

Utah Division of Facilities Construction and Management (DFCM)

**THE POINT – SITE INFRASTRUCTURE MASTER CIVIL
DESIGN ENGINEERING SERVICES**

PACKAGE 03

CULINARY WATER TRANSMISSION LINE

(DFCM PROJECT No. 25406300)

TECHNICAL SPECIFICATIONS (CD Submittal)

August 2025

Prepared By:



2162 W. Grove Parkway, Suite 400

Pleasant Grove, Utah 84062

Utah Division of Facilities Construction and Management (DFCM)

THE POINT – SITE INFRASTRUCTURE MASTER CIVIL DESIGN ENGINEERING SERVICES

PACKAGE 03

CULINARY WATER TRANSMISSION LINE

(DFCM PROJECT No. 25406300)

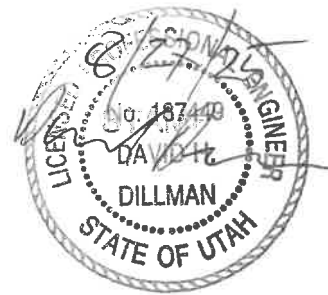
TECHNICAL SPECIFICATIONS (Bid Set)

Certification:

I hereby certify that I prepared the Project Plans and Specifications in the Contract Document or under my direct supervision and that I am a duly registered Engineer under the laws of the State of Utah.



David Dillman P.E.



August 2025

BID SET



2162 W. Grove Parkway, Suite 100

Pleasant Grove, Utah 84062

THE POINT REDEVELOPMENT PROJECT
PACKAGE 03 – CULINARY TRANSMISSION LINE

CONSTRUCTED UNDER
UTAH DFCM CONTRACT NO. 25406300

TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

VOLUME 1

Division 00 – Procurement and Contracting Requirements

00 30 10	Bid Schedule
00 30 20	Measurements and Payments
00 35 00	Bid Bond
00 35 60	Non-Collusion Affidavit
00 36 00	Notice of Award
00 50 00	Agreement
00 51 00	Notice to Proceed
00 60 00	Payment Bond
00 61 00	Performance Bond
00 70 00	General Conditions
00 73 84	Materials Dispute Resolution
00 75 00	Special Provisions

Division 01 – General Requirements

01 10 00	Summary of Work
01 14 00	Work Restrictions
01 22 00	Measurement
01 29 00	Payment
01 30 00	Administrative Requirements
01 33 00	Submittal Procedures
01 35 43	Environmental Compliance
01 43 33	Manufacturers Services
01 45 00	Testing and Process Control
01 45 13	Materials Quality Requirements
01 50 00	Temporary Facilities and Controls
01 55 26	Traffic Regulation
01 57 13	Temporary Erosion and Sediment Control
01 57 20	Dust Control and Watering
01 70 00	Contract Closeout
01 71 23	Survey

Division 02 – Existing Conditions

02 41 10	Site Preparation

- 02 41 12 Remove Structure and Obstructions
- 02 41 20 Noxious Weed Control

Division 03 – Concrete

- 03 11 00 Concrete Formwork
- 03 20 00 Concrete Reinforcement
- 03 30 00 Concrete Work
- 03 30 40 Portland Cement Concrete
- 03 35 00 Concrete Finishing
- 03 39 00 Concrete Curing
- 03 41 00 Precast Box Culvert
- 03 61 00 Grout

Division 05 – Metals

- 05 05 00 Bolts, Washers, and Anchors
- 05 12 00 Structural Steel
- 05 12 10 Miscellaneous Structural Steel and Aluminium
- 05 21 00 Steel Joist Framing
- 05 53 00 Gratings, Cover Plates, Handrails, and Roof Access Hatch

Division 09 – Finishes

- 09 90 00 Painting
- 09 97 10 Cold Applied Wax Tape Coating

Division 26 – Electrical

- 26 42 15 Cathodic Protection

Division 31 – Earthwork

- 31 11 00 Clearing and Grubbing
- 31 20 00 Earthwork and Dewatering
- 31 20 01 Utility Trenches
- 31 23 16 Roadway Excavation
- 31 23 23 Common Fill
- 31 23 24 Select Fill
- 31 23 27 Soil Compaction
- 31 23 30 Embankment Borrow and Backfill
- 31 23 33 Excavation and Backfill Operations
- 31 23 43 Restoration of Surface Improvements
- 31 32 19 Geosynthetics
- 31 35 00 Geotextiles
- 31 37 00 Riprap
- 31 40 00 Shoring and Underpinning
- 31 71 00 Tunnel Excavation and Initial Support
- 31 73 00 Contact Grout
- 31 74 23 Carrier Pipe Installation & Backfill
- 31 75 00 Construction Shafts

Division 32 – Exterior Improvements

32 01 05	Informational Regulatory and Warning Signs
32 11 23	Untreated Base Course (APWA)
32 12 13	Prime Coat and Tack Coat
32 12 17	Asphalt Material
32 12 20	Hydrated Lime
32 17 23	Pavement Markings
32 19 00	Pavement Smoothness
32 21 26	Fences And Gates
32 84 00	Pressurized Irrigation System
32 90 10	Landscape Planting
32 90 20	Rock Mulch
32 92 19	Seeding

