressure Valve	Solenoid Valve							ILD-SOL.H.1AS	Mfr. Std.	0102-I101	IPS ODOR CONTROL SYSTEM
01	PG	40151	0100-X607	40 73 00	FOA Fan Suction Pressure Gauge	Pressure Gauge										
01	PIT	40152	0100-X607	40 73 00	FOA Fan Suction Pressure Transmitter	Pressure Transmitter	-25 w.c.	-20 w.c.	-14 w.c.	-25 w.c. - 406.78 w	0 w.c.	406.78 w.c.	ILD-P.H.1C	0100-I702	0102-I101	
01	MD	40153	0100-X607	40 23 13.01 / 40 23 13.03	FOA Fan Discharge Modulating Damper	Open/Close Valve Actuator							ILD-MD.H.1A	Mfr. Std.	0102-I101	
01	PG	40154	0100-X607	40 73 00	FOA Fan Discharge Pressure Gauge	Pressure Gauge										
01	PG	71011	0100-X631	40 73 00	W2 Pump 1 Suction Pressure Gauge	Pressure Gauge							N/A	0100-I702		
01	PG	71012	0100-X631	40 73 00	W2 Pump 1 Discharge Pressure Gauge	Pressure Gauge							N/A	0100-I702	8001-P101	
01	PG	71021	0100-X631	40 73 00	W2 Pump 2 Suction Pressure Gauge	Pressure Gauge							N/A		8001-P101	
01	PG	71022	0100-X631	40 73 00	W2 Pump 2 Discharge Pressure Gauge	Pressure Gauge							N/A	0100-I702		
01	HS	71010-1	0100-X631	40 78 00	W2 Pump 1 LOS Switch	Lock/Off/Stop Switch							Mfr. Std.	Mfr. Std.	0101-I102	
01	HS	71010-2	0100-X631	40 78 00	W2 Pump 1 HOA Switch	Hand/Off/Auto Switch							Mfr. Std.	Mfr. Std.	0101-I102	
01	HS	71020-1	0100-X631	40 78 00	W2 Pump 2 LOS Switch	Lock/Off/Stop Switch							Mfr. Std.	Mfr. Std.	0101-I102	
01	HS	71020-2	0100-X631	40 78 00	W2 Pump 2 HOA Switch	Hand/Off/Auto Switch							Mfr. Std.	Mfr. Std.	0101-I102	
01	FIT	71010	0100-X631	40 71 00	W2 Break Tank Influent Flowmeter	Flowmeter			85					0100-I701	0101-I102	
01	PG		0100-X631	40 73 00	W2 Break Tank Influent Pressure Gauge	Pressure Gauge							N/A			
01	FIT	71020	0100-X632	40 71 00	W3CW Distribution Flowmeter 1	Flowmeter			65				ILD-FE.H.1AS	0100-I701	0101-I102	
01	PG	71021	0100-X632	40 73 00	W3CW Distribution Pressure Gauge 1	Pressure Gauge							N/A			
01	FIT	71030	0100-X632	40 71 00	W3CW Distribution Flowmeter 2	Flowmeter							ILD-FE.H.1AS	0100-I701	0104-P101	
01	PG	71031	0100-X632	40 73 00	W3CW Distribution Pressure Gauge 2	Pressure Gauge							N/A			
01	FIT	71040	0100-X632	40 71 00	W1 Distribution Flowmeter	Flowmeter							ILD-FE.H.1AS	0100-I701	0104-P101	
01	PG	71041	0100-X632	40 73 00	W1 Distribution Pressure Gauge	Pressure Gauge							N/A			
01	LSL	81111	0100-X655	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	FV	81113	0100-X655	40 72 00	Generator Fueling System	Open/Close Valve Actuator			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	FV	81114	0100-X655	40 72 00	Generator Fueling System	Open/Close Valve Actuator			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM

Area	Type	acm_Loop Number	Drawing Number	Spec	Associated Equipment	Device Type	Low Low Alarm	Low Alarm	Set Point	Set Point Adjustable Range	High Alarm	High High Alarm	Loop Wiring Diagram	Standard Detail	Location Drawing	Vendor Package
01	LSL	81121	0100-X655	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	FV	81123	0100-X655	40 72 00	Generator Fueling System	Open/Close Valve Actuator			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	FV	81124	0100-X655	40 72 00	Generator Fueling System	Open/Close Valve Actuator			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	PG	81116	0100-X655	40 73 00	Generator Fueling System	Pressure Gauge							N/A			GENERATOR FUELING SYSTEM
01	PG	81126	0100-X655	40 73 00	Generator Fueling System	Pressure Gauge							N/A			GENERATOR FUELING SYSTEM
01	PSH	81117	0100-X655	40 73 00	Generator Fueling System	Pressure Switch			Per Vendor				Mfg. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	PSH	81127	0100-X655	40 73 00	Generator Fueling System	Pressure Switch			Per Vendor				Mfg. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	FSH	81118	0100-X655	40 71 00	Generator Fueling System	Flow Switch			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	FSH	81128	0100-X655	40 71 00	Generator Fueling System	Flow Switch			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	PSH	81132	0100-X656	40 73 00	Generator Fueling System	Pressure Switch			Per Vendor				Mfg. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	PG	81131	0100-X656	40 73 00	Generator Fueling System	Pressure Gauge							N/A			GENERATOR FUELING SYSTEM
01	PG	81141	0100-X656	40 73 00	Generator Fueling System	Pressure Gauge							N/A			GENERATOR FUELING SYSTEM
01	PSH	81142	0100-X656	40 73 00	Generator Fueling System	Pressure Switch			Per Vendor				Mfg. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	FSH	81150	0100-X656	40 71 00	Generator Fueling System	Flow Switch			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	HS	99113	0100-X657	40 78 00	Generator Fueling System	OCR Switch							Mfr. Std		N/A	GENERATOR FUELING SYSTEM
01	HS	99123	0100-X657	40 78 00	Generator Fueling System	OCR Switch							Mfr. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	PG	99212	0100-X657	40 73 00	Generator Fueling System	Pressure Gauge							N/A			GENERATOR FUELING SYSTEM
01	PG	99213	0100-X657	40 73 00	Generator Fueling System	Pressure Gauge							N/A			GENERATOR FUELING SYSTEM
01	PSH	99214	0100-X657	40 73 00	Generator Fueling System	Pressure Switch			Per Vendor				Mfg. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	PSH	99215	0100-X657	40 73 00	Generator Fueling System	Pressure Switch			Per Vendor				Mfg. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	FSH	99216	0100-X657	40 71 00	Generator Fueling System	Flow Switch			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	PG	99222	0100-X657	40 73 00	Generator Fueling System	Pressure Gauge							N/A			GENERATOR FUELING SYSTEM
01	PG	99223	0100-X657	40 73 00	Generator Fueling System	Pressure Gauge							N/A			GENERATOR FUELING SYSTEM
01	PSH	99224	0100-X657	40 73 00	Generator Fueling System	Pressure Switch			Per Vendor				Mfg. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	PSH	99225	0100-X657	40 73 00	Generator Fueling System	Pressure Switch			Per Vendor				Mfg. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	FSH	99226	0100-X657	40 71 00	Generator Fueling System	Flow Switch			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	HS	99133	0100-X658	40 78 00	Generator Fueling System	OCR Switch							Mfr. Std	0100-I701	N/A	GENERATOR FUELING SYSTEM
01	HS	99143	0100-X658	40 78 00	Generator Fueling System	OCR Switch							Mfr. Std		N/A	GENERATOR FUELING SYSTEM
01	PG	99232	0100-X658	40 73 00	Generator Fueling System	Pressure Gauge							N/A			GENERATOR FUELING SYSTEM
01	PG	99233	0100-X658	40 73 00	Generator Fueling System	Pressure Gauge							N/A			GENERATOR FUELING SYSTEM
01	PSH	99234	0100-X658	40 73 00	Generator Fueling System	Pressure Switch			Per Vendor				Mfg. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	PSH	99235	0100-X658	40 73 00	Generator Fueling System	Pressure Switch			Per Vendor				Mfg. Std	0100-I702	N/A	GENERATOR FUELING SYSTEM
01	FSH	99236	0100-X658	40 71 00	Generator Fueling System	Flow Switch			Per Vendor				Mfg. Std		N/A	GENERATOR FUELING SYSTEM
01	LIT	99111	0100-X659	40 72 00	Generator Fueling System	Ultrasonic Level Transmitter			Per Vendor					0100-I703	N/A	GENERATOR UNITS
01	LSLL	99112	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LSL	99113	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LSH	99114	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LSHH	99115	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LIT	99121	0100-X659	40 72 00	Generator Fueling System	Ultrasonic Level Transmitter			Per Vendor					0100-I703	N/A	GENERATOR UNITS
01	LSLL	99122	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LSL	99123	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LSH	99124	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LSHH	99125	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LIT	99131	0100-X659	40 72 00	Generator Fueling System	Ultrasonic Level Transmitter			Per Vendor					0100-I703	N/A	GENERATOR UNITS
01	LSLL	99132	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LSL	99133	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LSH	99134	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS
01	LSHH	99135	0100-X659	40 72 00	Generator Fueling System	Float Switch			Per Vendor				Mfg. Std		N/A	GENERATOR UNITS

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SECTION 40 71 00

FLOW MEASUREMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide flow measurement instrumentation as specified in this section and in compliance with Section 40 70 00 and other related sections and Contract Documents.

B. The Work of this section includes the provision of instrument data sheets for all instruments supplied for this project. The contractor shall provide an as-constructed instrument data sheet for each instrument supplied for this project based on the ISA S20 standard instrument specification forms.

C. Refer to Section 40 61 13 for additional requirements related to instrument specification sheets.

1.02 REFERENCES:

A. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S5.4: Instrument Loop Diagrams

3. S7: Instrument Air

4. S12: Electrical Equipment for Hazardous Locations

5. S18.2: Alarm Management

6. S20: Instrument Specifications

7. S50: Electrical Control Signals

8. S75: Control Valve Design, Specification and Testing

9. S96: Valve Actuators

10. S99: Control System Cyber Security

11. 101: Human-Machine Interfaces

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings for each specified instrument together with a completed Instrument Data Sheet in accordance with ISA S20 standard.

1. Each instrumentation submittal shall include a copy of the respective specification section marked up to show compliance or non-compliance with specified requirements. Provide written justification for any non-compliance features.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 MAGNETIC IN-LINE FLOW METERS

A. Magnetic in-line flow meters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each magnetic flow meter and signal converter shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic drawings.

2. Flow tubes shall be flanged and lined full-lay-length flow tube suitably rated for the respective process piping pressure rating.

3. Flow tube sizes shall generally be as shown on the contract drawings. Notify the Engineer if the proposed flow meter size will result in flow velocity lower than 1 ft/sec or greater than 16 ft/sec during normal operation.

4. Liner material shall be selected for compatibility with the process application chemical characteristics and operating temperature range.

5. Measuring electrodes and built-in grounding electrodes shall be 316SS bullet-nose unless an alternate material is required for application specific chemical resistance.

6. Line size 316SS grounding/protection rings shall be provided for applications with abrasive slurries and where the process piping system is non-conductive or has a non-conductive liner.

7. Signal converters shall be suitable 120 VAC power supply or as otherwise specified and shall have an accuracy of 0.5 percent of calibrated span or better. Outputs shall include 4-20 maDC analog and a Totalizer Pulse output as a minimum.

8. Provide remote wall mounted signal converters with pre-terminated power and signal cables to facilitate installation of the signal converter at 5.5 feet above finished floor. The signal converter may be mounted directly to the flow tube where the installed height of the signal converter display is between 4 feet – 6 feet above finished floor.

B. The flow tube, signal converter, and related ancillaries shall have environmental ratings suitable for their respective process areas. In no case shall the flow tube or signal converter environmental rating be less than NEMA 4X.

C. Suitable manufacturers of magnetic flow meters include;

1. Siemens

2. Endress + Hauser

3. ABB

2.02 DOPPLER FLOW METERS:

A. Doppler flow meters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

2.03 TRANSIT TIME FLOW METERS:

A. Transit Time flow meters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

2.04 OPEN CHANNEL FLOW METERS:

A. Open Channel flow meters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

2.05 FLOW SWITCHES:

A. Flow switches provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

PART 3 - EXECUTION

3.01 QUALIFICATIONS:

A. Flow meters are to be set up, configured, and calibrated by Journeyman instrumentation technician working under the approval of the instrument manufacturer.

3.02 INSTALLATION:

A. Install primary flow elements and signal converters in accordance with manufacturer's installation instructions.

1. For magnetic flow meters, flow tubes shall be installed in a designated "meter run" comprising a minimum upstream straight pipe length of 5D and downstream straight pipe length of 3D of the nominal pipe diameter. There shall be no valves, bends, tees, process taps, chemical injectors or other flow disturbing fittings located within the Meter Run.

3.03 CALIBRATION:

A. Refer to the Instrumentation Index for instrument operating conditions, ranges, setpoints, and alarms.

B. Flow meters shall be factory pre-calibrated and calibration shall be verified on site.

C. Provide printed calibration reports of the factory calibration and as-commissioned in-situ calibration check including all smart device configuration parameters.

1. In line liquid flow meter calibrations shall be verified in-situ using volumetric draw down or similar test approved by the Engineer.

D. Submit calibration reports for review by the Engineer and include copies of reviewed and accepted calibration reports in the O&M manuals.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 72 00

LEVEL MEASUREMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide level measurement instrumentation as specified in this section and in compliance with Section 40 70 00 and other related sections and Contract Documents.

B. The Work of this section includes the provision of instrument data sheets for all instruments supplied for this project. The contractor shall provide an as-constructed instrument data sheet for each instrument supplied for this project based on the ISA S20 standard instrument specification forms.

C. Refer to Section 40 61 13 for additional requirements related to instrument specification sheets.

1.02 REFERENCES:

A. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S5.4: Instrument Loop Diagrams

3. S7: Instrument Air

4. S12: Electrical Equipment for Hazardous Locations

5. S18.2: Alarm Management

6. S20: Instrument Specifications

7. S50: Electrical Control Signals

8. S75: Control Valve Design, Specification and Testing

9. S96: Valve Actuators

10. S99: Control System Cyber Security

11. 101: Human-Machine Interfaces

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings for each specified instrument together with a completed Instrument Data Sheet in accordance with ISA S20 standard.

1. Each instrumentation submittal shall include a copy of the respective specification section marked up to show compliance or non-compliance with specified requirements. Provide written justification for any non-compliance features.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 ULTRASONIC LEVEL METERS:

A. Ultrasonic level meters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each ultrasonic level transmitter and corresponding transducer shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic drawings.

2. Level transmitters shall be suitable 120 VAC power supply and shall have an accuracy of 0.5 percent of calibrated span or better.

3. The transmitter shall be a smart programmable type with local display and keypad. Provide a hand-held programming tool with the transmitter.

4. Outputs shall include 4-20 mA DC analog and three programmable relay outputs as a minimum.

5. The transducer model shall be selected for optimum performance at the required measurement range and process vessel configuration for each application.

6. Provide transducer with pre-terminated signal cable of adequate length to facilitate installation of the transmitter at 5.5 feet above finished floor and with enough slack to facilitate sensor removal and inspection without requiring cable disconnection. Supply a minimum cable length of 15 feet.

    a. Junction boxes are not permitted in the Influent Pumping Station Raw Water Wet Wells. For instruments located in the wet wells, provide a cable of sufficient length to suit an initial termination point exterior to the well.

7. Design the transducer mounting bracket(s) and/or stilling well to ensure that the sensor is mounted at least 12 inches above the maximum possible liquid level. Where potential sensor flooding is anticipated, provide the sensor with a flood proof hood.

8. Provide a stilling well for the transducer in accordance with the manufacturers recommendations where the process vessel has turbulent liquid surface conditions, floating foam, floating debris, or when there are stationary objects in the transducer beam path. Stilling wells shall have flanged transducer mounting to facilitate transducer maintenance activities.

B. The transmitter, transducer, cabling and related ancillaries shall have environmental ratings suitable for their respective process areas. In no case shall the transmitter, transducer, or cabling environmental rating be less than NEMA 4X.

1. Devices installed within the Influent Pumping Station Raw Water Wet Wells must carry an intrinsically safe designation and be provided with all required accessories (IS barrier etc.) for a complete IS installation.

C. Suitable manufacturers of ultrasonic level meters include:

1. Siemens Milltronics MultiRanger

2. Endress+Hauser

3. Vega

2.02 RADAR LEVEL METERS:

A. Radar level meters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each radar level transmitter and corresponding antenna shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic drawings.

2. Level transmitters shall be pulsed radar type suitable for 24VDC loop power supply and shall have an accuracy of plus or minus 0.1 percent of calibrated span or better.

3. The transmitter shall be a smart programmable type with local display and programming keypad.

4. Outputs shall include 4-20 mA DC analog and three programmable relay outputs as a minimum.

5. The antenna model shall be selected for optimum performance at the required measurement range and process vessel configuration for each application. The antenna shall include a quick-disconnect feature to facilitate maintenance.

6. Provide antenna with pre-terminated signal cable of adequate length to facilitate installation of the transmitter at 5.5 feet above finished floor and with enough slack to facilitate sensor removal and inspection without requiring cable disconnection. Supply a minimum cable length of 15 feet.

    a. Junction boxes are not permitted in the Influent Pumping Station Raw Water Wet Wells. For instruments located in the wet wells, provide a cable of sufficient length to suit an initial termination point exterior to the well.

7. Design the antenna mounting bracket(s) and/or stilling well to ensure that the sensor is mounted at least 300 mm above the maximum possible liquid level. Where potential sensor flooding is anticipated, provide the sensor with a flood proof hood.

8. Provide a 316SS stilling well for the transducer in accordance with the manufacturers recommendations where the process vessel has turbulent liquid surface conditions, floating foam, floating debris, or when there are stationary objects in the transducer beam path. Stilling wells shall have flanged transducer mounting to facilitate transducer maintenance activities.

9. Orient the antenna rotationally such that non liquid and indirect reflections are minimized.

B. The transmitter, antenna, cabling and related ancillaries shall have environmental ratings suitable for their respective process areas. In no case shall the transmitter, transducer, or cabling environmental rating be less than NEMA 4X.

    1. Devices installed within the Influent Pumping Station Raw Water Wet Wells must carry an intrinsically safe designation and be provided with all required accessories (IS barrier etc.) for a complete IS installation.

C. Suitable manufacturers of radar level meters include:

1. Magnetrol Pulsar

2. Endress+Hauser

3. VEGA

2.03 LASER LEVEL METERS:

A. Laser level meters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

2.04 SUBMERSIBLE HYDROSTATIC LEVEL METERS:

A. Submersible Hydrostatic level meters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each submersible level transmitter shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic drawings.

2. Level transmitters shall be submersible hydrostatic type suitable for 24VDC loop power supply and shall have an accuracy of plus or minus 0.2 percent of calibrated span or better.

3. The transmitter shall be factory calibrated type with the span preset for each application.

4. Provide a sensor protection cap to prevent accidental diaphragm damage.

5. Output shall be 4-20 maDC loop powered analog. Provide sensor with pre-terminated signal cable of adequate length to facilitate installation of the termination box 5.5 feet above finished floor and with enough slack to facilitate sensor removal and inspection without requiring cable disconnection. Supply a minimum cable length of 15 feet.

6. Provide a stilling well for the transducer in accordance with the manufacturers recommendations where the process vessel has turbulent conditions or where the sensor is installed in close proximity to pumps or tank mixers. Stilling wells shall have flanged transducer mounting to facilitate transducer maintenance activities. Suspend the transducer from the mounting flange using sensor manufacturer's standard cable grip fitting. Suspend the sensor 4 inches above the tank bottom and record the zero offset in the calibration report.

B. The transmitter, cabling and related ancillaries shall have environmental ratings suitable for their respective process areas. In no case shall the transmitter, or cabling environmental rating be less than NEMA 4X.

C. Suitable manufacturers of submersible level meters include:

1. Endress+Hauser

2. KPSI

3. General Electric

2.05 LEVEL SWITCHES:

A. Float level switches provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Float switches shall have SPDT output contacts rated for pilot duty.

2. Provide polypropylene float casing with pre-terminated signal cable. Float switch density shall be selected for optimal performance in the specified process liquid.

3. Extension cable shall be 3 conductor 50 foot length

a. Junction boxes are not permitted in the Influent Pumping Station Raw Water Wet Wells. For instruments located in the wet wells, provide a cable of sufficient length to suit an initial termination point exterior to the well.

B. The level switch, cabling and related ancillaries shall have environmental ratings suitable for their respective process areas. In no case shall the transmitter, or cabling environmental rating be less than NEMA 4X.

1. Devices installed within the Influent Pumping Station Raw Water Wet Wells must carry an intrinsically safe designation and be provided with all required accessories (IS barrier etc.) for a complete IS installation.

C. Suitable manufacturers of level switches include:

1. FLYGT ENM-10 with Flygt cable holders and anti-sway rings

2.06 OPTICAL LEVEL SWITCHES:

A. Optical level switches provided for this project shall all be sourced from the same manufacturer and in compliance with this specification

1. Optical switches shall have SPST output contacts rated for pilot duty

2. Provide PFA Teflon float casing with pre-terminated signal cable.

3. Cable shall be 4 conductor 10 foot length with PFA Teflon jack.

4. Provide all fittings and mount to install sensor in location indicated on drawings.

B. The optical level switch, cabling and related ancillaries shall have environmental ratings suitable for their respective process areas. In no case shall the transmitter, or cabling environmental rating be less than NEMA 4X.

C. Suitable Manufacturers of optical level switches include:

1. Flowline Switch-Tek LO10 and associated fittings

PART 3 - EXECUTION

3.01 QUALIFICATIONS:

A. Flow meters are to be set up, configured, and calibrated by Journeyman instrumentation technician working under the approval of the instrument manufacturer.

3.02 INSTALLATION:

A. Install primary level sensors and transmitters in accordance with manufacturer's installation instructions and as described herein.

1. Where possible, locate instruments near an access hatch or manway to facilitate testing and maintenance activities.

2. For ultrasonic level transmitters, the transducer shall be mounted at least 1 ft above the maximum liquid level.

3. Stilling wells shall be fabricated from a continuous length of PVC pipe with no seams or joints. The stilling well diameter shall be selected to accommodate the level sensor OD and manufacturer's recommendations.

4. Stilling wells shall have a flanged sensor mounting 1 foot above vessel cover or finished floor level, 1inch vent hole located above the maximum liquid level, and a 45 degree slash-cut bottom (refer to standard details).

5. Where Ultrasonic or Radar sensors are used in round process vessels, the sensor shall be located at 1/3 of the tank diameter away from the tank wall.

6. Level switches shall be suspended from mounting brackets fabricated from 316 stainless steel. Suspend floats from the mounting brackets using J hooks and float manufacturer's cable grips. Provide anti-sway rings for all float cables longer than 6 feet. Maximum spacing of anti-sway rings is 6 feet.

3.03 CALIBRATION:

A. Refer to the Instrumentation Index for instrument operating conditions, ranges, setpoints, and alarms.

B. Level meters shall be factory pre-calibrated and calibration shall be verified on site.

C. Provide printed calibration reports of the factory calibration and as-commissioned in-situ calibration check including all smart device configuration parameters.

1. In line liquid flow meter calibrations shall be verified in-situ using volumetric draw down or similar test approved by the Engineer.

2. Level meters shall be verified in-situ by adjusting the actual liquid level and verifying the measurement against a manual level measurement to a known structural or other fixed reference point such as the vessel bottom or top of access cover.

3. Level switches shall be verified in-situ by adjusting the actual liquid level and verifying the trip point against a manual level measurement to a known structural or other fixed reference point such as the vessel bottom or top of access cover

D. Submit calibration reports for review by the Engineer and include copies of reviewed and accepted calibration reports in the O&M manuals.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 73 00

PRESSURE, STRAIN, AND FORCE MEASUREMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide pressure, strain, and force measurement instrumentation as specified in this section and in compliance with Section 40 70 00 and other related sections and Contract Documents.

B. The Work of this section includes the provision of instrument data sheets for all instruments supplied for this project. The contractor shall provide an as-constructed instrument data sheet for each instrument supplied for this project based on the ISA S20 standard instrument specification forms.

C. Refer to Section 40 61 13 for additional requirements related to instrument specification sheets.

1.02 REFERENCES:

A. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S5.4: Instrument Loop Diagrams

3. S7: Instrument Air

4. S12: Electrical Equipment for Hazardous Locations

5. S18.2: Alarm Management

6. S20: Instrument Specifications

7. S50: Electrical Control Signals

8. S75: Control Valve Design, Specification and Testing

9. S96: Valve Actuators

10. S99: Control System Cyber Security

11. 101: Human-Machine Interfaces

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings for each specified instrument together with a completed Instrument Data Sheet in accordance with ISA S20 standard.

1. Each instrumentation submittal shall include a copy of the respective specification section marked up to show compliance or non-compliance with specified requirements. Provide written justification for any non-compliance features.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 PRESSURE AND DIFFERENTIAL PRESSURE GAUGES:

A. Pressure gauges provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each pressure gauge shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic drawings.

2. Pressure gauges shall have an accuracy of 0.5 percent of full scale or better.

3. Select gauge range such that the maximum process pressure reads at 1/2 to 2/3 of scale.

a. If a flushing connection is supplied, select a gauge range that will not be damaged at the W3 system pressure.

4. Provide gauges with 4-inch dial and 1/2 inch NPT stem mounting.

5. Wetted parts and movement shall be 316SS with a phenolic case and fluid fill.

6. Provide pressure gauges with factory assembled and filled diaphragm seals or line size pressure sensors where specified.

7. All pressure gauges, with or without diaphragm seals, shall be supplied with a 316 stainless steel block and bleed manifold to facilitate maintenance and calibration activities.

B. Suitable manufacturers of pressure gauges and accessories, include:

1. Ashcroft Duragauge Type 1279 with Ashcroft Plus Performance option

2.02 GAUGE PRESSURE TRANSMITTERS:

A. Gauge pressure transmitters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each gauge pressure transmitter shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic Drawings.

2. Gauge pressure transmitters shall be suitable for 24VDC loop power supply and shall have an accuracy of plus or minus 0.5 percent of calibrated span or better.

3. The transmitter shall have a local display scaled in engineering units.

4. Output shall include 4-20 maDC loop powered analog.

5. All gauge pressure transmitters shall be supplied with specified process connections and/or valve manifold to facilitate the measurement, maintenance and calibration activities.

B. The transmitter, and related ancillaries shall have environmental ratings suitable for their respective process areas. In no case shall the transmitter environmental rating be less than NEMA 4X.

C. Suitable manufacturers of differential pressure transmitters include:

1. Rosemount 3051

2. Endress + Hauser

3. Honeywell

2.03 DIFFERENTIAL PRESSURE TRANSMITTERS:

A. Differential pressure transmitters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each differential pressure transmitter shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic drawings.

2. Differential pressure transmitters shall be suitable for 24VDC loop power supply and shall have an accuracy of plus or minus 0.5 percent of calibrated span or better.

3. The transmitter shall have a local display scaled in engineering units.

4. Output shall include 4-20 maDC loop powered analog.

5. All differential pressure transmitters shall be supplied with specified process connections and/or valve manifold to facilitate the measurement, maintenance and calibration activities.

B. The transmitter, and related ancillaries shall have environmental ratings suitable for their respective process areas. In no case shall the transmitter environmental rating be less than NEMA 4X.

C. Suitable manufacturers of differential pressure transmitters include:

1. Rosemount 3051

2. Endress + Hauser

3. Honeywell

2.04 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES:

A. Pressure and differential pressure switches provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each pressure and differential pressure switch shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic drawings.

2. Pressure and differential pressure switches shall have a setting accuracy of plus or minus 0.5 percent of calibrated range or better.

3. Deadband shall be 10 percent of set point or less.

4. Select switch adjustable range such that the maximum process pressure is 1/2 to 2/3 of maximum range.

5. Pressure and differential pressure switches shall have SPDT contacts rated 3A @ 120 VAC.

6. Pressure switches shall have 1/2 inch NPT stem mounting.

7. Wetted parts and movement shall be 316SS with a corrosion resistant case.

8. Provide pressure gauges with factory assembled and filled diaphragm seals or line size pressure sensors where specified.

9. All pressure switches, with or without diaphragm seals shall be supplied with a 316SS block and bleed manifold to facilitate maintenance and calibration activities.

B. The switch enclosure, cabling and related ancillaries shall have environmental ratings suitable for their respective process areas. In no case shall the switch, or cabling environmental rating be less than NEMA 4X.

C. Suitable manufacturers of pressure switches include:

1. Asco Tri-Point – S Series

2. Ashcroft

2.05 DIAPHRAGM SEALS AND LINE SIZE PRESSURE SENSORS:

A. Diaphragm seals provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Diaphragm seals shall be constructed of 316SSs with an elastomeric diaphragm and fill fluid to provide chemical seal from the process fluid.

2. The elastomer sensing element and fill fluid shall be selected for chemical and temperature resistance to the process fluid.

3. Acceptable manufacturers for diaphragm seals include:

a. Ashcroft: Diaphragm Seal Type 100

B. Line size pressure sensors provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Line size pressure sensors shall be constructed of 316SS with an elastomer sensing element providing 360 degree line-size non-clogging pressure sensing.

2. The elastomer sensing element and fill fluid shall be selected for chemical and temperature resistance to the process fluid.

3. Acceptable manufacturers for line size pressure sensors include:

   a. Red Valve: Red Valve Pressure Sensor Series 40/42

   b. Ronningen-Petter

C. All diaphragm chemical seals and line size pressure sensors shall be factory filled and assembled with specified gauges, switches, and/or transmitters.

2.06 PRESSURE INSTRUMENT MANIFOLDS:

A. Pressure instrument Block and Bleed, 3 Valve, and 5 Valve manifolds provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Where specified, manifolds for pressure instrument impulse lines shall be constructed of 316SS.

2. Block and bleed style manifolds shall be used where specified for pressure gauges, pressure switches, gauge pressure transmitters, and absolute pressure transmitters.

3. 3 Valve, or 5 Valve manifolds shall be used where specified for differential pressure transmitters.

4. Acceptable manufacturers for instrument manifolds include:

   a. Anderson Greenwood

PART 3 - EXECUTION

3.01 QUALIFICATIONS:

A. Pressure instruments and sensors are to be installed, set up, configured, and calibrated by Journeyman instrumentation technician working under the approval of the instrument manufacturer.

3.02 INSTALLATION:

A. Install primary pressure gauges, sensors, and transmitters in accordance with manufacturer's installation instructions and as described herein.

1. Dials and readouts shall be located and positioned where the dial or readout can be easily read from adjacent walkway or platform to facilitate operation, testing, and maintenance activities.

2. Locate sensors and instruments as close as possible to the measurement point to minimize the use of impulse tubing.

3. Where impulse tubing is required, impulse tubing shall be 1/4 inch stainless steel with Swagelok tube fittings.

4. For air or gas applications, the impulse line shall generally be sloped down to the process tap location to prevent condensate buildup in the impulse line. Where this is not possible, provide a condensate drip pot with manual drain valve at the low point in the impulse line.

5. For liquid applications, the impulse line shall generally be sloped up to the process tap location to prevent air buildup in the impulse line. Where this is not possible, provide an automatic air release valve at the high point in the impulse line.

6. Install impulse tubing with a continuous slope from the instrument to the process tapping and avoid high or low spots in the tubing run.

7. Impulse tubing shall be continuously supported for mechanical protection and to prevent sagging.

3.03 CALIBRATION:

A. Refer to the Instrumentation Index for instrument operating conditions, ranges, setpoints, and alarms.

B. Pressure instruments shall be factory pre-calibrated and calibration shall be verified in-situ.

C. Provide printed calibration reports of the factory calibration and as-commissioned in-situ calibration check including all smart device configuration parameters.

1. Pressure gauges shall be verified on site using a certified test gauge, pressure calibrator, or equivalent test approved by the Engineer.

2. Pressure transmitters shall be verified in-situ using a certified pressure calibrator.

D. Submit calibration reports for review by the Engineer and include copies of reviewed and accepted calibration reports in the O&M manuals.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 40 74 00

TEMPERATURE MEASUREMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide temperature measurement instrumentation as specified in this section and in compliance with Section 40 70 00 and other related sections and Contract Documents.

B. The Work of this section includes the provision of instrument data sheets for all instruments supplied for this project. The contractor shall provide an as-constructed instrument data sheet for each instrument supplied for this project based on the ISA S20 standard instrument specification forms.

C. Refer to Section 40 61 13 for additional requirements related to instrument specification sheets.

D. This specification covers process temperature measurement. For HVAC temperature measurement refer to Section 23 09 13.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Delegated Design Submittals: For each device, equipment or appurtenance provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems, anchorage and equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

C. Operation and Maintenance Data:

1. Operation and maintenance manuals shall be specific to equipment purchased and crossing out of non-applicable items is not acceptable.

2. Comply with requirements of Section 01 78 23.

1.03 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide a list of recommended spare parts for the first year of operation and for the first five years of operation, including a price list and location of the nearest facility from which all spare parts can be obtained.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.07 WARRANTY:

A. Comply with the requirements specified in Section 01 78 36.

PART 2 - PRODUCTS

2.01 RTD SENSOR AND TEMPERATURE INDICATING TRANSMITTER:

A. RTD sensors and temperature indicating transmitters provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each RTD sensor and temperature indicating transmitter shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic drawings.

2. The RTD sensor and temperature indicating transmitter as installed shall be capable of measuring between 32 degrees and 120 degrees Fahrenheit with an accuracy of plus or minus 0.5 percent of the installed span.

3. Each RTD shall have a 316 SS thermowell.

a. Provide weld-o-lets as needed

b. Thermowells mounted on process piping shall be sized to extend to the center of the pipe.

c. Thermowells mounted on tanks shall be sized to extend 4 inches into the liquid.

4. Indicating transmitters shall be rated NEMA 4X and have an LCD or LED display scaled in engineering units.

5. RTD sensor and temperature indicating transmitter shall be loop powered with a 4-20 mA output rated for a 500 Ohm load.

6. Where local transmitter displays are not viewable from a standing position without the use of a ladder or a lift, provide a remote mounted indicating transmitter on the wall. Coordinate with Engineer for location.

B. Suitable manufacturers of temperature devices include:

1. Rosemount

2. Emerson

3. Endress+Hauser

PART 3 - EXECUTION

3.01 QUALIFICATIONS:

A. Temperature sensors are to be set up, configured, and calibrated by a Journeyman instrumentation technician working under the approval of the instrument manufacturer.

3.02 INSTALLATION:

A. Install primary flow elements and signal converters in accordance with manufacturer's installation instructions.

B. Thermowells installed in tanks shall be horizontally mounted at a depth to ensure continuous submergence in the fluid.

3.03 FIELD TESTING:

A. Validate the PLC scaling and alarming by injecting a 4-20 mA signal into the PLC terminals with the temperature sensor disconnected.

3.04 TRAINING:

A. Provide field operation and maintenance instruction.

B. Coordinate training time with the Engineer and Owner.

3.05 CALIBRATION:

A. Refer to the Instrumentation Index for instrument operating conditions, ranges, setpoints, and alarms.

B. Temperature sensors shall be calibrated on site.

C. Provide printed calibration reports of the factory calibration and as-commissioned in-situ calibration check including all smart device configuration parameters.

1. Calibrations shall be verified in-situ using a separate thermal sensor with equal or higher accuracy or similar test approved by the Engineer.

D. Submit calibration reports for review by the Engineer and include copies of reviewed and accepted calibration reports in the O&M manuals.

3.06 ADJUSTING:

A. Adjust the calibrated and scaled range for each temperature transmitter as requested during commissioning.

3.07 DEMONSTRATION:

A. Demonstrate RTD accuracy by removing from the installation and applying varying amounts of heat to the probe. Verify the temperature reading with a separate thermal sensor with equal or higher accuracy.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 76 00

PROCESS GAS ANALYTICAL MEASUREMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide process gas analytical measurement instrumentation as specified in this section and in compliance with Section 40 70 00 and other related sections and Contract Documents.

B. The Work of this section includes the provision of instrument data sheets for all instruments supplied for this project. The contractor shall provide an as-constructed instrument data sheet for each instrument supplied for this project based on the ISA S20 standard instrument specification forms.

C. Refer to Section 40 61 13 for additional requirements related to instrument specification sheets.

1.02 REFERENCES:

A. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S5.4: Instrument Loop Diagrams

3. S7: Instrument Air

4. S12: Electrical Equipment for Hazardous Locations

5. S18.2: Alarm Management

6. S20: Instrument Specifications

7. S50: Electrical Control Signals

8. S75: Control Valve Design, Specification and Testing

9. S96: Valve Actuators

10. S99: Control System Cyber Security

11. 101: Human-Machine Interfaces

B. National Fire Protection Association (NFPA):

1. NFPA 820: Standard for Fire Protection in Wastewater Treatment and Collection Facilities

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings for each specified instrument together with a completed Instrument Data Sheet in accordance with ISA S20 standard.

1. Each instrumentation submittal shall include a copy of the respective specification section marked up to show compliance or non-compliance with specified requirements. Provide written justification for any non-compliance features.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 COMBUSTIBLE GAS MONITORS:

A. Combustible gas monitors provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each combustible gas monitor shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic drawings.

2. The sensor shall be based on Infra-Red-Light absorption for detection of Methane gas in ambient air.

3. The sensor and transmitter shall operate successfully with ambient temperature range of -40 degrees F to +167 degrees F and ambient humidity of 5 to 95 percent RH.

4. The transmitter shall operate on 24 VDC power supply and include the following outputs:

   a. 4 to 20 mA DC calibrated to 0 – 50 percent LFL. Minimum one 4 to 20 mA input required. Transmitters with additional 4 to 20mA inputs to service multiple sensors are acceptable where practicable.

   b. 1 Form-C Warning alarm relay set at 5 percent LFL

   c. 1 Form-C Alarm relay set at 10 percent LFL

   d. 1 Form-C Instrument Fail Alarm relay

5. The transmitter shall have a local display with keypad.

6. Optional features shall include an alarm relay board, non-intrusive calibration, and calibration kit c/w instructions, fittings, and calibration span gas.

B. The sensing element, transmitter, and related ancillaries shall be rated for Class 1, Zone 1 hazardous areas and shall have environmental ratings suitable for their respective process areas. In no case shall the product environmental rating be less than NEMA 4X.

C. Suitable manufacturers of combustible gas monitors include:

1. Honeywell

2. Det-Tronics

3. MSA

2.02 TOXIC GAS MONITORS:

A. Toxic gas monitors provided for this project shall all be sourced from the same manufacturer and in compliance with this specification.

1. Each toxic gas monitor shall be tagged in accordance with the Instrumentation Index and as shown on the P&ID and HVAC Schematic drawings.

B. Hydrogen Sulfide Gas Detectors:

1. The sensor shall be based on Catalytic Bead for detection of H_2S gas in ambient air.

2. The sensor and transmitter shall operate successfully with ambient temperature range of -40 degrees F to +140 degrees F and ambient humidity of 15 to 95 percent RH.

3. The transmitter shall operate on 24 VDC power supply and include the following outputs:

   a. 4 to 20 mA DC calibrated to 0 – 50 ppm. . Minimum one 4 to 20 mA input required. Transmitters with additional 4 to 20mA inputs to service multiple sensors are acceptable where practicable.

   b. 1 Form-C Warning alarm relay set at 2 ppm.

   c. 1 Form-C Alarm relay set at 5 ppm.

   d. 1 Form-C Instrument Fail Alarm relay.

4. The transmitter shall have a local display with keypad.

5. Optional features shall include an alarm relay board, non-intrusive calibration, and calibration kit c/w instructions, fittings, and calibration span gas.

C. Carbon Monoxide (CO) Detector Transmitter:

1. The sensor shall be based on electrochemical CO gas in ambient air.

2. The sensor and transmitter shall operate successfully with ambient temperature range of -4 degrees F to +131 degrees F and ambient humidity of 15 to 95 percent RH.

3. The transmitter shall operate on 24 VDC power supply and include the following outputs:

   a. 4 to 20 mA DC calibrated to 0 – 200 ppm. . Minimum one 4 to 20 mA input required. Transmitters with additional 4 to 20mA inputs to service multiple sensors are acceptable where practicable.

   b. 1 Form-C Warning alarm relay set at 25 ppm (ventilation increased to maximum outside air).

   c. 1 Form-C Alarm relay set at 100 ppm.

   d. 1 Form-C Instrument Fail Alarm relay.

4. The transmitter shall have a local display.

5. Optional features shall include an alarm relay board, non-intrusive calibration, and calibration kit c/w instructions, fittings, and calibration span gas.

D. All combustible and toxic gas sensing elements, transmitters, and related ancillaries shall be rated for Class 1, Zone 1 hazardous areas and shall have environmental ratings suitable for their respective process areas. In no case shall the product environmental rating be less than NEMA 4X.

E. Suitable manufacturers of toxic gas monitors include:

1. Honeywell

2. Det-Tronics

3. MSA

2.03 GAS DETECTION NOTIFICATION

A. Gas detectors shall be interlocked to local annunciation panels as shown on the drawings. Where multiple types of gas detection are interlocked to one panel, any one alarm state for any type of gas shall trigger the required visual and/or audible alarms.

B. Gas detector notification panels shall be complete with:

1. Horn

2. Strobe

3. Alarm silence pushbutton

4. Terminal blocks for connection to transmitters.

5. Enclosure and any ancillaries shall be rated for Class 1, Zone 1 hazardous areas and shall have environmental ratings suitable for their respective process areas. In no case shall the product environmental rating be less than NEMA 4X.

6. Auxillary power supply such that continuous operation is maintained during failure of the normal power supply and shall provide at enough runtime to sufficiently alert personnel.

7. Provide additional components as required by NFPA820 for a fully functional and safe notification system.

PART 3 - EXECUTION

3.01 QUALIFICATIONS:

A. Process gas analytical transmitters are to be set up, configured, and calibrated by Journeyman instrumentation technician working under the approval of the instrument manufacturer.

3.02 INSTALLATION:

A. Install primary sensors and transmitters in accordance with manufacturer's installation instructions and in accordance with this specification.

1. Refer to location diagrams and standard installation details provided for this project.

3.03 CALIBRATION:

A. Provide printed calibration reports of the factory calibration and settings.

B. Verify calibration and output scaling in-situ and record all as-commissioned data including all smart device configuration parameters.

C. Submit calibration reports for review by the Engineer and include copies of reviewed and accepted calibration reports in the O&M manuals.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 78 00

PANEL MOUNTED INSTRUMENTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide panel mounted instruments and devices as specified in this section and in compliance with Section 40 70 00 and other related sections and Contract Documents.

B. The Work of this section includes the provision of instrument data sheets for all instruments supplied for this project. The contractor shall provide an as-constructed instrument data sheet for each instrument supplied for this project based on the ISA S20 standard instrument specification forms.

C. Refer to Section 40 61 13 for additional requirements related to instrument specification sheets.

1.02 REFERENCES:

A. International Society of Automation (ISA):

1. S5.1: P&IDs and Tagging

2. S5.4: Instrument Loop Diagrams

3. S7: Instrument Air

4. S12: Electrical Equipment for Hazardous Locations

5. S18.2: Alarm Management

6. S20: Instrument Specifications

7. S50: Electrical Control Signals

8. S75: Control Valve Design, Specification and Testing

9. S96: Valve Actuators

10. S99: Control System Cyber Security

11. 101: Human-Machine Interfaces

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings for each specified instrument together with a completed Instrument Data Sheet in accordance with ISA S20 standard.

1. Each instrumentation submittal shall include a copy of the respective specification section marked up to show compliance or non-compliance with specified requirements. Provide written justification for any non-compliance features.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 INDICATING LIGHTS:

A. The quality and type of switches and pushbuttons shall be based on industrial grade types generally as described below.

B. All control indicator lamps in ordinary locations to be heavy duty oil tight such as Allen Bradley 800T or 800E.

C. All control indicator lamps in classified or Category 1 & 2 areas, or outdoors to be heavy duty weatherproof such as Allen Bradley 800H.

D. All control indicator lamps shall be push-to-test type.

2.02 SWITCHES AND PUSHBUTTONS:

A. The quality and type of switches and pushbuttons shall be based on industrial grade types generally as described below with contact rated for connected loads.

1. All control pushbutton switches, and selector switches in ordinary locations to be heavy duty oil tight such as Allen Bradley 800T or 800E.

2. All pushbutton switches, and selector switches in classified or Category 1 & 2 areas, or outdoors to be heavy duty weatherproof such as Allen Bradley 800H.

2.03 RELAYS:

A. The quality and type of relays shall be based on industrial grade types generally as described below with contact rated for connected loads.

1. 120 VAC relays to be 4PDT, plug-in, complete with test button and operation indicator, and surge suppressor.

2. 24 VDC relays to be 2PDT plug-in, complete with test button and operation indicator, and surge suppressor diode.

3. Time delay relays for behind panel mounting to be Model 2PDT, plug-in, and programmable for sixteen (16) time ranges and four (4) operation modes.

4. Time delay relays for flush panel mounting and operator accessible timing range modifications to be SPDT, screw terminals, programmable for five (5) timing ranges and eight (8) operation modes, complete with digital display, module for time settings and flexible protective cover.

5. Where the contact ratings of the relays listed are insufficient for the application select an appropriate type from an approved Manufacturer with the same quantity of contacts as was originally specified.

6. Provide relay plug-in sockets for DIN mounting complete with stacked screw clamp terminals.

2.04 ANALOG LOOP CURRENT ISOLATOR:

A. The quality and type of analog loop current isolators shall be based on industrial grade types generally as described below.

1. Provide current loop signal isolators as required to provide isolation of milliampere transmission signals to prevent “ground loop” signal errors caused by mismatched transmitters and receivers.

2. Isolators are to be located in control panels and shall be Din rail mounted.

3. Analog loop current isolators shall be loop powered.

4. Isolator input and output signals to be 4-20 mA, with an error not exceeding 0.1 percent of span. Input resistance will not exceed 550 ohms with an output load of 250 ohms.

2.05 INTRINSIC SAFETY BARRIERS AND RELAYS:

A. The quality and type of analog loop current isolators shall be based on industrial grade types generally as described below.

1. Provide intrinsic safety barriers where required for two-wire transmitters of the active, isolating, loop powered type.

a. Manufacturers:

(1) MTL

(2) Phoenix

(3) Stahl

(4) P+F

2. Provide dual type intrinsic safety barriers for process switches.

a. Manufacturers:

(1) MTL

(2) Phoenix

(3) Stahl

(4) P+F

3. Intrinsic safety relays.

a. Manufacturers:

(1) MTL

(2) Phoenix

(3) Stahl

(4) P+F

2.06 SIGNAL CONDITIONING MODULES:

A. Manufacturers:

1. Red Lion

2. Omega

3. Weidmuller

B. All modules specified in this section to be industrial grade and the product of a single Manufacturer.

C. Where required, provide signal conditioning modules which comply with the following requirements:

1. Analog signal inputs: 4-20 mA DC into 500 ohms or less.

2. Analog signal outputs: 4-20 mA DC into 500 ohms.

3. Discrete output contacts: SPDT or DPDT rated 5A.

4. Arrange electronic trips so that output contact opens in case of loss of signal or loss of power supply.

5. Signal conditioning and isolating modules to be rated for continuous operation in an ambient temperature of 32 degrees F to 175 degrees F. The ambient temperature effect on module accuracy is not to exceed plus or minus 0.01 percent per degrees°F.

6. Span and zero adjustments to be made by front accessible multi turn potentiometers.

7. Provide electronic trip modules with LED indicators for relay status.

8. Signal conditioning modules to withstand 30 V per meter radio frequency radiation between 200 and 500 MHz with not more than 0.25 percent calibration effect. Provide modules with traps on the terminals to shunt conducted radio frequency interference to ground.

9. Provide effective isolation of signal and power supply terminals from the case.

PART 3 - EXECUTION

3.01 QUALIFICATIONS:

A. Panel mounted instruments and related operator devices are to be set up, configured, and calibrated by Journeyman instrumentation technician working under the approval of the instrument manufacturer.

3.02 INSTALLATION:

A. Install panel mounted instruments and related operator devices in accordance with manufacturer's installation instructions and in accordance with this specification.

B. Review the process area classification and panel environmental ratings and install instruments and operator devices with environmental and hazardous area ratings equal to or better than the area requirements.

C. Use normally closed contacts for alarm actuation. The contacts open to initiate the alarm.

D. Use normally open contacts to control equipment. The contacts close to start the equipment.

E. Contacts monitored by solid state equipment to be hermetically sealed and adequately rated for the connected load.

F. Contacts monitored by electro-magnetic devices such as mechanical relays to be rated NEMA ICS 2, designation B300.

G. Provide double barriers between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.

H. Switch electrical enclosures to be rated EEMAC 4, minimum.

I. 120 VAC switches to have a 4 A rating.

3.03 CALIBRATION:

A. Provide printed calibration reports of the factory calibration and settings.

B. Verify calibration and output scaling in-situ and record all as-commissioned data including all smart device configuration parameters.

C. Submit calibration reports for review by the Engineer and include copies of reviewed and accepted calibration reports in the O&M manuals.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 41 22 23.19

HOISTING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test hoisting equipment, motors, gear reducers, controls and appurtenances as indicated and in compliance with Contract Documents.

1. Rail and supporting beams included in building structure, refer to structural drawings.

2. Hoist capacities and operating data are indicated in the Hoisting Schedule.

1.02 REFERENCES:

A. American Bearing Manufacturers Association (ABMA):

1. 9-2015: Load Ratings and Fatigue Life for Ball Bearings

2. 11-2014: Load Ratings and Fatigue Life for Roller Bearings

B. American Society of Mechanical Engineers (ASME):

1. ASME B30.16-2017: Overhead Underhung and Stationary Hoists

C. American Welding Society (AWS):

1. D1.1-2015: Structural Welding Code – Steel

D. National Electric Code (NEC), NFPA 70-2017

E. National Electrical Manufacturers Association (NEMA):

1. MG 1-2016: American National Standard for Motors and Generators

F. Occupational Safety and Hazard Association (OSHA):

1. 29 CFR 1910.179: Overhead and Gantry Cranes

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Data regarding hoisting equipment characteristics and performance:

2. Manufacturer's literature as needed to supplement certified data.

3. Operating and maintenance instructions and parts lists.

4. Listing of reference installations as specified with contact names and telephone numbers.

5. List of recommended spare parts other than those specified.

6. Shop and field inspection reports.

7. Motor shop test results.

8. Qualifications of field service engineer.

9. Recommendations for short and long-term storage.

10. Shop and field testing procedures, equipment to be used.

11. Special tools.

12. Number of service person-days provided and per diem field service rate.

13. Manufacturer’s product data, specifications and color charts for shop painting.

14. The latest ISO 9001 series certification.

15. Provide Certificate of Responsibility. See Section 01 33 00 for Certificate form.

16. Provide scaled drawing height and weight of equipment serviced by the hoisting equipment including hook height and travel dimensions.

17. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.

B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide spare parts that are identical to and interchangeable with similar parts installed.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Permanently mark the capacity of the hoist and trolley on each hoist, in easy to read letters and in a prominent position.

C. Provide only safety type hooks.

D. Provide hoists so that hook can reach the floor at the lowest level of the lift.

E. Do not use hoists for construction purposes of any nature.

F. Hoists shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

G. Welding: In accordance with American Welding Society Code D1.1.

H. Provide shop tests as specified.

I. Hoisting equipment manufacturer shall provide hoists, motors, gear reducers, switches, and controls regardless of manufacturer as a complete integrated package to ensure coordination, compatibility and operation of the systems.

J. Services of Manufacturer's Representative as stated in Section 01 45 00 and as specified herein.

K. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

    a. Each person-day requirement is per area.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of electrical:

    a. 1.0 person-day

3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.

    a. 1.0 person-day

4. Field Testing: Field performance test equipment specified.

    a. 1.0 person-day

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

    a. 1.0 person-day.

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

L. Manufacturer of hoisting equipment shall have a minimum of five (5) operating installations with hoists of the size specified and in the same service as specified operating for not less than five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Hoisting equipment capacities and operating data are indicated in the Hoist Schedule.

2.02 HOIST AND TROLLEY MANUFACTURERS:

A. Konecranes

B. ACCO-Wright

C. Yale Hoisting Equipment Division

D. Dresser Industries

2.03 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 MANUAL HOISTS:

A. Hoist Mechanism: Fully enclosed high-speed, spur-geared, ball or roller bearing, hand-operated, chain hoist with a retaining brake or other acceptable device built into hoisting mechanism.

B. Hooks: High grade, forged steel with swivel, antifriction bearings.

C. Load Wheel: Make with accurately formed chain pockets to fit load chain.

D. Hoist Operating Wheel: A load limiting clutch mechanism consisting of spring loaded rollers that run between an outer race and an inner hub mounted on the outside of the wheel. The clutch shall be designed to limit the chain pull to not more than 150 percent of that required to lift the rated load capacity of the hoist. Provide with chain guides with chain of sufficient length to hang 3 feet above operating floor.

E. Chain Bucket: Provide where specified to collect load chain. Arrange chain bucket so it will not interfere with smooth operation of hoist.

F. Lightweight Hoists: Make with high strength aluminum frame, hand wheel and housing.

G. Provide each hoist with a clevis connection for use with a trolley, a suspension hook at top, or be integrally built into trolley as indicated on drawings or specified herein.

2.05 ELECTRIC HOISTS:

A. Electric Hoists: Spur-gear driven antifriction bearings throughout, a mechanical load brake, and a separate electrically operated motor brake. Design mechanical load brake with capability of supporting the full load at any point when the motor is stopped. Motor brake shall be externally adjustable, electrically operated friction disk brake that shall apply automatically when the power is off. The brake shall hold 150 percent of the rated load and 125 percent of the rated load at any operating speed. Design shafts of motor, drum, and drum pinion to run in grease-lubricated ball or roller bearings. Design the mechanical-load brake and gear train and bearings to be oil-bath lubricated.

B. Arrange hoist for parallel lug mounting from a 4-wheel geared trolley.

C. Hoist: Standard type.

D. Design drum with machine-cut grooves and guarded flanges and with capacity to take entire run of cable in one layer with no overlapping.

E. Provide hoist with an upper and lower geared limit switch with automatic reset control circuit to prevent overtravel. Settings to be field adjustable in accordance with OSHA 29 CFR 1910.179.

F. Supply sufficient hoisting cable with hoists for two-part single reeving and to accommodate not only the maximum lift but two additional wraps on drum. Make cable flexible high-strength plowsteel cable with a load safety factor of at least 5 to 1.

G. Make load block of rugged construction containing a ball-bearing sheave and a high-grade forged-steel swivel hook with antifriction bearings.

H. Provide control equipment in an enclosed compartment which forms an integral part of hoist and include a transformer for a 120-volt control circuit.

2.06 TROLLEYS:

A. Manual Trolleys: 4-wheel type fabricated from heavy steel or aluminum sections with sides extending beyond wheel flanges to provide bumper protection. Design wheels with machined treads surface-hardened and set at proper angle to bear load evenly on supporting beam flanges. Provide wheels with lifetime lubricated ball or roller bearings.

B. Plain Trolleys: Push type with a hole for attaching suspension hook.

C. Army Type Hoists: Close headroom type, integrally built into a 4-wheel plain or geared trolley.

D. Provide trolley operating wheels with chain guides and make chains for each of sufficient length to hang 3 feet above operating floor.

E. Make trolleys designed for operation on beam or rail indicated on drawings. Trolleys to be provided by the hoist manufacturer.

2.07 JIB CRANE:

A. Jib Crane Manufacturers:

1. ACCO-Wright

2. CONTRX

3. Dresser Industries, Inc., Hoist & Tower Division

4. Ohio Hoist & Mfg. Co., Inc.

B. Jib Crane: Steel S-beam boom, with an adjustable tie rod brace, a hinge-bracket or bar support for both boom and tie rod which permits 180 degrees swing. Fix safety stop at outer end of boom to prevent trolley from running off open end.

C. Base: Special casting adequate to support crane with its maximum load on hoist at extreme end of trolley beam.

2.08 DAVIT:

A. Davit Crane Manufacturers:

1. Thern, Inc.

B. Provide crane capacity and reach as indicated in the davit crane schedule and drawings

C. Crane shall have adjustable sheave block and boom angle

D. Materials: Heavy-duty welded structural steel pipe and tubing

E. Finishes: as indicated on davit crane schedule and drawings

F. Winch and Rope: As indicated in the davit crane schedule and drawings

G. Base: Base and base hardware shall be supplied by jib crane manufacturer as indicated in the davit crane schedule and drawings. Ensure base is adequate to support crane with its maximum load on hoist at extreme end of davit arm.

2.09 SWITCHES AND SWING-OUT SECTIONS:

A. Manufacturers:

1. American Monorail Co.

2. Richards-Wilcox Mfg

3. ACCO-LoudenSwitches: Glide or sliding type, manually operated. Design transfer mechanisms and locking devices capable of positioning switch to maintain true vertical and horizontal alignment of track and conductors and prevent switch operation when any part of trolley is in switch.

C. Furnish swing-out sections at roll-up doors as indicated on drawings.

2.10 SAFETY STOPS:

A. Provide safety stops on all open ends of track (or where indicated) to prevent trolley from running off ends or damaging building. Provide stops with capability of withstanding impact imposed by motion of fully loaded hoist and trolley.

2.11 TRACK:

A. Monorail Track: Standard beam of sizes indicated on drawings.

B. Shop fabricate all curves for either track or switches to radius indicated.

C. Erect track level throughout, with section ends machined fitted and spliced with web-type or other designed couplings to provide flush level connections. Maximum gap between adjacent ends not exceeding 1/16 inch.

2.12 DRUM GRAB:

A. Manufacturers:

1. American Chain & Cable Co.

2. Sterling, Fleishman Co.

3. Heppenstall Co., Material Handling Division

B. Provide drum grab for lifting and tilting 600 pound drums.

C. Make grab with an inverted U-shaped yoke frame made of steel with a lifting eye at its top center. Suspend on trunnions between ends of frame a wide flexible strap or other acceptable device which can be wrapped and fastened around a metal drum approximately 14-inch in diameter and 24-inch high. Fit one trunnion with a hand wheel operated turning gear by which trunnion can be rotated 180 degrees so that drum held by strap can be tilted and emptied. Enclose the gear in a metal housing. Design trunnions

to turn in bushings set in frame. Make provision for lubricating trunnions, gears and their shafts. Construct frame sufficiently rigid, and if necessary, reinforced to ensure no distortion in service.

2.13 DRUM LIFT:

A. Manufacturers:

1. Sterling, Fleishman Co.

2. Morse Mfg. Co.

3. Hercules Industries

B. Make drum lift for handling drums with a hydraulically operated hoisting arm mounted on a steel frame dolly. Make dolly with four wheels, two of which are fixed and two of which are revolving-type casters.

C. Fit hoisting arms with a clamp-on type of saddle of proper size to handle drums. Design saddles to be pivoted in hoisting arms to permit tilting drums in any desired position, and accomplish tilting with a lever handle, spur gear and hand crank.

D. Provide stops for locking wheels or an acceptable floor locking device to prevent movement while drum is being emptied.

2.14 PALLET LIFTER:

A. Manufacturers:

1. Cady Metal Fabrication, Inc.

2. Lewis-Shepard Co., a subsidiary of Hyster Co.

3. Heppenstall Co., Material Handling Division

B. Pallet Lifter: C-shaped welded box frame with two heavy alloy-steel forks, a lifting eye, a counterweight, and guiding handles.

C. Design pallet lifter with a lifting capacity as indicated at least 48 inch and be no wider than 25 inch.

2.15 PORTABLE GANTRY:

A. Manufacturers:

1. Spanco, Inc.

2. Konecranes

B. Portable Gantry: Four-leg rolling-type gantry with capacity as indicated. Horizontal standard aluminum or steel beam suspended at each end by pipe legs adjustable for both height and span at floor, adequately braced, with locking swivel casters for each leg.

C. Position legs and span by pins provided with springs and a locking device to fit matching holes in telescoping pipe members.

D. Fit casters with ball bearings and wheels of rubber plastic treads designed for rated capacity of gantry.

E. Provide stops at ends of beam to prevent trolley rolloff.

F. Design Factors: Gantries shall be designed for a factor of

1. 15 percent of the rated capacity for hoist and trolley weight, and

2. 25 percent of the rated capacity.

2.16 CABLE REELS:

A. Manufacturers:

1. Gleason Reel Division

2. Aero-Motive Mfg. Co.

3. Liftech

B. Feed cable reel for electric current supply for all electric hoists with trolleys, except as otherwise indicated, through a single flexible, multi-conductor power cable from a self-winding spring-operated reel located near mid-point of trolley travel or where indicated on drawings.

1. The cable shall have at least four conductors.

2. The reel shall have a swivel base.

3. The reel shall have an explosion-proof Class 1, Division 1 or 2, Group C/D enclosure based on rating of space where equipment is located.

4. The reel shall have a weatherproof enclosure when located outdoors.

C. Furnish junction box to connect cable reel to power supply circuit with hoist.

2.17 ELECTRICAL CONTROLS:

A. Provide in accordance with Division 40 and as specified herein.

B. Supply complete integral electrical control system with the electric hoisting equipment (by hoist manufacturer) consisting of starters, circuit breakers, overload relays, limit switches, control transformer for a 120-volt control circuit, control relays, and controlling devices.

C. Furnish magnetic controls for motors. Design controls to permit "inching" in both forward and reverse directions under full load, automatically regulated acceleration, and rapid brake response.

D. Provide each hoist with limit switches of automatic-reset control circuit type to prevent overtravel in both raising and lowering directions.

E. Compliance: Make all electrical equipment including motors, controls, resistors, brakes plus all conduit, wiring, panels, and enclosures with applicable requirements for materials, workmanship, construction, and installation of latest NEMA and National Electrical Code Standards.

2.18 MOTORS:

A. Provide in accordance with Section 26 20 00 and as specified herein.

B. Motors for Hoists and Trolley: Totally enclosed, reversible, induction motors especially adapted to hoist service.

1. Enclosure: As indicated in the Hoist Schedule.

2. Insulation: Minimum Class “F” with Class “B” temperature rise, 40 degrees C ambient unless otherwise indicated or specified.

3. Service Factor: 1.15.

4. Provide capacity to start and operate hoists at maximum speed rated capacity indicated without exceeding nameplate ratings for current and power and without operating in the service factor.

5. Provide ball or roller bearings, in accordance with ABMA Standard 9 and Standard 11; minimum L-10 life of 100,000 hours.

6. Premium efficient motors, nominal and minimum motor efficiencies per NEMA MG1.

7. Rating: 460V, 3-phase, 60 Hertz.

2.19 PUSHBUTTON CONTROL:

A. Provide pendent pushbutton control station with pushbuttons to control all operations of hoists and trolley. Clearly mark each pushbutton to indicate its function. Make cable long enough to reach within 4 feet of operating floor or platform level with a supporting

chain. If necessary, attach an arm to hoist so that pendent cable and pushbutton controls will hang vertically and be readily accessible from operating positions.

B. Controls for Wound-Rotor Motors: Five-step, full magnetic type. Design all other controls to be designed for single-speed motors.

C. For control of pump building hoist, use a five-step pushbutton station operating magnetic controls to provide automatically regulated acceleration and rapid brake response.

D. Provide hoist with an upper limit switch of automatic reset control circuit type to prevent overtravel.

2.20 CONDUCTORS AND COLLECTORS:

A. Manufacturers:

1. Insul-8-Bar Protected Conductors made by Insul-8-Corp.

2. Safety-T-Bar Conductor Systems made by Howell Corp.

3. Duct-O-Bar Conductor System made by Duct-O-Wire Co.

B. Use equipment and accessories approved by Underwriter's Laboratories (UL).

C. For conductor for electric current supply use safety type in which conductor is shielded by a molded-plastic cover that surrounds conductor except for a slotted opening shaped to contour of collector head. Provide separate conductor for each phase. (Dual conductors in a single insulating shield are not acceptable.) Make conductor of plated steel or copper designed for carrying maximum anticipated current. Make molded-plastic shield of high dielectric strength, rigid yet sufficiently flexible to permit bending to radius of curves or switches, and resistant to corrosion and deterioration from sunlight or weather. Space insulated supports not over 5 feet on straight track and 3 feet on curves.

D. Provide weather shield for exterior conductors.

E. Use collectors of sliding shoe type with an adjustable spring-load arm capable of horizontal or vertical movement to automatically adapt to irregularities of conductor. Set shoe in a molded-plastic head that will prevent external contact with shoe when it is running on conductor. There shall be no exposed bare current-carrying surfaces or wires in collector or arm where shoe is in contact with conductor.

2.21 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 90 00.

B. Surface preparation, mixing and application and safety requirements shall be in accordance with the paint manufacturer’s printed instructions and as specified.

C. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

D. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

PART 3 - EXECUTION

3.01 TRAINING:

A. Provide training in accordance with specification Section 01 78 24.

3.02 INSTALLATION:

A. Install items in accordance with manufacturer's printed instructions and as indicated and specified.

B. Check horizontal and vertical alignment of track and rails.

C. Erect rack level throughout, with section ends machined fitted and spliced with web-type couplings to provide flush level connections. Maximum gap between adjacent ends not exceeding 1/16-inch.

D. Do not use cast fittings.

3.03 FIELD TESTING:

A. Provide in accordance with Section 01 78 25 and as specified herein.

B. Perform all tests with instrumentation controls and motor controls. Perform testing in accordance with OSHA 29 CFR 1910.179 and as specified herein.

C. After installation of hoist equipment, and after inspection, operation, testing and adjustment have been completed by manufacturer's field service technician, conduct test for each hoist in presence of the Engineer to determine its ability to operate at rated speeds and capacity under conditions specified and indicated. During tests, observe and record, capacity and motor inputs. Promptly correct or replace all equipment not conforming to the requirements of this section revealed by or noted during tests, at no additional cost to the Owner, and repeat tests until specified results are obtained. Contractor to provide all labor, weights and materials for conducting tests.

1. Provide a 60 minute test for each hoist.

2. Running test shall consist of moving hoist and trolley through two complete cycles. The first cycle will be with no load. For the second cycle, the unit will be loaded with 100 percent of the specified load rating.

3. Test and simulate all limit switches, locking and safety devices.

D. Make all adjustments to place equipment in specified working order at time of above tests.

E. After three (3) unsuccessful testing attempts, remove and replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated.

3.04 FIELD TOUCH-UP PAINTING:

A. After installation and testing, apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

DAVIT CRANE HOIST SCHEDULE

Facility	**0100 -IPS**
Location	Exterior IPS
Description	Stop logs, maintenance equipment removal
Number of Cranes	1
Number of Bases	3
Type	Portable
Winch	Manual stainless steel spur gear hand winch with brake and 304SS, 1/4-inch wire rope
Base	Pedestal
Finish	Corrosion-resistant electrostatic powder coating
Lifting Capacity (lb)	2,000
Hook Reach, Design	
Minimum Clearance under Boom	24 in
Minimum Lift Below Floor Level	22 ft
Model No.	Thern Commander 2000

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DIVISION 43

PROCESS GAS AND LIQUID HANDLING, PURIFICATION AND STORAGE EQUIPMENT

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SECTION 43 21 00.34

VERTICAL WET PIT SOLIDS HANDLING PUMPS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test vertical wet pit solids handling pumps, motors, variable frequency motor controllers, and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Bearing Manufacturers Association (ABMA):

1. 9: Load Ratings and Fatigue Life for Ball Bearings.

2. 11: Load Ratings and Fatigue Life for Roller Bearings.

B. American National Standards Institute (ANSI):

1. S1.11: Standard Octave-Band and Fractional-Octave-Band and Digital Filters.

C. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel.

2. A48: Standard Specification for Gray Iron Castings.

3. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

4. A582: Standard Specification for Free-Machining Stainless Steel Bars.

5. A743: Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.

D. American Society of Mechanical Engineers (ASME):

1. B16.1: Standard for Cast Iron Pipe Flanges and Flanged Fittings, 125 lb.

2. B16.5: Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

E. American Water Works Association (AWWA):

1. C210: Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines

F. Hydraulic Institute (HI):

1. Current Standards

2. 14.6: Rotodynamic Pumps for Hydraulic Performance Acceptance Tests

G. National Electrical Manufacturers Association (NEMA):

1. MG1: Motors and Generators.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Data regarding pump and motor characteristics and performance:

a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate pumps, showing they meet indicated and specified requirements for head, capacity, horsepower, pump efficiency, wire to water efficiency, submergence and NPSH3. Provide a combined discharge head and column headloss curve.

(1) For units of same size and type, provide curves for a single unit only.

(2) Provide performance curve showing bowl performance and for combined bowl, column and discharge head performance.

b. Provide catalog performance curves at maximum pump speed indicated and specified showing maximum and minimum impeller diameters available.

c. Results of shop performance tests as specified.

d. Pump internal headloss from suction bell to discharge head flange at the Design Rating Point specified and indicated.

e. Provide separate discharge head headloss and discharge column headloss curves.

f. Provide transient analysis of power interruption and any undesirable effects on the piping and valve system.

g. Provide information on time to spin down/spin up in the event of unforeseen pump interruption or restart.

h. Submit all curves for guaranteed performance, headloss data and shop performance tests on 8-1/2-inch by 11-inch sheets, one curve per sheet.

i. Curves for all internal friction losses for the entire pump assembly.

j. Shaft power loss

k. Thrust bearing power loss

2. Characteristic curves for variable speed pumps for maximum pump speed and for speeds required to obtain minimum pump flow and head conditions specified and indicated. Identify curves by speed and provide all curves on one sheet. Provide submergence and NPSH3 curve for each speed.

3. Provide thrust factor and thrust curves.

4. Materials list

5. Component and total pump assembly weights.

6. Shop drawing data for accessory items.

7. Certified setting plans, with tolerances, for anchor bolts.

8. Manufacturer's literature as needed to supplement certified data.

9. Operating and maintenance instructions and parts lists.

10. Listing of reference installations as specified with contact names and telephone numbers.

11. Welding procedures

12. Certified results of hydrostatic testing.

13. Certified results of dynamic balancing.

14. List of recommended spare parts other than those specified.

15. Shop and field inspection reports.

16. Pump shop test results, including performance curves with ANSI/HI acceptance grade and tolerances, all corrections and calculations and pictures of each major pump component showing exterior and interior surfaces.

17. Motor shop test results.

18. Qualifications of field service engineer.

19. Recommendations for short and long-term storage.

20. Resonant frequency analysis.

21. Shop and field testing procedures and equipment to be used and ANSI/HI 14.6 testing tolerances to be followed.

22. Special tools.

23. Number of service person-days provided and per diem field service rate.

24. Results of field vibration test data including a vibration signature for each pump and drive assembly. Provide vibration testing procedure for review.

25. Seal and bearing water flow rate and pressure required.

26. Recommended size and location of air/vacuum valve.

27. Manufacturer's product data, specifications and color charts for shop painting.

28. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

29. The latest ISO 9001 series certification.

30. Provide a scaled drawing for each pump service showing the pumps, motors, and hoists including equipment weights, lifting attachments and clearances for equipment removal and maintenance per contract drawings.

31. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes

are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Provide in accordance with Section 01 61 00 and as specified herein.

B. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. For each pump:

a. One complete set of gaskets

b. One mechanical seal and restriction brushing for each pump provided with mechanical seals

c. One set of wearing rings

2. For each set of pumps of the same size and performance.

a. One set of all special tools required

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 45 00 and as specified.

B. Pumps shall be the product of one manufacturer.

C. Pumps shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Welding: In accordance with latest applicable American Welding Society Code or equivalent.

E. Shop tests as specified.

F. The Contractor shall obtain the pumps, motors, discharge column, discharge head and hydrocones with vanes, from a single pump manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

1. Variable frequency motor controllers can be supplied by the Contractor or the pump manufacturer at the Contractor's option. The pumping system must be a complete and integrated package to insure proper coordination and compatibility and operation of the system.

a. The Contractor shall coordinate the variable frequency motor controllers with the pump and motor manufacturer and submit as part of the shop drawings a written statement signed by the Contractor, pump manufacturer, motor manufacturer and variable frequency motor controller manufacturer that the variable frequency motor controller manufacturer has received the required information from the pump and motor manufacturers and that all parties have reviewed the system and coordinated the equipment selection. Also include all motor data and information that has been used for the coordination.

b. Failure to include the above statement will result in submittal return without review until the above statement is submitted in a complete package.

2. Provide variable frequency motor controllers in accordance with Section 26 29 23.

G. Manufacturer of pumps shall have a minimum of three (3) operating installations with pumps of the size specified or larger and in the same service as specified operating for not less than five (5) years in a self-cleaning trench wet well.

H. If equipment proposed is heavier or taller than specified and indicated; provide all structural, architectural and mechanical revisions at no additional cost to the Owner.

I. For each pump service provide all pump assemblies of the same length so that any pump can be installed in any position.

J. For variable speed pump systems the pump manufacturer must perform an analysis of the combined motor and pump assembly for resonant frequency or their harmonics independent of a structure.

1. Submit a copy of these calculations for the record.

2. Should calculations indicate the probability of encountering such frequencies within the speed range required, provide all additional supporting devices necessary to affect the unit mass, and raise or lower resonant point as necessary.

3. Provide and install such additional devices at no additional cost to the Owner.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with APWA Section 01 66 00 and as specified.

1.07 PUMP INTAKE DESIGN:

A. A physical hydraulic model study of the facility was performed by the Engineer.

B. The physical modeling verified that the pump intake design satisfies or is better than the acceptance criteria as specified by Hydraulic Institute Standards, ANSI/HI 9.8-Latest Edition.

C. The pump manufacturer must review the pump installation with particular attention to the pump suction and intake configuration.

D. Pump suction bell outside diameter:

1. Pump Bell Diameter: As specified herein as indicated in the Process Pump Schedule

a. Suction bells with outside diameters less than or greater than specified and indicated, may be submitted and acceptable only if a physical hydraulic modeling study plan is submitted to the Engineer for review and acceptance and subsequently a physical hydraulic model study is conducted by the Contractor to demonstrate that the pump manufacturer's proposed suction bell outside diameter and wet well and intake modifications satisfies all acceptance criteria specified by ANSI/HI 9.8-Latest edition for all specified pump performance requirements and conditions of service specified and indicated.

2. Physical hydraulic model study must incorporate all dimensional modifications to the wet well, pump intake and pump bay design configuration associated with the proposed pump suction bell design and performed at no additional cost to the Owner.

3. Submit physical hydraulic model study to the Engineer for review and acceptance.

4. Submit all modifications associated with the wet well and intake bay design by the Contractor for review and acceptance and stamped by a registered Professional Engineer.

5. All work associated with any design and construction changes due to changes in bell diameters and physical modeling study results must be at no additional cost to the

Owner and is not considered cause for any claim of schedule delay or extension to the contract duration.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Pump capacities and operating data are indicated in the Process Pump Schedule.

B. Influent Pump Station Pumps: Pump raw, unscreened wastewater from wet wells.

C. Pumps are to be installed in a self-cleaning trench wet well, with intake configuration as indicated and as modeled.

D. Equipment Limitations:

1. Pumps: Influent Pump Station Pumps

a. Refer to Process Pump Schedule

b. Coordinate pump dimensions and weights with cranes to be utilized for pump removal with the Owner.

E. Design Heads:

1. The head requirements indicated in the Process Pump Schedule are the heads required at the pump's discharge head outlet.

2. The pump manufacturer must include all internal losses from the intake bell to the discharge head outlet.

2.02 MANUFACTURERS:

A. Fairbanks Nijhuis

B. Flowserve

2.03 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 PUMP CONSTRUCTION:

A. Pumps: Vertical wet pit solids handling single-stage, centrifugal pumps with non-reverse ratchet. Driven as indicated in the Process Pump Schedule.

B. Design and proportion all parts of pump specially adapted for the service specified and indicated. Provide room for inspection, repair and adjustment.

C. Bowl Assembly:

1. Cast iron ASTM A48/A48M Class 30.

2. Provide discharge bowls with three symmetrically arranged diffuser vanes.

a. Provide vanes of hydrofoil design with well rounded edges to prevent accumulation of fibers and stringy solids.

3. Bowl shaft: ASTM Type 416 stainless steel. Chrome plated under rubber bearings.

4. Provide lifting eyes on bowls for handling.

5. Provide components with machined registered concentric shoulder fits to ensure precision alignment. Equipment without registered fits is unacceptable.

6. Provide bronze backed Neoprene rubber upper and lower bowl bearings.

a. Bronze: ASTM B505 C39200

7. Provide bowl bearings protected by a PEEK restrictor-bushing system or other field proven system that limits backflow of sand, grit or other potential destructive material during pump shutdown.

a. Provide the restrictor bushing to throttle or limit the amount of flush water used during pump operation, as well as provide proper pressurization of the enclosing tube and bearing lubrication system. Provide the restrictor bushing locked in place with a retaining ring, but free to float along the shaft.

D. Suction Bell:

1. Cast iron ASTM A48 Class 30.

2. Provide bell without any vanes or supporting ribs, for unrestricted flow to the impeller.

3. Provide size as indicated and specified.

    a. If submitted equipment requires a different suction bell diameter from that indicated and specified, prepare and submit for review: physical hydraulic model study and detailed structural, architectural and mechanical drawings showing all necessary changes. All changes are at no additional cost to the Owner.

E. Bowl Assembly and Suction Bell Lining:

1. Manufacturer:

    a. Belzona Supermetalglide

2. Type: Ceramic filled epoxyPercent Solids by Volume: 100 percent

4. Provide two coats 8 to 15 mils thick with total minimum DFT of 20 mils.

5. Cured Hardness: 90D in accordance with ASTM D2240.

6. Surface preparation, mixing and application and safety requirements shall be in accordance with the lining manufacturer's printed instructions and as specified.

F. Impeller:

1. Type: Enclosed solids handling single suction type.

    a. Provide impeller of one piece hydrofoil design with well-rounded leading edges to prevent the accumulation of fibers and stringy material.

2. Provide a maximum of two vanes with wide suction and waterways that will pass solids and stringy materials without clogging.

3. Provide pump capable of passing a minimum diameter sphere, as indicated, between the periphery of the maximum diameter impeller and bowl diffuser vanes.

4. Material:

    a. CA6MN stainless steel.

5. Do not design hub with ports for reduction of thrust on impeller.

    a. Wiper vanes are not acceptable.

6. Key-seat and securely hold impeller to tapered shaft by a key and capscrew and capable of holding securely in event of motor reversal under full torque.

    a. Impeller fasteners: Type 416 stainless steel.

7. Statically and dynamically balance each impeller.

8. Provide means of adjustment of wearing ring clearance.

9. Vertical turbine type pump impellers are not acceptable

G. Wearing Rings:

1. Provide axial type wearing rings on impeller and in pump suction bell.

2. Wearing Ring: Stainless Steel ASTM A743 Grade CA-40 with a 410 to 484 BHN.

a. Provide bell wearing rings of Stainless Steel ASTM A743 Grade CA-40 with a 300 to 350 BHN.

H. Discharge Column Assembly:

1. Column Pipe: Steel ASTM A53 Grade B.

a. Wall Thickness:

Column Size	30
OD, in	30
Wall Thickness, in	0.375

b. Epoxy coated and lined in accordance with AWWA C210.

2. Provide the number of column sections as indicated and specified. Provide with flanged registered connections. Provide column lengths of the length required so that pump can be removed within the space indicated.

3. Provide column pipe with welded in place splitter vane designed to prevent material pumped from accumulating on the shaft enclosing tube. Provide vane running the entire length of the column and align with the bowl diffuser vane and discharge elbow splitter vane.

4. Provide weld neck flange for top column piece connecting to the discharge head. Slip-on flanges are not acceptable.

5. Provide lifting lugs with lifting eyes 180 degree apart below each column flanged connection for pump removal.

6. Hardware: Type 316 stainless steel.

7. Line Shaft and Threaded Couplings: ASTM A582 Type 416 stainless steel.

a. Chrome line shaft in bearing area.

b. Line Shaft Enclosing Tube: Schedule 80 Type 316L stainless steel.

(1) Provide interchangeable lengths not to exceed 5.0 feet.

(2) Carbon steel enclosing tubes are not acceptable.

8. Provide water flush of bearings and seals.

9. Column and lineshaft with spider type bearing retainers are not acceptable.

I. Discharge Head:

1. ASTM A36 fabricated steel discharge head and sole plate sized for mounting the driver specified and indicated.

a. Provide a minimum of four (4) supports and bracing for variable speed operation on all pumps. Heads without bracing are not acceptable.

2. Provide surface type discharge, flanged, drill flange to ANSI/ASME B16.5 Class 150-lb ANSI standard.

a. Provide a minimum three (3) piece mitered bend per contract documents.

3. Provide a flanged adjustable coupling for vertical solid shaft motors.

a. Non-spacer type, John Crane CPAT Style 2.

4. Provide a drain tap for stuffing box leakage and route to nearest floor drain to minimize tripping hazard.

5. Provide a Type 316L stainless steel safety cage conforming to OSHA requirements.

6. Provide Type 316 stainless steel hardware.

7. Epoxy coated and lined in accordance with AWWA C210.

J. Hydrocones with Vanes:

1. Provide fabricated Type 316L stainless steel hydrocones with vane as indicated by pump supplier and hydraulic modeling.

a. Provide Type 316L stainless steel hardware and anchor bolts.

2.05 SEALS:

A. Type: Split Mechanical

1. Manufacturer: Chesterton Style 442

2. Materials:

a. Gland: Type 316 stainless steel

b. Rotary Holder: Type 316 stainless steel

c. Hardware: Type 316 stainless steel

d. Springs: Hastelloy C or Elgiloy

e. Rotating Faces: Silicon Carbide

f. Stationary Faces: Silicon Carbide

g. Elastomers: Viton

2.06 MOTORS:

A. Provide in accordance with Section 26 20 00 and as specified and indicated.

1. Vertical solid shaft with non-reverse ratchet.

B. High thrust motors

C. Horsepower Rating of Motors: Not less than maximum brake horsepower requirements of pumps under any condition of operation specified and indicated without operating in the motor service factor.

D. Motor Enclosure and Speed: As indicated in the Process Pump Schedule.

E. Provide motors with base supports with machined registered joints for mounting on pump discharge head.

F. In addition to the requirements for bearings specified under Electric Motors in Section 26 20 00, provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours. Provide non-reverse ratchet.

G. Overall sound-pressure level of each motor shall not exceed 88 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall sound-pressure level as average of four or more readings at evenly spaced points, 3 feet from motor.

H. Operate without overheating at the speeds specified and indicated.

I. Service Factor: 1.15, with 1.0 inverter duty rating for pumps equipped with variable frequency motor controllers.

J. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

K. Rating: 4160 V, 3-phase, 60 Hertz

L. Insulation: Class H with Class B temperature rise, 122 degree F ambient.

M. Site Altitude: 4225 feet above sea level

N. Provide Inpro/Seal bearing isolators

O. Motor Temperature Monitoring System:

1. The Resistance Temperature Detector (RTD) monitor system:

a. Platinum, 100 ohm RTDs embedded in the motor windings for each phase and in each motor bearing.

b. Continuously monitor the temperature of the three-wire bearing RTDs via SCADA.

c. Include a display and switch to permit monitoring of actual bearing temperature.

d. Provide an adjustable alarm feature to select an alarm temperature. Selection of temperature range by pump manufacturer. Alarm when bearings reach the selected temperature.

e. Provide an alarm light until reset, and a set of contacts, rated not less than 5 amps at 120 VAC.

f. Temperature range as recommended by the motor manufacturer.

g. Trip point repeatability of not more than 1.8 degree F. detection circuit response time of 5 milliseconds, maximum; deadband, 2 percent maximum; calibration accuracy of 1 degree F.

h. Mount monitors in the variable frequency motor controller as indicated and specified in Section 26 29 23. Mounting in separate panels is not acceptable.

P. Vibration Monitoring System:

1. Reference the requirements listed in Section 26 20 00, including requirements for a vibration monitoring system and accessories.

2.07 DISCHARGE HEAD BASEPLATES:

A. Fabricated ASTM A36 Grade B structural reinforced steel baseplate designed and furnished by pump manufacturer and machined to suit motor base.

B. Grout and anchor baseplate to concrete curb with a minimum of four (4) anchor bolts.

C. Provide supports and bracing for variable speed operation.

2.08 DRAIN, VENT AND SEAL WATER PIPING:

A. Provide drains from stuffing box and drain piping and valves to discharge into nearest floor drain that minimizes risk of tripping, or as indicated.

B. Provide seal water piping, valves and accessories at pump, pre-assembled on rack, as specified and indicated.

C. Drain, seal water and bearing flushing water piping: Type 316 stainless steel in accordance with Section 40 23 19.03 and with a sufficient number of unions to permit removal of each valve and in-line device.

D. Valves: Provide size and type as indicated and as specified in Section 40 23 13.01.

E. Provide seal water control and monitoring unit in accordance with Section 40 23 19.05.

2.09 AIR/VACUUM RELEASE VALVE:

A. Provide an air/vacuum release valve for wastewater service for each pump as specified in Section 40 23 13.01.

B. Locate on discharge piping at high point as indicated.

C. Provide minimum size as indicated.

2.10 GAUGES:

A. Provide gauge assemblies for discharge of each pump as specified in Section 40 73 00 and as indicated.

B. Discharge gauges: Provide standard range with top limit above pump shutoff head at maximum pump speed indicated.

1. Scale: See Section 40 73 00

2.11 SHOP TESTING:

A. Provide as specified herein.

1. Provide motor shop testing in accordance with Section 26 20 00.

B. Pump Tests:

1. Test pump discharge head and bowl separately under a hydrostatic head of at least 75 psi or 150 percent of rated shutoff head, whichever is greater.

2. Provide witness tests as specified herein for all Influent Pump Station Pumps.

3. Witness testing:

a. Run pump at full speed rating point for 60 minutes prior to start of any testing.

b. Full speed tests:

(1) Provide a test curve with a minimum of ten (10) points.

(2) Test pumps at all conditions specified and indicated in the Process Pump Schedule and as a minimum at the following conditions:

(a) Shut off head, if applicable to the type of pump specified

(b) Minimum continuous safe flow

(c) Best Efficiency Point (BEP)

(d) Preferred Operating Range (POR), 2 points, 1 each side of the BEP

(e) Maximum flow or runout

(f) Provide full speed rating curve without the use of a VFD.

(3) Take readings at each point to determine flow rate, differential pressure, rpm, horsepower or kW, and wire to water efficiency.

(a) Wire to Water Efficiency: Pump and job motor combined efficiency excluding any adjustable speed drive.

(b) Provide vibration readings for all submersible and dry pit submersible pumps in accordance with ANSI/HI 11.6

(c) Provide vibration readings for all other pumps 100 hp (75 kW) and larger in accordance with ANSI/HI 9.6.4

(4) Operate each pump for not less than 30 minutes at the specified minimum head condition and take readings to determine that the pump will operate as specified and indicated without cavitation at the specified minimum head condition with not more than the specified and indicated job submergence.

(5) Provide performance curves adjusted for the submitted and approved pump speed.

(6) Provide indication of the specified test acceptance grade and tolerance band.

c. Variable speed tests:

(1) Conduct tests as specified above for full speed but with a minimum of seven (7) points at reduced speeds except that tests for cavitation at minimum head conditions are not required.

(2) As a minimum provide the following test points for reduced speed tests:

(a) Shut off head, if applicable to the type of pump specified

(b) Minimum continuous safe flow

(c) Best Efficiency Point (BEP)

(d) Maximum flow or runout

(e) Specified and indicated rating points

(3) Run one speed test at the speed required to discharge the minimum rating point specified and indicated in the Process Pump Schedule.

(4) Run a second test at a speed approximately midway between full and minimum speed.

(5) Run tests for all reduced speed operating condition specified and indicated in the Process Pump Schedule.

(6) Run one additional test or at the condition specified at the time of the factory testing or as provided in the shop drawing review.

d. Factory tests on pumps:

(1) String test the complete job motor, job variable frequency motor controller, discharge head, bowl assembly and a minimum of 10 feet of column or as many sections as is practical for the manufacturer's test pit.

(a) Use all job motors that are shipped to the pump testing facility for use in these pump tests and match mark each motor serial number with a pump serial number.

(b) Use one (1) job variable frequency motor controller that is shipped to the pump testing facility for use in these pump tests.

(c) Provide performance curves adjusted for the final job column length and provide calculations.

e. Provide a minimum of 30 days written notice to the Engineer prior to shop testing.

4. Run all tests in accordance with the latest standards of the Hydraulic Institute and as specified.

5. Testing Acceptance Grade and Tolerances:

a. ANSI/HI 14.6 Acceptance Grade: 1U.

b. Efficiency Tolerance: -0 percent.

c. If pumps do not meet the tolerances specified, make modifications, adjust the impeller, and pump tolerances and retest until the specified results are obtained.

6. Tests of variable frequency motor controllers specified in Section 26 29 23.

7. In the event that specified tests indicate that pump, motor, or variable frequency drive will not meet specifications, Engineer has the right to require additional complete witnessed tests for all pumps, motors, and variable frequency motor controllers at no additional cost to the Owner.

8. Repeat tests until specified results are obtained.

9. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

10. Pump manufacturer must provide roundtrip airfare from Job site, all local transportation, meals and lodging for witness testing for two (2) people. If air travel is greater than 6 hours, provide business class airfare.

a. Credit the cost of the travel and lodging to the Owner if a virtual witness test is selected.

b. Provide the option of virtual witness testing, Testing must including the following as a minimum:

(1) Real time video of test and data collected

(a) Real time data collected for flow, head, speed, kW and efficiency

(b) Real time performance curve development with specified ANSI/HI 14.6 acceptance grade and tolerances

(2) Provide final performance curve with all corrections at the time of testing.

2.12 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy and system color in accordance with Section 09 91 10.

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with accepted shop drawings, manufacturer's printed instructions and as indicated.

B. Install pumping units on a concrete pad and align thereon.

1. Set base on metal shims placed directly under the part of the base carrying the greatest weight and spaced close enough to provide uniform support.

C. After alignment is correct, grout using high grade non-shrink grout.

1. Do not imbed leveling nuts in grout.

3.02 STARTUP AND TESTING:

A. Services of Manufacturer's Representative as stated in Section 01 45 00 and as specified herein.

B. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect location of anchor bolts; grouting, setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:

   a. 2 person-days

3. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.

   a. 2 person-days

4. Field Performance Testing: Field performance test equipment specified.

   a. 3 person-days

5. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

6. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

3.03 FIELD TESTING:

A. Provide as specified herein.

B. Test piping connections to prove the pump nozzle are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with pump nozzles by removing and reinstalling all bolting from the pump discharge head flange.

C. After installation of pumping equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct running test for each pump in presence of the Engineer to determine its ability to operate within the vibration and temperature limits specified, and to deliver its rated capacity under specified conditions.

1. During tests, observe and record head, capacity, motor inputs, motor bearing housing temperatures, noise and vibration.

2. Provide vibration signature test data for each pump and drive assembly.

   a. Limit: 75 percent of ANSI/HI allowable limits at maximum pump speed under load.

3. Bearing and Motor Temperature:

   a. Run each pump for a minimum of one hour, or until the bearings reach a stable temperature prior to taking temperature readings of the motors.

   b. Bearing temperature not to exceed 180 degrees F (82 degrees C).

4. Test Duration: Determined by the Engineer, but not less than one hour of continuous operation at each condition specified and indicated.

5. Immediately correct or replace all defects or defective equipment revealed by or noted during tests, at no additional cost to the Owner, and repeat tests until specified results and results acceptable to the Engineer are obtained.

6. Repeat tests until specified results are obtained.

7. Contractor to provide all water labor, piping, testing equipment, equipment, flow meters, vibration testing equipment and test gauges for conducting tests.

   a. Contractor to provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters for all pumping systems even in those cases where permanent flow meters are installed.

   b. All calibrations and certifications must be within 30 days of the field testing.

   c. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted and approved.

D. Make all adjustments necessary to place equipment in specified working order at time of above tests.

E. Test pumps on product only. If product is not available, test with water. Water for testing furnished by Contractor.

F. Remove and replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted and accepted.

3.04 TRAINING:

A. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions. See Section 01 78 24.

   1. 3 person-days

3.05 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

PROCESS PUMP SCHEDULE

Description:	**IPS Pumps**
Tags:	01-P-11110, 01-P-11220, 01-P-11130, 01-P-11240, 01-P-11150,
Number of Pumps:	4 duty, 1 standby
Design Conditions:	
Liquid	Unscreened raw wastewater
Liquid Temperature Range, deg F	50-77
Min. Sphere Size Required to Pass, in	8
Design Rating Point:	
Rated Flow, gpm	18,230
Head, ft (1)	77
NPSH Available w/ Margin, ft (2)	39
Pump Efficiency, %	82
Wire to Water Efficiency, %	77
Nominal Pump Speed, rpm	581
Shutoff Head, ft (minimum)	121
Minimum Speed Operating Condition:	
Flow Rate, gpm	10,417
Head, ft (1)	56
Seal:	
Seal Type	Split Mechanical
Seal Water	Yes
Suction/Discharge:	
Suction Bell Outside Diameter, in	60
Discharge Column Size, in	30
Pump Discharge Head, in	30
Driver:	
Drive Type	Direct
Motor Type	VSS, High Thrust
Electrical Service	4160 V, 3-phase, 60 Hertz
Motor Speed, rpm	581
Motor Horsepower	500
Motor Enclosure	TEFC
Motor Space Classification	Unclassified
Speed Control	VFD

Description:	**IPS Pumps**
Equipment Limitations:	
Max Pump and Motor Weight, lbs	55,000
Heaviest Piece or Assembly to be lifted, lbs	20,000
NOTES: 1. Refer to Paragraph 2.01.E. 2. NPSH available includes a margin of 5 feet.	

END OF SECTION

SECTION 43 21 00.42

ODOR CONTROL EXHAUST STACK

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide an odor control exhaust stack for the location as shown in the Contract Drawings. The exhaust stack material of construction is to be fiberglass reinforced plastic (FRP). The stack and accessories are to be provided and installed as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Civil Engineers (ASCE)

1. ASCE/SEI 52-10: Design of Fiberglass-Reinforced Plastic (FRP) Stacks

B. ASTM International (ASTM):

1. C916: Standard Specification for Adhesives for Duct Thermal Insulation.

2. C1290: Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts, Type III.

3. E96: Standard Test Methods for Water Vapor Transmission of Materials.

C. National Fire Protection Association (NFPA):

1. 255: Standard Method of Test of Surface Burning Characteristics of Building Materials, 2006 Edition.

2. 259: Standard Test Method for Potential Heat of Building Materials, 2013 Edition.

D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1. Thermoset FRP Duct Construction Manual, 2nd Edition

2. Accepted Industry Practice for Industrial Duct Construction.

3. Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition, 1981-2008

E. Underwriters Laboratories Inc. (UL):

1. 181: Standard for Factory-Made Air Ducts and Air Connectors (2013-07-25 edition).

F. Local and National Building Codes

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Duct Fabrication Drawings:

1. Manufacturer's Product data including details of materials, construction, dimensions of all components, layout, installation details, and finishes for the following items:

a. FRP stack

b. Mounting and anchoring hardware

c. Sampling ports

d. Stack flanges

e. Sealants and gaskets

2. Structural engineering design calculations are to be stamped by a Professional Engineer licensed in the State of Utah.

3. Drawn after actual site measurements are obtained.

4. Drawn to a scale not smaller than 1:50, on drawing sheets of the same size as the Contract Drawings, detailing:

a. Fabrication, assembly, and installation details including plans, elevations, sections, details of components, and attachments to other Work. Other Work includes facility process equipment such as odor control ductwork and accessories.

b. Stack drawings, indicating pressure classifications, and sizes in plan view

c. Stack material and thickness

d. Reinforcing details

e. Seam and joint construction details

f. Spatial coordination with other systems installed in same space

C. Informational Submittals in accordance with Section 01 33 00.

1. Product Data:

a. Submit Product data sheets for the equipment as specified herein. Product data sheets are defined as catalogue sheets, brochures, literature, technical data, performance charts, diagrams, specifications, instruction books, lubrications charts, maintenance instructions/schedule, spare parts lists and similar data used to illustrate quality, characteristics, capacity, maintenance, replacement parts, and performance of the supplied manufactured Products.

2. Record Drawings:

a. At Contract closeout, the Contractor shall submit record drawings of installed ductwork, accessories, and joints, in accordance with Section 01 33 00.

D. Delegated Design Submittals:

1. For the odor control exhaust stack and accessories, provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems, anchorage and equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 61 00.

B. Manufacturers: Firms regularly engaged in manufacture of FRP exhaust stacks of the types, materials, and sizes required, whose products have been satisfactorily used in similar service for a minimum of 5 years.

C. Ensure that the suppliers of stack and fitting components provide, on request, the following information:

1. Laboratory performance data for materials.

2. Laboratory performance data for fittings, including zero length dynamic losses.

D. Changes or alterations to layout or configuration of the exhaust stacks shall be:

1. Specifically approved in writing.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. The equipment and appurtenances shall be delivered to the site in a condition satisfactory to the Engineer and any omissions, discrepancies or damage evident on delivery shall be addressed to the Engineer's satisfaction.

C. The equipment shall be of sufficient strength and rigidity for normal handling during loading, transport, unloading, installation, and assembly. Supports and reinforcements shall be used to maintain the equipment integrity as required.

D. Do not ship the exhaust stacks by nesting small diameter components inside larger components.

E. Protect shop-fabricated and factory-purchased equipment, accessories, and purchased Products from damage during shipping, storage, and handling. Prevent end damage and prevent dirt and moisture from entering the exhaust stacks and fittings.

F. Protect flanged sections by bolting wooden blinds 2 inches greater than outside diameter of flange.

G. For non-flanged components, use either rigid plugs inside ends to prevent deflection or protect with wooden boxes.

H. Crate materials, wherever practical, prior to shipment.

I. Firmly fasten and pad components shipped to prevent shifting or flexing of components after assembly.

J. Lifting lugs shall be shop installed as required to permit safe handling during shipping and erection with conventional hooks or slings.

K. The Contractor shall obtain the manufacturer's written instructions for precautions to be observed in connection with storing the equipment. A copy of all instructions shall be provided to the Engineer.

L. Where possible, store the exhaust stacks inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping

M. Protect exhaust stacks from dirt, water, and debris. During storage on the site, keep ends of the exhaust stacks covered to prevent foreign objects and water from entering.

PART 2 - PRODUCTS

2.01 GENERAL:

A. For this contract, the Contractor is responsible for the supply of one (1) odor control exhaust stack for operation with the Influent Pump Station (IPS) odor control system as indicated on the Contract Drawings and complete with all accessories and features as indicated in this Specification.

B. The exhaust stack shall be a one-piece, free-standing, self supporting, double wall insulated FRP stack, designed and constructed so that the outer casing and inner liner can expand and contract vertically independent of each other. The stack will be bolted to a concrete base as shown on the contract drawings.

C. All materials and components used in the manufacture of this equipment shall be new and unused, and free of all defects and imperfections.

D. All equipment supplied shall be suitable for continuous operation in a corrosive gas stream generated by the treatment of odors produced from a wastewater pumping station facility.

E. The Contractor shall install the odor control exhaust stack and accessories with strict adherence to the manufacturer's written instructions.

F. Material and equipment to conform to the latest edition of all applicable standards, which are in force at the time of tendering, including those listed in Subsection 1.02. In the case of conflict between the requirements of these specifications and any standards, the more stringent requirement of the two applies.

2.02 PROCESS DESIGN PARAMETERS:

A. Process design parameters and service conditions for the odor control exhaust stack and accessories are described as follows:

Process Parameters	**IPS**
Hydrogen Sulphide, average ppm	23
Hydrogen Sulphide, peak ppm	200
Average Inlet RH, percent	>95
Maximum Working Pressure, "w.c.	14
Process Air Temperature, degrees F	40 to 90
Outdoor Temperature, degrees F	-40 to 120

B. The exhaust stack shall be air and watertight up to the pressure indicated in Article 2.02.

C. Materials:

1. Resin System: Premium corrosion resistance, fire retardant vinyl ester, or approved equivalent.

2. Liner Resin: Premium grade and corrosion resistant.

3. Flame Spread Index: ASTM E84, less than 25; fire retardant additives used only in structural layer.

4. Color: Exhaust stack shall be white. Submit sample for approval prior to manufacture

D. Reinforcement:

1. Veil: Chemical surfacing mat, polyester fabric, with finish and binder compatible with layup resin.

2. Corrosion Barrier: Resin rich interior surface of nominal 2.5 to 3.0 mm thick, using chopped strand mat backing the veil. Use no additive in corrosion barrier

E. Exhaust stacks shall be constructed following ASCE/SEI 51-10

F. Flanges for stack-to-duct: Meet or exceed the requirements of ASTM D3982, ANSI B16.5, ANSI B16.47.

G. Gaskets: EPDM, 1/8-inch thick, full face, Durometer – A50 to A60.

H. Insulation: minimum 3.87 lbs/ft^3 density, semi-rigid glass fiber insulation, 3-inch thick, supported vertically every 12-feet, arranged with staggered joints, and banded to the inner liner on 1-foot centers with 1-inch stainless steel bands.

I. Breeching/air duct connection: Rectangular single wall FRP terminated with a flanged connection compatible with ductwork connection flanges, and with the opening around the outer casing reinforced to suit.

J. Anchor hardware and metallic fittings to be of 316L stainless steel material.

K. Sampling ports: two (2) sampling ports not less than 3-inch in diameter and fitted with screw-on air-tight FRP caps shall be provided as shown on the Contract Drawings, at the same elevation and 90 degrees from each other.

L. Cleanout door: minimum 3-foot x 3-foot FRP cleanout door connected to the inner liner, extended out through the outer casing, with reinforcing around the outer casing opening, and equipped with a flanged bolt-on cover plate. Size cleanout door to suit actual size of stack diameter.

M. Stack drain and rain shelf: 2-inch stack drain connection at base of stack provided with a sloped 316L stainless steel plate rain shelf continuously around the circumference of the inner liner to channel water into drain.

N. Lightning protection: two (2) type 304L stainless steel lightning rods secured to the top of the stack, and a minimum of two (2) ground lugs welded to the top of the stack.

O. Approved Vendors:

1. Perry Fiberglass Products, Inc.

2. Composite & Metal Products USA, Inc.

2.03 SEISMIC-RESTRAINT DEVICES:

A. Refer to Sections 01 41 20 and 23 05 48 for requirements for restraint components and applications.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION:

A. Cut, fit, and install in accordance with the exhaust stack manufacturer's instructions and the Contract Drawings.

B. Install so that the exhaust stack shall be free of vibration while in operation.

C. Install plumb, straight, and in proper alignment.

D. Anti-seize thread compound shall be applied to all nuts and bolts.

E. Flange bolts shall be tightened to torque values specified by the manufacturer. Install gaskets at each flange connection and flat washer under each nut and bolt head.

F. Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.

G. Spare parts shall be packaged in containers suitable for long-term storage and shall bear labels clearly designating the contents and equipment for which they are intended.

H. Temporary shipping braces if required shall be clearly identified for removal after assembly.

I. Lifting lugs shall be shop installed, as required, to permit safe handling during shipping and erection with conventional hooks or slings.

3.02 FIELD TESTING:

A. Comply with requirements of Section 01 78 25.

3.03 CLEANING:

A. Blow exhaust stack clean continuously for a minimum of 24 hours at the airflow rates shown on the contract drawing P&IDs.

B. Contractor shall protect debris from entering the odor control system.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

DIVISION 44

POLLUTION CONTROL EQUIPMENT

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SECTION 44 60 13

ODOR CONTROL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide bioscrubber and biofilter odor control systems as indicated, and in compliance with the Contract Documents.

B. Scope includes:

1. Furnish, install and test the biological odor abatement systems with performance as specified herein. The bioscrubber and biofilter odor control system shall include a containment vessel, engineered media, media support, irrigation systems, nutrient addition system, instruments, control panel, and all appurtenances and mechanical equipment to make them operable, as indicated and as specified.

2. The bioscrubber, biofilter, and engineering medias are to be the end product of a single biological odor abatement system manufacturer.

3. The location of the bioscrubber and biofilter systems areas shown on the Contract Drawings.

4. Obtain all state, local or federal permits.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. C582: Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment

2. D648: Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.

3. D3982: Standard Specification for Contact Molded “Fiberglass” Ducts

4. D4385: Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Protruded Products

5. D746: Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

6. D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

7. D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique.

8. D1525: Determination of Vicat Softening Temperature of Plastics.

9. D1693: Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.

10. D1998: Standard Specification for Polyethylene Upright Storage Tanks.

11. D2583: Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

12. D3299: Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.

13. D4097: Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.

14. D4167: Standard Specification for Fiber-Reinforced Plastic Fans and Blowers

15. E84: Standard Test method for Surface Burning Characteristics of Building Materials.

16. E679: Standard Practice for Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits.

B. Fiberglass Reinforced Plastics Institute, Inc. (FRPI):

1. Laminate Certification Manual.

C. International Organization for Standardization (ISO):

1. 17855-1: Plastics – Polyethylene (PE) molding and extrusion materials

2. 19069-1: Plastics – Polypropylene (PP) molding and extrusion materials

D. National Bureau of Standards (NBS):

1. PS 15: Custom Contact Molded Reinforced Chemical Resistant Process Equipment.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Certified shop and working drawings. Drawings for the vessels shall also include a complete description of the laminate and material of construction as specified within this section and be accompanied by a detailed post-cure procedure that will be utilized.

a. Drawings shall include plan views, sectional views, title block, and details of all related items. In cases where certain information is proprietary and is omitted, provided a statement indicating that the information is proprietary and is being omitted.

b. Files shall include Tag Names, Parts List (identifying each component), Dimensions, and connection sizes.

c. Files shall be drawn to scale.

d. Drawings shall be in conformance with all other requirements as specified in this specification.

e. Drawings shall show access paths for maintenance activities and provide sufficient clearance for equipment removal.

f. Drawings are to show the supplied odor treatment equipment within the odor treatment equipment areas as shown on the Contract Drawings.

g. Drawings are to coordinate with and show the locations of where the ductwork, piping, and other services connect to the odor treatment equipment as shown on the Contract Drawings.

h. Drawings to include panel elementary diagrams for pre-wired panels. Include, in the diagrams, control devices and auxiliary devices (e.g. relays, alarms, fuses, lights, fans, and heaters). The diagrams are to be fully comprehensive so that every circuit loop can be followed completely. Indicate the types of loads, switches, transducers and power supplies such as motors, relays, lights, indicators, mechanical float, isolators, signal selectors, dedicated 24 volt DC power suppliers, etc. Number and identify each component circuit and terminal. Also show wiring terminals and devices which are external to the panel including items supplied by the Contractor. Identify all wires/cables, enclosures, terminals, and devices. Show tag numbers.

2. P&ID schematic and wiring schematic with interconnection diagram showing description of operations. List component identification of schematic diagrams as stated herein, along with component instruction manual references.

3. A process control description of the entire system including setpoints and measurement ranges for instrumentation and valves, along with system schematic drawings.

4. Manufacturer's literature and specifications. Show catalog dates.

5. Operating and maintenance instructions and parts list.

    a. In operating instructions incorporate the process control description of the entire system including system schematics.

    b. In maintenance instructions, clearly define requirements for particular system components, and explain special calibration and test procedures.

    c. Provide troubleshooting and maintenance guides for all equipment.

    d. Provide a maintenance schedule for all components of the odor treatment systems.

6. Clearly mark all drawings and provide all technical data for the odor treatment equipment including, nozzle schedule, bill of materials, rated capacities, material of construction, layouts and construction details of all components. Show dimensions, mounting and external connection details, and supports on all drawings.

7. Number and identify all equipment to correspond with terminology on drawings. Also use these numbers on all submittal sheets and shop drawings.

8. List of five (5) operating reference installations in which the manufacturer has supplied the same medias which will be used for the application specified herein. Installations to have been in continuous operation for at least five (5) years.

    a. Provide performance data for each reference installation.

    b. Provide current (verified) contact information for each reference installation.

9. Submit details of:

    a. Vessel construction material

    b. Resin Type

    c. Types and amounts of filler

    d. Corrosion liner description

    e. Reinforcement types for hand lay-up or chopped laminates

    f. Gel coat and UV inhibitor

g. Material final color

10. Shop test results.

11. Qualifications of field service technician.

12. Schematic control and power wiring diagrams.

13. Shop and Field inspections reports.

14. List of recommended spare parts other than those specified.

15. Recommendations for short and long term storage of shipped and spare parts.

16. Special tools.

17. Shop and field-testing procedures and equipment to be used.

18. Manufacturer's product data, specifications, and color charts for shop painting.

19. Provide documentation showing material compatibility and corrosion resistance with process air and fluids as specified.

20. The most recent ISO 9000 series certification.

21. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required".

    a. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

22. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

    a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

    b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in rejection of the entire submittal with no further review and consideration.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Furnish and deliver to the Owner at the site of Work the following spare parts, all identical and interchangeable with similar parts installed in the Work:

1. One (1) of each type pressure and differential pressure gauge, as necessary for each bioscrubber and biofilter system.

2. Two (2) spare gaskets of all types, materials and sizes for each bioscrubber and biofilter system.

3. Two (2) spare mist eliminator pads for each bioscrubber and biofilter system.

4. One (1) year supply of bioscrubber nutrients.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

B. Systems shall be the product of one (1) manufacturer, who shall be responsible for the design coordination and proper operation of this equipment. The manufacturer shall ensure the satisfactory installation of the equipment, and the satisfactory performance that meets the performance requirements as specified herein. Any modifications or revisions required to meet the satisfactory installation and performance of the odor treatment equipment will be at no additional cost to the Owner.

C. Systems shall be a manufacturer’s standard cataloged product and modified to provide compliance with the drawings, specifications, and the service conditions specified herein.

D. Do work required by and in accordance with applicable State and local codes; arrange for permits, inspections and tests required by these codes; and provide complete systems ready for use. Provide vessels and accessories that conform to applicable safety standards, including those for safety of personnel.

E. Provide components to manufacturer's standard for service specified and indicated unless otherwise required.

F. Provide components and accessories of manufacturers' latest and proven design.

G. Services of Manufacturer's Representative as stated in Section 01 45 00 and as specified herein.

H. FRP Fabricator: demonstrate, through past records, their capability in successful manufacturing of filament-wound fiberglass.

I. FRP vessel fabricator's quality assurance supervisor: minimum 10 years' experience in the fabrication of fiberglass structures.

J. If equipment proposed is heavier, larger, different rotation, or discharge arrangement than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner. Odor treatment equipment and accessories to fit within the odor treatment areas as shown in the Contract Drawings.

K. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified maximum equipment weight and the lifting capacity of the hoisting equipment indicated and specified.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

1.08 WARRANTY:

A. The Manufacturer shall warrant that all bioscrubber and biofilter engineered medias will not compact, degrade or decompose for a period of 10 years from the date of achieving substantial completion.

B. Comply with the requirements specified in Section 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS:

A. The odor control system shall be supplied by BIOREM Environmental Limited.

B. Supply products from a single manufacturer responsible for the complete bioscrubber, biofilter, and engineered medias, complete with all features and accessories in this specification.

C. The manufacturer is to have a minimum of 10 years of experience in the design and supply of engineered media, bioscrubber, and biofilter odor control treatment equipment.

D. The bioscrubber and biofilter are to be supplied for the location shown on the Contract Drawings and specified herein.

E. The Contractor is to install the manufacturer supplied equipment in accordance with the manufacturer's detailed instructions.

F. The Contractor is to supply and install all wiring and power cables.

G. Water piping, fittings, and nozzles internal to the bioscrubber and biofilter equipment are to be supplied and installed by the manufacturer. Water piping external to the bioscrubber and biofilter equipment is to be supplied and installed by the Contractor in accordance with the manufacture's detailed instructions.

H. Interconnecting ductwork to the bioscrubber and biofilter is to be supplied and installed by the Contractor.

I. Supply products modified as necessary by the manufacturer to provide the specified features and to meet the specified operating conditions.

J. All electrical equipment, instrumentation, and panels installed within 3 ft of the odor control ductwork, process fans, bioscrubber, and biofilter vessels are to be supplied explosion proof for a Class 1 Division 2 rated environment.

K. Comply with the requirements specified in Section 01 61 00.

2.02 PERFORMANCE REQUIREMENTS:

A. Process parameters:

	Influent Pump Station Bioscrubber and Biofilter
Equipment Tag	01-TK-40100; 01-TK-40140
Airflow Rate, cfm	5,000
Min Bioscrubber EBRT, sec	12
Max Biofilter EBRT, sec	50
Avg. Inlet RH, %	>90
Air Inlet Temperature, ^{o}F	40 to 90
Ambient Air Temperature, ^{o}F	-40 to 100
Bioscrubber Unit Quantity, ea	*1*
Biofilter Unit Quantity, ea	*1*
Average Loadings	
Avg. H_2S, ppm	23
Avg. Methyl Mercaptan, ppm	1
Avg. Dimethyl Disulfide, ppm	0.1
Avg. Carbon Disulfide, ppm	0.1
Avg. Odor, ou	25,000
Maximum Loadings	
Max. H_2S, ppm	200
Max. Methyl Mercaptan, ppm	2
Max. Dimethyl Disulfide, ppm	1
Max. Carbon Disulfide, ppm	0.5

	Influent Pump Station Bioscrubber and Biofilter
Max. Odor, ou	100,000
Removal Performance	
Bioscrubber H_2S Removal, %	99
Biofilter H_2S Removal, %	99
Biofilter TRS Removal, %	90
Total Odor Removal, %	95

B. The manufacturer is responsible for providing proper humidification of the process air prior to biofilter treatment.

C. The odor control systems are to be designed for continuous 24 hour, 7 days per week, operation.

2.03 BIOSCRUBBER AND BIOFILTER SYSTEM COMPONENTS:

A. Bioscrubber Odor Control System:

1. The bioscrubber system shall include engineered bioscrubber media, bioscrubber vessel, media support, instrumentation, controls, spray systems, recirculation pump, water control panel, nutrient supply system, winterization, access hatches, and all appurtenances and fittings required for one (1) independent bioscrubber system as shown on the Contract Drawings.

2. The bioscrubber system shall be supplied with an FRP vessel whose design and supply is provided by the manufacturer. The Contractor shall install the vessel in accordance with the manufacturer's detailed drawings and instructions.

3. The bioscrubber vessel is to be able to withstand an operating negative pressure of 14 inch w.c.

4. The manufacturer is to supply all piping, fittings, and spray nozzles for a fully functioning spray system.

5. All piping and nozzles are to be of corrosion resistant material.

6. The manufacturer is to provide non-clogging water spray nozzles, and to include a y-strainer in the water panel on the recirculated water line to minimize clogging.

B. Bioscrubber Media:

1. The bioscrubber media shall be a permanent engineered media. The media shall be formulated with nutrients, buffering agents and adsorbents as required.

2. The media shall be resistant to degradation and compaction. Media shall not settle by more than 1.5 percent of its original depth within six (6) months after installation. The media shall not shrink or swell with varying moisture contents.

3. The media is to be supplied in a volume that is sufficient to treat the design airflow at no less than the minimum empty bed residence time as specified herein.

C. Biofiltration Odor Control System:

1. The biofilter system shall include engineered biofilter media, biofilter vessel, media support, instrumentation, controls, spray systems, winterization, access hatches, view ports, and all appurtenances and fittings required for one (1) biofilter system as shown on the Contract Drawings.

2. All equipment supplied is to be suitable for continuous operation in a corrosive foul air stream generated from the treatment of wastewater from a wastewater treatment facility.

3. The equipment is to be the manufacturer's standard design. The design is to have been proven effective and reliable under similar operating conditions.

4. The biofilter vessel is to be able to withstand an operating negative pressure of 14 inch w.c.

5. The odor control system is to be designed to operate 24 hours per day, 7 days per week.

6. A humidification system is to be supplied with the biofilter system to raise the relative humidity of the airflow to a minimum of 98 percent or higher if the upstream bioscrubber does not sufficiently raise the airflow relative humidity to a minimum of 98 percent or more. The humidification system is to be integral to the biofilter vessel.

D. Biofilter Media

1. The biofilter media shall be a permanent engineered media. The media shall be formulated with nutrients, buffering agents and adsorbents as required.

2. The media shall be resistant to degradation and compaction. Media shall not settle by more than 1.5 percent of its original depth within six (6) months after installation. The media shall not shrink or swell with carrying moisture contents.

3. Minimum service life of all biofiltration media is 10 years.

2.04 CONFIGURATION, COMPONENTS, FEATURES:

A. General:

1. Auxiliary equipment as indicated in the Contract Drawings.

2.05 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.06 BIOFILTRATION AND BIOSCRUBBER VESSELS:

A. All materials and components used in the manufacture of this equipment shall be new and unused and free of defects and imperfections. Biofiltration and bioscrubber vessels will be designed in accordance with the following requirements:

1. The vessel is to be designed to handle air with the characteristics specified herein, and process water with a pH level as low as 1.0.

2. The vessel is to be manufactured so that all parts are proportioned to have liberal strength and stiffness and to be especially adapted for the intended working conditions.

3. Material of construction of the bioscrubber vessels is to be FRP, while the biofilters can be 316 stainless steel or FRP.

4. For FRP construction, construct the vessel as follows:

a. The inner shell is to be approximately 25 percent glass and 75 percent resin. Provide an internal C-glass surface veil liner for corrosion resistance.

b. Resin (flame retardant versions only)

(1) Acceptable Products:

(a) Hetron FR922 by Ashland Chemical Co.

(b) Derakane 510C-350

(c) Dion ver9300FR

(d) Vipel K022-AC Series

c. Reinforcing material is to be commercial grade glass fiber containing a coupling agent to produce a suitable bond with the resin used.

d. All materials are to be suitable for exposure to hydrogen sulfide fumes at a concentration of up to 300 ppm and sulfuric acid at a pH of 1.0.

e. Ultraviolet absorbers are to be added to the exterior surface for improved weather resistance. Color samples are to be provided to the Consultant for selection by the Owner.

f. All surfaces are to be finished so as to obtain complete cure of the resin without air inhibition. The finished laminate is to be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, air bubbles, pinholes and pimples. The vessels are to conform to the manufacturer's minimum standard for Barcol hardness.

g. Vessel rigidity to be designed to prevent collapse, implosion or any other damage to the unit from operation of the suction fan at any point along its performance curve.

5. The vessel is to be equipped with the accessories as listed below:

a. Provide Lifting eyebolts (minimum of 4) for use in transporting and placing the vessel.

b. Provide hold downs (minimum of 4) each consisting of Type 316 stainless steel anchor bolts. The anchor bolts are to be used for anchor bolting to the concrete odor control pad.

c. All necessary access doors, nozzles and other attachments. Vessel connection flanges are to be compatible with connecting piping and ductwork.

d. Provide at least one side entry manway for each media lift and spray nozzle assembly and is to be a minimum of 36 inches diameter with bolted flanged covers, that are suitable for the operating suction pressure specified herein. Provide bolted manways with 0.126 inch thick full face neoprene gaskets with Type 316 stainless steel bolts. Provide manways as needed for inspection and access to internals of the vessel.

e. All bolts and fasteners are to be Type 316 stainless steel.

f. All gaskets are to be EPDM.

g. The media support is to be vinyl ester FRP grid type. Packing support plates and mid-span supports are to be suitable to support the weight of the packing and entrained recirculation solution.

h. Provide integral sump to allow for continuous water recirculation.

i. Provide a chevron-style, mist eliminator at the top of each vessel.

j. Permanent personnel fall-arrest anchors to be provided on the biofilter roof and side of the bioscrubber vessels for safety tie-down during maintenance and inspection. Personal fall protection anchors must have a load capacity in any direction of at least 5,000 lbs.

k. Media support

(1) FRP grating supported by FRP I-beams are to be installed to support the weight of the medias plus entrained process water.

(2) Openings in FRP grating shall be large enough to let inlet air and process water to pass freely but not allow passage of media particles.

(3) A 2 inch mesh polypropylene screen shall be placed on the FRP grating to prevent media from falling through.

(4) The slats shall be designed and constructed to ensure even distribution of air across all cells.

(5) The media support materials shall be corrosion resistant and selected for low pH resistance as appropriate for the process.

2.07 HUMIDIFICATION MEDIA:

A. If a humidification system is required, provide random-dumped or structured packing, high-efficiency, designed to achieve maximum gas liquid contact at minimum pressure drop. Provide packing material with a minimum geometric surface area of 44 ft^2/ft^3 and a maximum air pressure drop of 0.20 in (H_2O) per ft of depth at a gas loading rate of 3,900 $lb/min/ft^2$, and a liquid loading rate of 2,935 $lb/min/ft^2$.

2.08 RECIRCULATION AND SPRAY IRRIGATION SYSTEMS:

A. The recirculation system for the bioscrubber, and spray irrigation system for the biofilter, shall consist of a spray nozzle assembly that is located above the top of each media bed layer.

B. The recirculation system and spray irrigation system are to provide full and even coverage of the media to ensure uniform media moisture content throughout the bioscrubber and biofilter systems.

C. All instruments and valves for the water supply lines, recirculation lines, and spray irrigation lines, are to be supplied by the manufacturer.

D. The recirculation system is to be operated continuously for entire the life of odor control system.

E. A media irrigation system that operates intermittently shall be utilized for the biofilter. Frequency and duration of irrigation shall be determined by the manufacturer.

F. Provide insulation, aluminum jacketing and heat tracing for all exposed water and drainage piping to prevent freezing.

G. Recirculation pump:

1. Pump is to be of Type 316L stainless steel material and suitable for operation with a corrosive low pH solution.

2. The pump is to be appropriately sized for the process requirements of the bioscrubber.

3. Provide equipment that is non-overloading and that operates without noise, vibration, heating, or damage when operating for the specified operating conditions. The pump is to be designed for continuous duty pumping of the bioscrubber recirculation water.

4. Shafts shall be machined and surface ground to ensure the interchangeability of shafts and the attached parts. Shafts are to be of adequate size and strength to transmit the full motor horsepower with a liberal safety factor to ensure rigid support of the impeller and to prevent vibration at operating speeds

5. The selected pump should not use the maximum size of impeller for that series of pump.

6. Pumps are to be ANSI pumps with sealless magnetic drive motors.

7. Acceptable Manufacturers:

   a. Finish Thompson Inc., ultrachem series, UC

   b. Iwaki America Inc., equivalent model

   c. Sundyne, equivalent model

8. Provide each pump with a discharge mounting base with flush mounted mating surfaces (between pump and base) and an ANSI Class 125 flange bolting pattern pipe connection.

9. Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and to minimize shaft deflection.

10. The impeller shall be statically and dynamically balanced, positioned rigidly and secured on the shaft with a stainless steel key and impeller lock nut or lock screw

11. All electrical equipment shall be Class 1, Division 2, explosion proof.

12. The Contractor shall supply and install all necessary connection wiring and cables to the control panels and associated accessories as per the manufacturer's instructions.

13. Electric Motors:

    a. The motor shall be sized for runout conditions and is to be non-overloading throughout the entire pump range of operation without utilizing the motor service factor.

    b. The motor is to be designed for continuous duty and shall be capable of sustaining at least ten (10) evenly spaced starts per hour.

    c. Motors to be sealless magnetic drive motors.

14. Controls and Instrumentation:

    a. The motor starter for the pump, including instrumentation and controls, shall be incorporated in the odor treatment system control panel.

    b. A single 480 VAC 3 phase feed shall be supplied to the odor control panels to provide power to the motor starters.

    c. The pump is to be hardwired, interlocked to the odor control panels.

    d. The panel will contain all operator interface and local control devices and circuit breakers.

    e. Provide a single main disconnect switch with a lockable door handle for the power supply on the control panel.

    f. Provide terminals in the control panel. All equipment is to be wired to the odor control panel.

    g. Provide a motor protection breaker type combination starter for the pump, with handles.

    h. Provide motor thermal overload protection.

15. Include the following on the odor control panel door for the recirculation pump:

    a. Hand-Off-Auto selector switch.

    b. Pump run (red) and alarm light (amber).

    c. High winding temperature light.

    d. Non-resettable elapsed time meter.

e. Reset pushbuttons to reset lights for the pump alarms.

f. All indicating lights shall be a push-to-test type (PTT).

16. External interfaces

a. Dry contact to close during low flow alarms (5A, 120 VAC).

b. Dry contact to close during any overload, high winding temperature, or leakage condition.

c. Dry contact to close when the pump runs.

17. The manufacture is to supply a field local e-stop push button control panel. The e-stop field control panel is to be installed by the Contractor.

18. Lifting Lugs: Provide lifting lugs for handling of equipment.

19. Anchor Bolts: Type 316 stainless steel, sized by the equipment manufacturer

2.09 WATERBOX:

A. Provide a heated waterbox, which houses components necessary for the recirculation and spray systems for the bioscrubber and biofilter systems.

B. Waterbox to be a minimum NEMA 4X enclosure of either FRP or Type 316 stainless steel. The waterbox is to be explosion proof for a Class 1 Division 2 environment if installed within 3 ft of the odor control ductwork, process fan, bioscrubber, or biofilter.

C. The waterbox is to be factory fabricated for field installation on a support frame.

D. The waterbox is to contain valves, y-strainer, and plumbing required for control of the biofilter media irrigation and humidification, and the bioscrubber recirculation spray system.

E. Provide field connections to external water supply. The Contractor is to coordinate the connection location with the manufacturer.

F. The waterbox is to contain the following instrumentation and fluid control valves at a minimum:

1. Two (2) flow meters, one (1) for recirculation flow monitoring, one (1) for make-up water flow monitoring

2. One (1) metering pump for the nutrient addition system.

3. One (1) pressure indicating transmitter for recirculated water pressure

4. One (1) pH sensor for bioscrubber recirculated water pH measurement.

5. Ball valves for isolation

6. Diaphragm valve for flow throttling

7. Y-strainers

8. Check valves

9. Pressure regulator for incoming water supplies

10. Blown Down flow gauge-indicator

G. The waterbox is to contain fittings for connections to the external water supply and the recirculation pump. The manufacturer is to coordinate with the Contractor for tie-in point locations.

H. All piping, metering pump, valves, and strainers shall be of corrosion resistant material.

I. The manufacturer is to appropriately size the waterbox to fit the necessary equipment for a functional bioscrubber recirculation system and biofilter irrigation system.

J. The waterbox location is to be as indicated on the Contract Drawings.

2.10 INSTRUMENTATION AND CONTROL

A. The manufacturer is to provide at a minimum the instrumentation shown on the Contract Drawings, and that required for fully functional bioscrubber and biofilter odor control systems.

B. All instruments and controls within 3 ft of the odor control ductwork, process fans, bioscrubber, and biofilter are to be rated for operation within a Class 1 Division 2 explosion proof environment.

C. All instruments that are located within the foul air stream shall be explosion proof, rated Class 1, Division 1, or equipped with a matching intrinsically safety (I.S.) barrier as required.

D. All instruments of the same type are to be identical, from the same equipment supplier, and interchangeable for the purpose of system configuration and ongoing maintenance.

E. The Contractor is to supply and install all wiring, cables, and power, to and from the instruments, control panels, and plant PLC in accordance with the manufacturer's instructions.

F. Control Panel:

1. The manufacturer is to provide one (1) free-standing, NEMA 4X enclosure with all internal components and wiring needed for a functional odor control system.

2. The control panel is to be located inside the IPS building facility. The Contractor is to install the control panel.

3. Operator controls and indicators on the front of the panels:

    a. Provide one (1) Operator Interface Terminal (OIT) on the panels.

    b. Provide all indication and controls on the panel OIT for the operation of the odor control system.

    c. Provide a Start/Stop switch for turning the odor control system on or off on the control panel.

    d. Provide system ready indication on the panel.

    e. Provide power on indication on the panel.

    f. Provide an alarm reset pushbutton.

4. Controls inside the panel

    a. Relays and IS barrier as required.

    b. Surge and transient protection device.

    c. Power supply (24 VDC) unit.

    d. All necessary terminal blocks and wire ways.

5. The odor control panels communicate with the plant PLC systems via ethernet cable. The odor control panel is to provide all of the signals to the PLC at the network including PLC, and power status and alarms.

6. Control panel electrical

    a. The control panels are to be suitable for 480 VAC, 3-phase supply.

    b. Complete with an interlock door breaker.

    c. Fused control transformer

d. Complete with breaker type NEMA style combination starter for the recirculation pump. Breakers for the starter must be operable from the front of the panel.

G. All instrument ranges shall be selected by the manufacturer to match the complete long-term operational ranges of the equipment.

H. Select instruments suitable for measuring foul air with characteristics described herein.

2.11 GASKETING AND SEALING:

A. Flanged nozzles: Viton or Hypalon full face gaskets of 50 to 60 Shore "A" Durometer hardness.

B. Fabricated gaskets: Machine-made or die-stamped with inside and outside edges parallel or concentric, as applicable. Make bolt holes oversized to prevent crimping of gasket when installed.

1. Neoprene.

2. 1/4 inch thickness.

3. Acceptable Product:

a. Garlock 7986.

2.12 AUXILIARY EQUIPMENT:

A. Nutrient Addition System

1. Provide one (1) nutrient addition system which will be connected to the bioscrubber.

2. The nutrient addition system shall contain the following:

a. FRP nutrient feed tank sized by the manufacturer to contain a minimum one (1) month supply of nutrient solution.

b. One (1) motorized mixer internal to the nutrient feed tank.

c. Connection to the metering pump installed within the waterbox for nutrient addition.

d. Connections from the waterbox to the bioscrubber recirculation line and irrigation line for nutrient addition.

e. Provide one (1) year supply of bioscrubber nutrients.

f. Ball valves for isolation.

g. Check valve.

h. Water supply connection to the nutrient feed tank.

i. Overflow drain from the nutrient feed tank.

3. All piping shall be of corrosion resistant material.

B. Provide FRP heated enclosures (hotboxes) for the recirculation pump and the nutrient addition system. The hotboxes are to heat the equipment for winterization within the ambient air temperatures specified in section 2.02 A. above. The hotboxes are to be supplied with a thermostat which will turn on the hotbox heater at an ambient temperature no lower than 40ºF. Indication that the hotbox heater is operating is to be shown on the odor control panel OIT.

C. Provide an inline recirculation water heater for winterization and maintaining the foul air inlet temperature to the bioscrubber and biofilters within the manufacturer's optimal operating range. The foul air inlet temperature and ambient air temperature ranges are as specified in section 2.02 A. above.

D. The Contractor is to provide all anchor bolts required for the complete installation of the equipment. All anchor bolts shall be 316 stainless steel unless otherwise specified in the Contract Documents.

E. Flanges:

1. For equipment, valves, and devices with integrally cast flanges, provide flanges in accordance with the dimensions and drilling of ANSI B16.1or ANSI B16.5 with bolt-holes straddling the vertical centerline.

2. For equipment, valves, and devices with PVC flanges provide flanges in accordance with the dimensions and drilling of ASTM D2466-06, or ASTM D2467-06 with bolt-hole straddling the vertical centerline.

3. For fabricated equipment and vessels, provide forged flanges of the same material as the equipment or vessel. Provide stainless steel equipment with 316 stainless steel flanges; FRP equipment and vessels with FRP flanges. Stainless steel specified in section 2.02 A. above with plain steel backing rings are not acceptable. Neither lap-joint nor Van Stone flanges are acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:

1. Install equipment and appurtenances in accordance with manufacturer's recommendations.

2. Provide all materials and equipment required.

3.02 BIOFILTER AND BIOSCRUBBER:

A. Install the bioscrubber and biofilter along with all components in accordance with the manufacturer's recommendations.

B. Install the bioscrubber and biofilter on the odor control concrete pad as indicated on the Contract Drawings.

C. Installation of the bioscrubber and biofilter media is to be completed only when the WRF is commissioned to avoid prematurely degrading the media.

3.03 FIELD AND FUNCTIONAL TESTING:

A. After installation, perform all of the following full operational tests in presence of the Owner. Furnish all labor, materials and equipment required for such tests.

1. Biofilter and Bioscrubber:

a. Factory test with water to the height of the overflow or the straight side height of the vessel, greater amount. Submit test data.

b. The water level must be unchanged after 24 hours with no visible signs of leakage or wall deflection exceeding 1/4 percent of span.

c. Hydrostatic test shall be witnessed by the CM.

2. Startup:

a. Provide the services of a factory-trained service technician, certified by the manufacturer to service the type of equipment herein specified, to assist in start-up operation.

b. Tests to be performed consist of start-up and operation of entire system at design capacity, and verification of operation of drives and other components, without, overheating, leakage, cracking of parts, structural damage, jamming, binding, or other defects.

B. In case of failure to demonstrate ability to function as indicated and specified, modify, rebuild or replace equipment or parts thereof at no additional cost to Owner, until equipment is in accordance with specifications. After three (3) unsuccessful test attempts, replace non-conforming equipment at no additional cost to the Owner. Repeat tests until specified requirements have been met, at no additional cost to the Owner.

3.04 STARTUP AND TESTING:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Comply with requirements for checkout, startup, and testing in Section 01 78 25.

3. Installation: Inspect any grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:

    a. 2 person-days

4. Functional Completion Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.

    a. 1 person-day

5. Field Performance Testing: Field performance test equipment specified.

    a. 2 person-days

6. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions. See Section 01 78 24.

    a. 1 person-day

7. Credit to the Owner, all unused service person-days specified above, at the manufacturer’s published field service rate.

8. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

B. Functional Tests: Recirculation pumps.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

2. Vibration Test:

   a. Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified by the manufacturer. The pump shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes exceeding the limits of the equipment suppliers.

3. If units exhibit vibration in excess of the limits, adjust or modify as necessary. Any units which cannot be adjusted or modified to conform as specified shall be replaced.

4. Performance Test:

   a. Conduct on each recirculation pump.

5. Test for a continuous 3-hour period without malfunction.

6. Test and record the following:

   a. Total static head and total discharge head.

   b. Capacity (flow measured by plant instrumentation, temporary instrumentation, and/or storage volumes).

   c. Driving motor voltage and amperage measured for each phase

C. Air Leakage Test

1. The bioscrubber and biofilter vessels are to have an air leakage test completed to ensure the vessels, and all hatches, doors, and flanges are airtight and do not allow air leakage.

2. The Contractor is to pressurize the vessels to a design operating pressure of 14 inch w.c. for one (1) hour.

3. The Contractor is to inspect the bioscrubber and biofilter vessels, all access hatches, doors, and flanges, for air leaks by soap testing.

4. Ductwork and piping inlets and outlets are to be blinded to avoid air leakage during testing.

5. The Contractor is to provide a pressure gauge to measure and indicate the internal pressure of the vessels during the leak test. The pressure is not to decrease more than 2 percent of the initial test pressure.

6. If leaks are found, the Contractor is to rectify all leakages, and rerun the leak test until no further leakages from the vessel are found

D. System Performance Testing

1. Performance Testing shall be completed in accordance with the requirements of Section 01 78 25, and Section 01 78 26, after the reliability demonstration has been completed.

2. Testing Requirements:

a. Following the Owner approval of start-up results, provide services of an independent State qualified air testing laboratory to measure and report on efficiency and performance of the odor control system. Submit testing procedures of testing laboratory to the Owner at least 15 days prior to tests. Have manufacturer's service technician present during system testing.

b. Testing shall include certification that the units have been tested and rated in accordance with the applicable AMCA Standard Test Code and Certified Ratings Program and that they bear the AMCA seal.

c. Odor performance testing shall follow ASTM/ANSI E679-19 "Standard Practice for Determination of Odor and Taste Threshold by a Forced-Choice Ascending Concentration Series Method of Limits"; and all testing is to be coordinated with the Consultant.

(1) Compounds to be tested are those specified under subsection 2.02 A. herein and odor units.

(2) Grab bag samples for odor and reduced sulfur compound measurement are to be collected four (4) times during a 24-hour period.

(3) During each of the four (4) sampling periods, three (3) tedlar bag samples plus one (1) blank are to be obtained from the inlet air into the bioscrubber and the outlet air from the biofilter.

(4) During the 24-hour test, the Contractor is to record H_2S concentrations by use of a Detection Instruments Odalog, or approved equivalent. The Odalog is to record H_2S concentrations from the outlet air from the biofilter at a minimum of 5-minute intervals.

(5) Odor concentration is to be assessed by an odor panel to estimate odor concentration from the inlet air into the bioscrubber and the outlet air from the biofilter.

(6) The Contractor is to setup access platforms or scaffolding to for the performance testing to be completed.

E. The manufacturer shall be aware that the Contractor is responsible for odor performance field testing, however the manufacturer is responsible for the odor treatment equipment's performance.

F. If a test fails it must be redone at the expense of the manufacturer.

3.05 FIELD TOUCH-UP PAINTING:

A. After installation and approved testing by the Engineer, Contractor shall apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.06 SYSTEM BALANCING:

A. Adjust manual and automatic control devices to balance airflows so they perform as indicated and specified.

B. Balance air systems so each system is within 5-percent of the airflow values indicated.

C. Submit report to the Owner outlining balancing procedures used; report to include:

1. Type of measuring devices used

2. Air quantities at each inlet and outlet

3. Fan speeds

4. Fan suction and discharge pressures

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

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SECTION 44 60 14

ODOR CONTROL DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide odor control ductwork for collection of foul odor air from locations as shown in the Contract Documents. Ductwork material includes high-density polyethylene (HDPE) and fiberglass reinforced plastic (FRP). Ductwork and accessories to be provided and installed as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. C916: Standard Specification for Adhesives for Duct Thermal Insulation.

2. C1290: Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts, Type III.

3. E96: Standard Test Methods for Water Vapor Transmission of Materials.

B. National Fire Protection Association (NFPA):

1. 255: Standard Method of Test of Surface Burning Characteristics of Building Materials, 2006 Edition.

2. 259: Standard Test Method for Potential Heat of Building Materials, 2013 Edition.

C. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1. Round Industrial Duct Construction Standards, 3rd Edition.

2. Thermoset FRP Duct Construction Manual, 2nd Edition

3. Accepted Industry Practice for Industrial Duct Construction.

4. Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition, 1981-2008

D. Underwriters Laboratories Inc. (UL):

1. 181: Standard for Factory-Made Air Ducts and Air Connectors (2013-07-25 edition).

E. Local and National Building Codes

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Duct Fabrication Drawings:

1. Manufacturer's Product data including details of materials, construction, dimensions of all components, layout, installation details, and finishes for the following items:

a. HDPE and FRP ductwork

b. Ductwork insulation and jacketing

c. Duct-mounted sampling ports

d. Ductwork flanges

e. Sealants and gaskets

f. Butterfly dampers

g. Flexible connections

2. Structural engineering design calculations are to be stamped by a Registered Professional Engineer from a Professional Engineer licensed in the State of Utah.

3. Drawn after actual site measurements are obtained.

4. Drawn to a scale not smaller than 1:50, on drawing sheets of the same size as the Contract Drawings, detailing:

a. Fabrication, assembly, and installation details including plans, elevations, sections, details of components, and attachments to other Work. Other Work includes facility process equipment and buildings.

b. Duct layout, indicating pressure classifications, and sizes in plan view.

c. Duct material and thickness.

d. Reinforcing details and spacing.

e. Seam and joint construction details.

f. Spatial coordination with other systems installed in same space with duct systems.

C. Informational Submittals in accordance with Section 01 33 00.

1. Product Data:

a. Submit Product data sheets for the equipment as specified herein. Product data sheets are defined as catalogue sheets, brochures, literature, technical data, performance charts, diagrams, specifications, instruction books, lubrications charts, maintenance instructions/schedule, spare parts lists and similar data used to illustrate quality, characteristics, capacity, maintenance, replacement parts, and performance of the supplied manufactured Products.

2. Record Drawings

a. At Contract closeout, the Contractor shall submit record drawings of installed ductwork, accessories, and joints, in accordance with Section 01 33 00.

D. Delegated Design Submittals:

1. For odor ductwork and accessories, provide written certification from Professional Engineer licensed in the State of Utah stating that supports systems, anchorage and equipment have been designed according to the requirements of Section 1613 of the building codes of Utah, Salt Lake City and ASCE/SEI 7, and in accordance with Specification 01 41 20. Submit calculations stamped by a Professional Engineer licensed in the State of Utah for support systems and anchorage for wind, seismic, and all other pertinent loads.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 61 00.

B. Industry Standards:

1. Unless otherwise indicated or specified in the Contract Documents, FRP ductwork shall be constructed and installed in accordance with the SMACNA duct construction standard relevant to ductwork system being provided. These standards are referenced in this Section as the SMACNA Manual, unless otherwise indicated in the Contract Documents.

2. Comply with the ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated in the Contract Documents.

C. Manufacturers: Firms regularly engaged in manufacture of ductwork products of the types, materials, and sizes required, whose products have been satisfactorily used in similar service for a minimum of 5 years.

D. Ensure that the suppliers of duct and fitting components provide, on request, the following information:

1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.

2. Laboratory performance data for fittings, including zero length dynamic losses.

E. Changes or alterations to layout or configuration of duct system shall be:

1. Specifically approved in writing.

2. Proposed layout shall provide original design results, without increasing system total pressure.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. The equipment and appurtenances shall be delivered to the site in a condition satisfactory to the Engineer and any omissions, discrepancies or damage evident on delivery shall be addressed to the Engineer's satisfaction.

C. The equipment shall be of sufficient strength and rigidity for normal handling during loading, transport, unloading, installation, and assembly. Supports and reinforcements shall be used to maintain the equipment integrity as required.

D. Do not ship ducting by nesting small diameter components inside larger components.

E. Protect shop-fabricated and factory-purchased ductwork, accessories, and purchased Products from damage during shipping, storage, and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

F. Protect flanged sections by bolting wooden blinds 2 inches greater than outside diameter of flange.

G. For non-flanged components, use either rigid plugs inside ends to prevent deflection or protect with wooden boxes.

H. Crate materials, wherever practical, prior to shipment.

I. Firmly fasten and pad components shipped to prevent shifting or flexing of components after assembly.

J. Lifting lugs shall be shop installed as required to permit safe handling during shipping and erection with conventional hooks or slings.

K. The Contractor shall obtain the manufacturer's written instructions for precautions to be observed in connection with storing the equipment. A copy of all instructions shall be provided to the Engineer.

L. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping

M. Protect ductwork from dirt, water, and debris. During storage on the site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

PART 2 - PRODUCTS

2.01 GENERAL:

A. All materials and components used in the manufacture of this equipment shall be new and unused, and free of all defects and imperfections.

B. All equipment supplied shall be suitable for continuous operation in a corrosive gas stream generated by the treatment of odors produced from a wastewater pumping station.

C. The Contractor shall install the odor control ductwork and accessories with strict adherence to the manufacturer's written instructions.

D. Material and equipment to conform to the latest edition of all applicable standards, which are in force at the time of tendering, including those listed in Subsection 1.02. In the case of conflict between the requirements of these specifications and any standards, the more stringent requirement of the two applies.

2.02 PROCESS DESIGN PARAMETERS:

A. Process design parameters and service conditions for the odor control ductwork and accessories are described as follows:

Process Parameters	IPS
Hydrogen Sulphide, average ppm	23
Hydrogen Sulphide, peak ppm	200
Average Inlet RH, percent	>90
Maximum Working Pressure, w.c.	-14
Process Air Temperature, degrees F	40 to 90
Outdoor Temperature, degrees F	-40 to 120

B. All ductwork shall be air and watertight up to the pressures indicated in Article 2.02.

2.03 HIGH-DENSITY POLYETHYLENE (HDPE) DUCTWORK:

A. The Contractor shall ensure that the manufacturer will fabricate, and supply, HDPE ductwork and accessories as shown on the Contract Drawings.

B. All ductwork shall be air and watertight up to the design pressures indicated in Article 2.02.

C. HDPE ductwork is to be suitable for underground service as shown on the Contract Drawings.

D. Duct lengths, fittings, and flanged connections to be joined by thermal butt-fusion and shall be of the same type and compound of high-density polyethylene supplied by the same raw material supplier

E. Duct Design:

1. The duct shall be made from high-density polyethylene resin compounds which meet the standards defined in ASTM D3350.

2. The high-density polyethylene resin shall conform to Type PE 3408.

3. Duct shall be capable of withstanding H-20 traffic loads.

4. Duct shall have a maximum allowable hoop stress of 800 psi at 73 degrees Fahrenheit.

5. Duct shall have a standard dimension ratio of 17 in accordance with the requirements of ASTM F714.

6. Hardware such as bolting, washers, and nuts shall be of 316 stainless steel material.

F. Fittings:

1. 6 inch and smaller: Molded fittings, butt fusion jointed, conforming to ASTM D3261.

2. 8 inch and larger: Same as pipe, butt fusion jointed, conforming to ASTM D3350.

3. All fittings shall have the same pressure rating and standard dimensions ratio as the HDPE duct.

4. Drains shall be supplied as indicated on the Contract Drawings and be subject to the same pressure and corrosion design constraints as the ductwork.

G. Flanges:

1. HDPE duct shall be flanged connected to FRP duct by the use of an HDPE flange adapter as shown on the Contract Drawings.

2. Flanges shall meet or exceed the requirements of ANSI B16.5, and ANSI B16.47 150lb flanges, and shall be suitable for the specified conditions within Article 2.02.

3. The Contractor is to ensure suitable flange-to-flange mating for HDPE to FRP duct.

4. Pressure performance of the backing ring shall equal the standard dimension ratio of the duct with a safety factor of 2.

5. Stub ends shall have the same pressure rating and standard dimension ratio as the duct.

2.04 FRP DUCTWORK:

A. Ductwork shall be constructed in accordance with the SMACNA Manual.

B. All ductwork shall be air and watertight up to the design pressures indicated in Article 2.02.

C. The ductwork shall be provided with sample ports at the locations indicated on the Contract Drawings.

D. Materials:

1. Resin System: Premium corrosion resistance, fire retardant vinyl ester, or approved equivalent.

2. Liner Resin: Premium grade and corrosion resistant.

3. Flame Spread Index: ASTM E84, less than 25; fire retardant additives used only in structural layer.

4. Color: Duct shall be white. Submit sample for approval prior to manufacture.

E. Reinforcement:

1. Veil: Chemical surfacing mat, polyester fabric, with finish and binder compatible with layup resin.

2. Corrosion Barrier: Resin rich interior surface of nominal 2.5 to 3.0 mm thick, using chopped strand mat backing the veil. Use no additive in corrosion barrier.

F. FRP Ductwork Fabrication:

1. Physical Properties: Meet or exceed the requirements of ASTM D3982.

2. Squareness of ends, fittings, elbows, and joints shall meet or exceed the requirements of ASTM D3982.

3. Butt joints shall be the method of joining duct sections, unless otherwise indicated on the Contract Drawings.

4. Flanges for duct-to-duct and duct-to-equipment connections: Meet or exceed the requirements of ASTM D3982, ANSI B16.5, ANSI B16.47.

5. The Contractor shall ensure suitable flange-to-flange mating for duct-to-equipment connections.

6. Gaskets: EPDM, 1/8-inch thick, full face, Durometer – A50 to A60.

7. Flange bolts and nuts: Type 316 stainless steel bolts, ASTM A320 Grade B8M, ASTM A194 Grade 8M hex head nuts and lock washers, shall be used on flanged joints.

8. Duct thickness: Minimum ductwork thickness shall be 5/16 inches.

9. Transitions: Transitions between differing duct dimensions shall be provided by the Contractor for the locations shown on the Contract Drawings. Joints shall be butt joints unless otherwise indicated on the Contract Drawings as a flange connection.

G. The Contractor shall supply and install insulation and aluminum wrapping for all outdoor ductwork as shown on the Contract Drawings and as specified in Article 2.05.

2.05 DUCT INSULATION:

1. Minimum 3.87 lb/ft^3 density, semi rigid glass fiber insulation, 2-inch thick supported longitudinally, arranged with staggered joints, and banded to the duct on 12-inch centers with 1/2-inch wide stainless steel bands.

2. Insulation to be jacketed with aluminum childers "lock-on" or equivalent 3/125-inch thick stucco embossed aluminum jacket material in accordance with ASTM B209, factory cut to size and, complete with moisture barrier and continuous modified Pittsburgh z-lock, and butt straps to weatherproof the end-to-end joints. Fittings are to be two-piece epoxy coated pressed aluminum with locking edge.

2.06 FLEXIBLE CONNECTIONS:

A. Flexible connections joints shall be provided for equipment-to-duct connections as shown in the Contract Drawings. Flexible connections shall be secured to the duct and the equipment outlet stub connectors with flange connections in order to provide a water and gas tight construction.

B. The flexible connection shall be sufficiently flexible to prevent the transmission of any discernible vibration from the equipment to the ductwork and allow for thermal expansion.

C. The manufacturer is to provide flexible connection flange details to the Contractor for coordination of ductwork to flex connection attachment.

D. All equipment supplied shall be suitable for continuous operation in the conditions specified in Article 2.02.

E. Flexible connections and installation shall be air and watertight up to the process pressure conditions specified in Article 2.02.

2.07 BUTTERFLY DAMPERS:

A. Butterfly dampers: All round isolation dampers shall be exposed to a humid, corrosive atmosphere as described is Article 2.02, and all dampers shall be constructed of fiberglass reinforced plastic. Butterfly dampers are to be supplied where indicated on the Contract Drawings.

B. Where control is indicated as being actuated on the Contract Drawings, the dampers shall be equipped with actuators, positioners, and local OPEN/CLOSE push button controls. All dampers shall have a manual open and close mechanism and/or override.

C. Manual dampers shall have the ability to be locked in place for the purposes of balancing and shall be equipped with a robust handle or chain and wheel positioner assembly for easy access by facility personnel.

D. All motorized dampers shall be rated for operation in a Class 1, Division 2, Group D environment as per NFPA 820.

1. Acceptable Actuator Manufacturers:

a. Rotork

b. Auma.

E. Dampers:

1. Single blade type, complete with channel type frame, close fitting axle, and bearings.

2. Same inside diameter as connecting ductwork.

3. Axles not less than 1 inch in diameter and shall be continuous through the damper.

4. Isolation dampers shall be furnished with full circumference molded in blade stop.

5. Flanges for duct connections to match ANSI B16.5 and ANSI B16.47.

F. Design Requirements:

1. Frame and seat leakage: No greater than 1 percent for isolation and 5 percent for balancing of design airflow rate in Article 2.02.

G. Materials:

1. Materials, resin, and flame spread shall be the same as FRP ductwork as specified in Article 2.04.

H. Construction:

1. Frames: FRP with resin as described herein.

2. Blades: FRP with resin as described herein. Blade thickness and stiffeners shall be designed to meet the design conditions required.

3. Axles: Continuous FRP rod with resin as described herein. Axle to extend 150 mm beyond frame.

4. Bearings: Moulded polytetrafluoroethylene (PTFE)

5. Blade Stops: FRP with resin as described herein

6. Blade Seals: Polychloroprene

7. Shaft Seals: Polychloroprene

2.08 SEISMIC-RESTRAINT DEVICES:

A. Refer to Sections 01 41 20 and 23 05 48 for requirements for restraint components and applications.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION:

A. Cut, fit, and install in accordance with the duct manufacturer’s instructions and the Contract Drawings.

B. Ductwork shall be free of vibration while in operation.

C. Install plumb, straight, and in proper alignment.

D. Anti seize thread compound shall be applied to all nuts and bolts.

E. Flange bolts shall be tightened to torque values specified by the manufacturer. Install gaskets at each flange connection and flat washer under each nut and bolt head.

F. Install ductwork with a minimum clearance of 1 inch, plus allowance for the insulation and wrapping thickness.

G. All horizontal ductwork shall be installed with the slopes indicated on the Contract Drawings to facilitate drainage to the nearest drain or process equipment connection.

3.02 STARTUP:

A. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified.

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Comply with requirements for checkout, startup, and testing in Section 01 78 25.

3. Installation assistance and inspection; certify proper installation:

a. 1 person-day

4. Ductwork testing:

a. 1 person-day

5. Commissioning:

a. 1 person-day

3.03 FIELD TESTING:

A. Comply with requirements of Section 01 78 25.

B. Field test ductwork after installation and before concealment or burying, with air test to a pressure of -14 inches w.c. for a period of 2 hours. Testing must demonstrate a pressure drop of no more than 2 percent of the test pressure over the course of the test period. The leak check shall be completed by a soap bubble test. Leaks shall be corrected, and duct retested by the Contractor until no further leaks occur.

3.04 CLEANING:

A. Blow ductwork clean continuously for a minimum of 24 hours at the ductwork branch airflow rates shown on the Contract Drawing P&IDs.

B. Contractor shall protect debris from entering the odor control system during construction, testing, and start-up.

3.05 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 44 60 15

ODOR CONTROL CENTRIFUGAL FANS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide engineering, design, fabrication, assembly, installation, inspection, testing, and delivery of one (1) Fiberglass Reinforced Plastic (FRP) backwards inclined centrifugal fan and accessories for operation with the new Bioscrubber and Biofilter odor control system as indicated and in compliance with the Contract Documents.

1.02 REFERENCES:

A. Air Movement and Control Association (AMCA):

1. 99-0401: Classifications for Spark Resistant Construction

2. 204: Balance Quality and Vibration Levels for Fans

3. 210: Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating

B. American National Standards Institute (ANSI):

1. S2.19 G1.0: American National Standard Mechanical Vibration – Balance Quality Requirements of Rigid Rotors

C. Local and international codes as required.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit the following data with the shop drawings:

1. Certified fan performance curves for the specified operating conditions.

2. Dimensioned shop drawings and Product data sheets for all components including the motor, belts, bearings, fan housing, disconnects, coatings, silencers, inlet boxes, etc., to be supplied as part of the fan package.

3. Fan sizing calculations stamped by a Registered Professional Engineer licensed to practice in the State of Utah.

4. A list of two (2) years' worth of spare parts.

C. Show on the shop drawings the Products, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for proper performance of the Work. Coordination of attachment and connection to the following Products shall be indicated by cross-references to the Contract Drawings and Specifications:

1. For the fan inlet flexible connections to the odor control ductwork flange attachments, refer to Section 44 60 14.

2. Indicate the fan base anchor bolt attachment to the fan housekeeping pads.

3. Indicate the fan inlet box anchor bolt attachment to the fan housekeeping pads.

D. Product Data:

1. Submit product data sheets for the equipment as specified in this Section. Product data sheets are defined as catalogue sheets, brochures, literature, technical data, performance charts, diagrams, specifications, instruction books, lubrication charts, maintenance instructions/schedule, spare parts lists and similar data used to illustrate quality, characteristics, capacity, maintenance, replacement parts, and performance of the specified manufactured products.

E. Operation and Maintenance Data:

1. Operation and maintenance manuals shall be specific to equipment purchased and crossing out of non-applicable items is not acceptable.

2. Comply with requirements of Section 01 78 23.

F. Quality Control:

1. The Contractor shall submit factory functional performance test reports.

2. The Contractor shall submit field functional performance test reports.

3. The Contractor shall submit a Certificate of Proper Installation.

1.04 SUSTAINABLE DESIGN:

A. Comply with the requirements specified in Section 01 81 13.01.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. All spare parts necessary for the continued operation of the equipment shall be provided.

C. Provide a list of recommended spare parts for the first year of operation and for the first five years of operation, including a price list and location of the nearest facility from which all spare parts can be obtained.

D. At a minimum, the following spare parts shall be provided, clearly labelled and packaged for long-term storage:

1. Two (2) complete sets of fan inboard and outboard bearings

2. Two (2) complete sets of motor bearings

3. Two (2) sets of seals, packing, and gaskets required for fan impeller/shaft assembly replacement

4. Two (2) fan impellers and shaft assemblies.

5. Two (2) sets of V-belts.

6. Two (2) additional flexible connections.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 45 00.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in APWA Section 01 66 00.

B. Furnish unloading, handling, storage and maintenance requirements for the equipment prior to start-up and operation.

C. All equipment shall be skid mounted or crated to protect against damage during shipment. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the equipment is ready for operation.

D. Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Twin City Fan and Blower

B. The New York Blower Company

C. Verantis Environmental Solutions Group

2.02 GENERAL:

A. The Contractor shall supply and install all appurtenances, fittings, and accessories necessary for the proper installation and functioning of the odor control centrifugal fan as specified herein and as described in the Contract Documents.

B. The fan and associated devices and equipment are to be suitable for outdoor conditions with an ambient temperature range between -40 degrees F and 120 degrees F.

2.03 MATERIAL AND WORKMANSHIP:

A. General:

1. Two or more items of the same type shall be identical, by the same equipment manufacturer, and interchangeable.

B. Material and equipment is to conform to the latest edition of applicable standards which are listed in Subsection 1.03 at the date of closing of this tender. In the event of a conflict between these Specifications with any standards, the more stringent of the two requirements applies.

C. Provide materials and equipment new and first class in every respect. Reconditioned equipment is not acceptable.

D. Design machinery such that working parts are readily accessible for inspection and repair, and that each part is suitable for the service required.

2.04 FIBERGLASS REINFORCED PLASTIC (FRP) CENTRIFUGAL FAN:

A. The manufacturer shall supply an FRP backward inclined centrifugal fan, complete with all accessories and features described in this Specification Section in the quantities listed below. The fan shall be installed by the Contractor in accordance with the manufacturer's detailed instructions.

Location	Quantity of Fans	Fan Tag Nos.
Influent Pump Station	1	01-BL-40150

B. Fan arrangement shall be arrangement No. 9, as specified by AMCA.

C. All equipment supplied shall be suitable for continuous operation in a corrosive gas stream generated by the treatment of odors from a wastewater pump station facility.

D. The equipment shall be the manufacturer's standard design. The design shall have been proven effective and reliable under similar operating conditions. No new or unproven design is acceptable.

E. Fans shall be oriented with the fan discharge arranged as shown on the Contract Drawings.

F. The manufacturer shall supply all information required for the design of concrete fan bases, including horizontal and vertical loads, the reflected inertia for rotating parts, size and location of anchor bolts and all clearances required.

G. The manufacturer shall include an allowance for internal pressure losses caused by fan accessories and fan components and add them to the required fan design static pressures as specified in Subsection 2.05.B.1.

H. The odor control system fan shall be operated by a variable frequency drivecontroller supplied by the Contractor. See Section 26 29 23.

2.05 PERFORMANCE:

A. Operating Requirements:

1. The fans shall be selected to achieve the design capacity at no greater than 95 percent of the maximum recommended RPM. Fans shall be non-overloading at all points on their curve.Capacity shall be determined in accordance with AMCA 210 standard.

2. The fans shall be of non-sparking construction in accordance with AMCA 99-0401, Type B standards.

3. The fan design provided shall be appropriate for heavy-duty industry applications. The design and construction will be explosion proof suitable for a Class 1, Division 2, Group D hazardous classification area. Adequate protection of bearings, etc. shall be provided.

B. Design Parameters:

1. The fans shall meet the operating conditions specified in the table below.

	Influent Pumping Station Bioscrubber and Biofilter
Maximum Air Flow rate, CFM	5,000
Inlet Static Pressure, “w.c.	-12
Outlet Static Pressure, “w.c.	2
Air Inlet Temperature, ºF	40 to 90
Ambient Air Temperature, ºF	-40 to 100
Relative Humidity. %	98 – 100

2. The fan shall be operating within with an airflow with the following air contaminant concentrations specified in Section 44 60 13.

3. The location of the fan will be outdoors as shown on the Contract Drawings and shall be suitable of outdoor operation during winter conditions.

4. The fans will be operated 24 hours a day, 7 days a week.

2.06 FAN WHEEL:

A. The Fans shall be designed with backward inclined fan blades.

B. The fan wheel shall be of spark resistant construction in accordance with AMCA 99-0401 Type B standards.

C. Fans shall not use any blade reinforcing rings, hoops, or other tie rod type devices located inside the blade channel.

D. The fan wheel shall be selected to provide maximum efficiency at the specified operating conditions in Subsection 2.05.B.1

2.07 FAN SHAFT:

A. The fan shafts shall be constructed of corrosion resistant material.

2.08 BALANCING:

A. The complete fan wheel and shaft assembly shall be statically and dynamically balanced in accordance with ANSI S2.19 G1.0 standards. The reports for the balancing shall be retained and included in the manufacturer's operating and maintenance manuals.

2.09 FAN BEARINGS:

A. Anti-friction type pre-lubed bearings shall be provided by the manufacturer. The bearings shall be selected to operate at no more than 90 percent of the maximum speed limit identified in the bearing manufacturer's data. The bearings shall have a minimum L10 life rating for 100,000 hours of fan operation as specified in this section.

B. Bearings shall be located out of the gas stream and mounted on pedestals independent of the fan casing so that they are changeable without any major dismantling of the fan housing.

2.10 HOUSING:

A. Materials of construction shall be FRP, spark resistant for surfaces which may come in contact with the gas stream and shall be suitable for outdoor weather conditions, water resistant, and UV (ultraviolet) protected.

B. Heavy duty housing, stiffened as required to result in low deflection, shall be provided.

C. Inlet and outlet flanges shall be a minimum of 1/8-inch thicker than the housing scroll thickness.

D. Flanges shall be drilled with bolt centers which are adequate to prevent leakage.

E. Wheel removal splits shall be bolted and gasketed.

F. Gaskets shall be made of non-asbestos material, and shall be adequate for the service indented.

G. At a minimum one (1) access door shall be provided to allow for maintenance access. Access door shall be secured with bolts and gaskets, and shall be of a suitable size to permit ease of access to the internal components of the fan.

H. Bolts and gaskets required to attach the fans to process ductwork shall be supplied and installed by the Contractor.

I. Each fan shall be supplied with a 2-inches NPT drain connection constructed of corrosion resistant material. The Contractor shall provide one (1) 2-inch p-trapped drain (including all associated piping) to connect to the fan drain connection. The locations and sizing of the drain piping shall be confirmed by the Contractor to suit the field installation and fan design parameters.

2.11 SHAFT SEALS:

A. Shaft seals shall be included on all process fans.

B. Shaft seals shall be designed to allow for the replacement of the internal seal parts without disturbing the shaft or bearings.

C. The shaft seal design shall provide for housing expansion and contraction due to temperature fluctuations.

2.12 MOTORS:

A. The Contractor shall ensure that the manufacturer will supply fan motors that shall be 480 volt, 3 phase, 60 Hertz, 1800 rpm nominal. Odor control system fan motors are to be driven by variable frequency drives, and the biofilter odor control system fan motors are to be driven by single-speed motor starters.

B. The fan motors shall be TEFC, and suitable for operation in a Class 1, Division 2, Group D environment.

C. Temperature sensors shall be provided by the manufacturer for each fan motor to indicate overheating if it occurs during operation. Indication of overheating shall be sent to the associated PCS system.

2.13 SAFETY GUARDS:

A. Guards shall be designed in accordance with the applicable safety standards, and shall protect personnel against moving parts, including:

1. Couplings

2. Belt drive components

3. Shafts

2.14 ACOUSTIC PERFORMANCE:

A. Fan sound ratings shall be based on tests made in accordance with AMCA Standard 300 and 301 and the fan shall be licensed to bear the AMCA Certified Ratings Seal for Sound. Only AMCA certified fans will be accepted with no exceptions.

B. Each fan shall not exceed a sound pressure level of 85 dBA (ref. 20 μPa) at a distance of 5 feet.

2.15 VIBRATION AND SHOCK ABSORPTION:

A. Provide with each fan base a minimum of four flexible machine mountings to absorb vibration and shocks due to fan operation.

B. Fasten the flexible mountings to the foundation by means of anchor bolts.

C. Vibrations shall be within the limits as described in ANSI/AMCA 204-96.

D. Provide a vibration sensor on each fan to indicate if excessive vibration occurs. Signal shall be sent to the PLC.

E. The manufacturer shall ensure that no vibration is transmitted to the motor through the shaft and/or foundation and/or fan base.

2.16 INLET AND OUTLET FLEXIBLE CONNECTIONS:

A. The Contractor shall ensure that the manufacturer will supply inlet and outlet flexible connections for the fan as shown on the Contract Drawings. Flexible connections shall be secured to the fan inlet, outlet, and odor control ductwork by flange connections. The flanges are to be constructed of FRP material and be water and gas tight.

B. Manufacturer to provide two (2) flexible connections in addition to the inlet and outlet flex connections as spares.

C. The flex joints shall have an internal flow baffle (air stream deflector), and shall be acoustically insulated against breakout noise.

D. The circular flex joint shall be shipped fully assembled, for direct installation by the Contractor.

E. The flexible connections shall be designed to eliminate transference of vibration caused by fan operation to the odor control ductwork.

F. Flexible material to be a polychroprene synthetic rubber suitable for operation within air from a wastewater pumping station facility.

2.17 FAN LOCAL CONTROL PANELS:

A. The manufacturer shall provide one NEMA 4X fan local control panels as shown on the Contract Drawings. Fan local control panels to be greater than 4’ away from the odor control ductwork and odor treatment equipment.

B. Each supplied fan shall be supplied with a dedicated local control panel.

C. Control panel shall include a REMOTE/OFF/LOCAL switch, start/stop push buttons, E-stop, and alarms.

D. The local control panel shall be wired to the fan variable frequency drives.

E. The Contractor shall supply and install all field wiring.

F. Control panels shall be installed by Contractor.

2.18 NAMEPLATES:

A. The manufacturer’s standard nameplate shall at a minimum include the following:

1. Fan model number

2. Serial number

3. Design flow rate

4. Design pressure

5. Maximum RPM

6. Maximum HP

7. Design gas temperature

8. Design gas density

B. The nameplate shall be securely fixed to the equipment with rivets or self-tapping screws.

C. The nameplate shall be constructed from 316 stainless steel material.

PART 3 - EXECUTION

3.01 SHOP TESTING OF EQUIPMENT:

A. The Contractor shall ensure that the manufacturer will perform shop inspection and tests on the applicable equipment before shipment from factory.

B. Provide the Engineer and Owner 10 days' notice of any factory and shop testing scheduled to be completed.

C. Inspection and tests performed shall confirm that the equipment provided meets all established standards listed in Subsection 1.03.

D. The Contractor shall ensure that the manufacturer will submit factory functional performance test reports summarizing shop testing.

3.02 PROTECTIVE COATING:

A. Shop prime and finish paint all equipment. Adequately grease all machined and working surfaces and/or protect with anti-rust compound prior to shipment.

3.03 INSTALLATION:

A. Install fans level and plumb.

B. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

C. Provide drain connection with a p-trap as seen on the Contract Drawings.

D. Equipment Support and Restraints:

1. Install floor-mounted units on concrete bases.

2. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.

E. Connections:

1. Refer to Section 44 60 14 and Section 40 23 19.02.

2. Isolate duct connections to fans.

3. Install ductwork adjacent to fans to allow proper service and maintenance.

3.04 FIELD QUALITY CONTROL:

A. Functional Tests:

1. Verify and record that any blocking and bracing used during shipping is removed.

2. Verify and record that the fans are secure on mounting and support devices, and that connections to ducts and electrical components are complete.

3. Verify and record that the proper thermal-overload protection is installed in motors and disconnect switches.

4. Verify and record that proper cleaning of equipment is complete.

5. Verify and record the proper motor rotation direction, fan wheel free rotation, and smooth bearing operation.

6. Verify and record belt alignment. Adjust if necessary.

7. Verify and record proper lubrication for bearings and other moving parts.

B. Performance Tests:

1. Performance tests shall be conducted in accordance with AMCA 210 standards

2. Starting Procedures:

a. Energize and adjust to manufacturer indicated revolutions per minute.

b. Measure and record the motor voltage and amperage.

C. Operation Test:

1. Start units to confirm and record proper motor rotation and unit operation.

2. Repair or replace any malfunctioning units and equipment; retest after repairs or replacements.

D. Vibration Tests:

1. Verify and record operation vibration levels.

2. Prior to shipment the Contractor shall ensure that the manufacturer will test and balance the fans to ensure vibration levels are in accordance with ANSI/AMCA Standard 204-05. If vibration limits are exceeded, the Contractor shall ensure that the manufacturer will rebalance the equipment until design tolerances are met.

3.05 TRAINING INSTRUCTIONS:

A. The manufacturer shall submit training instructions in accordance with Section 01 78 24.

B. The manufacturer shall conduct training sessions for the operating personnel to instruct the staff on the proper operation care, and maintenance of the equipment and units as specified herein.

C. Training: Provide classroom and field operation and maintenance in accordance with Section 01 78 24.

1. 1 person-day

D. Coordinate training schedule with the Engineer and Owner

3.06 MANUFACTURER'S SERVICES:

A. The Contractor shall ensure that the manufacturer will provide only a factory trained, licensed and experienced service technician for start-up testing, commissioning, and training.

B. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Comply with requirements for checkout, startup, and testing in Section 01 78 25.

3. Physical Checkout and Field Testing (Functional Completion Testing): Inspect field installation, location of anchor bolts; setting, leveling, alignment; coordination of ductwork connections, electrical and wiring connections; certify proper installation:

a. 1 person-day

4. Startup: Calibrate, check alignment and perform a functional test. Tests on items to include all items specified herein.

a. 1 person-day

5. Commissioning: Field performance test equipment specified.

a. 1 person-day

C. Within 10 days of completing these services, the Contractor shall ensure that the technical representative will submit a letter report (in duplicate), directly to the Engineer, covering the following;

1. Name

2. Business address

3. Telephone number

4. Date of visit

5. Findings, including list of items checked, problems encountered, corrective measures taken (if required).

6. Confirm that the equipment has been found to be satisfactorily installed and in proper working order.

D. The Contractor shall ensure that the manufacturer will submit a commissioning report including the following:

1. List of deficiencies found and recommended corrective action

2. Field testing reports

3. Start-up data report

3.07 CERTIFICATE OF PROPER INSTALLATION:

A. On satisfactory completion of installation, start-up, commissioning, testing, and training, submit to the Engineer the manufacturer's certification of the correctness of installation for each piece of equipment. Certification from the manufacturer is to state that the equipment is installed correctly, is in full operating condition, and is operating in accordance with its design rating. Submit the original certificates to the Engineer. Certificates are to include a statement indicating that any adjoining duct is properly and independently supported so as not to cause undue stress that would, otherwise, be detrimental to the performance of the equipment.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

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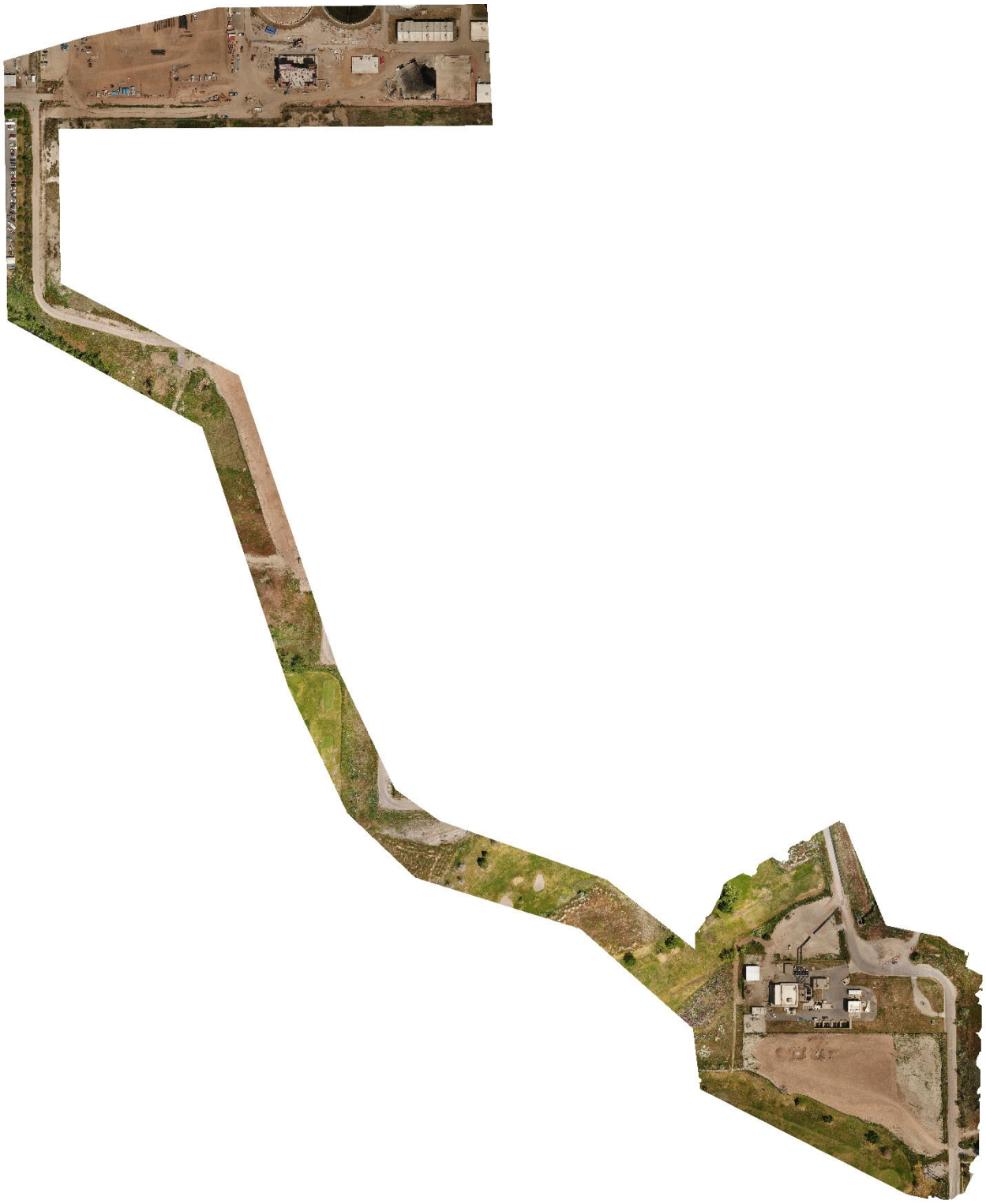
APPENDIX

DRONE AERIAL MAP

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APPENDIX

AERIAL IMAGE OF FORCEMAIN ALIGNMENT



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