Division 33 – Utilities

33 01 10	General Piping Requirements
33 05 24	Welded Steel Pipe and Specials
33 11 00	Water Distribution and Transmission Systems
33 11 12	Basic Piping Materials and Methods
33 11 15	Plastic Piping & Tubing (Culinary Water)
33 11 16	Polyethylene Piping and Tubing
33 11 25	Pipeline Testing
33 12 15	Drinking Water Air Release and Vacuum Relief Valves
33 12 16	Valves
33 12 19	Fire Hydrants
33 13 00	Disinfection
33 39 13	Manholes and Covers
33 41 00	Storm Drainage Utility Piping

TECHNICAL SPECIFICATIONS BY REFERENCE

AMERICAN PUBLIC WORKS ASSOCIATION, UTAH CHAPTER 2017 SPECIFICATIONS AND
STANDARD PLANS

DRAPER CITY STANDARD DRAWINGS AND SPECIFICATIONS

JORDAN VALLEY WATER CONSERVANCY DISTRICT STANDARD DRAWINGS AND
SPECIFICATIONS

UTAH DEPARTMENT OF TRANSPORTATION 2024 STANDARD DRAWINGS AND
SPECIFICATIONS ([HTTPS://WWW.UDOT.UTAH.GOV/CONNECT/BUSINESS/STANDARDS](https://www.udot.utah.gov/connect/business/standards))

In case of a conflict the most restrictive standard shall apply.

END OF DOCUMENT

SECTION 00 30 10 – BID SCHEDULE – 03 Transmission Line

Item No.	Description	Quantity	Units	Unit Price	Total Price
01	Mobilization	1	LS		
02	Traffic Control	1	LS		
03	SWPPP & Storm Water NOI	1	LS		
04	Import	1452	CY		
05	Base Course	1671	CY		
06	Granular Borrow	511	CY		
07	Concrete Pavement – Rapid Set	68	CY		
08	Lean Concrete	23	CY		
09	Hot Mix Asphalt	376	TON		
10	Connect to Existing 48" JVWCD Main	1	LS		
11	24" Mag Meter	1	EA		
12	24" Check Valve	1	EA		
13	8' x 29' x 12' Cast in Place Meter Vault	1	LS		
14	7' x 10' x 8' Cast in Place Vault	1	LS		
15	24" x 16" FL Reducer	1	EA		
16	24" x 20" FL Tee	1	EA		
17	16" DI Pipe	1192	LF		
18	24" DI Pipe	328	LF		
19	30" DI Pipe	1290	LF		
20	36" DR-11 HDPE Pipe	371	LF		
21	30" x 36" DI FL Adapter w/ Backup Ring	2	EA		
22	30" x 36" DI FI Reducer	2	EA		
23	16" Double Eccentric Butterfly Valve	2	EA		
24	20" Double Eccentric Butterfly Valve	1	EA		
25	24" FL Gate Valve	1	EA		
26	24" Double Eccentric Butterfly Valve	1	EA		
27	30" Double Eccentric Butterfly Valve	3	EA		
28	3" Combo Air Release/Vacuum Valve	1	EA		
29	6" Combo Air Valve Assembly	2	EA		
30	9' Manhole	2	EA		
31	Tunneled I-15 Crossing (309 LF)	1	LS		
32	Remove and Replace Curb and Gutter	36	LF		
33	Remove and Replace 5' Sidewalk	60	SF		
34	Natural Ground Repair	1600	SF		
35	30" FL Dismantling Joint	3	EA		

36	24" FL Dismantling Joint	1	EA		
37	20" FL Dismantling Joint	1	EA		
38	16" FI Dismantling Joint	1	EA		
39	Cathodic Protection System	1	LS		
	TOTAL				

Measurement and Payment Descriptions are included in Section 00 30 20

SECTION 00 30 20 MEASUREMENTS AND PAYMENTS

Bid Item # 1	Mobilization	LS
A.	Payment covers cost of mobilization, demobilization, installation of temporary facilities, and bringing all necessary construction equipment to the site. Payment will be made on a percentage of the LUMP SUM BASIS as follows: Percent of Original Contract Amount Earned 5 35 50 70	Percent of Amount Bid for Mobilization to be Paid 40 20 30 10
B.	Payment also includes the cost of scheduling processes required per project specifications.	
C.	Payment will include conforming to all applicable local, state and federal requirements.	
D.	Payment will also include any necessary traffic control.	
E.	Moving on the site any equipment required for first month operations.	
F.	Installing temporary construction power and wiring.	
G.	Developing construction water supply.	
H.	Providing on-site sanitary facilities and potable water facilities as specified.	
I.	Arranging for and erection of Contractor's work and storage yard.	
J.	Contractor and Subcontractor insurance and bonds.	
K.	Dust and Mud Control including UPDES storm water permit and fugitive dust control plan.	
L.	Contract Closeout	

Bid Item # 2	Traffic Control	LS
A.	Measurement and payment for Traffic Control shall be LUMP SUM. This item will be paid for as a percentage in relationship to the project percent complete. This item will be compensation in full for flagging, furnishing, installing and moving all traffic control devices. This item shall also include maintaining safe access to all residences and businesses.	

Bid Item # 3	SWPPP and Storm Water NOI	LS
A.	Measurement and payment for SWPPP and Storm Water NOI shall be Lump Sum. This Item will be paid for as a percentage in relationship to the project percent complete. This item will be compensation in full for preparing and implementing a SWPPP and Storm Water NOI, furnishing, installing and moving SWPPP waddles, silt fences and inlet covers and anything else that is required as part of the SWPPP and Storm Water NOI. Payment will cover the cost of all labor, materials, permits, equipment and tools to complete this item.	

Bid Item # 4	Import	CY
A. Measurement: Cubic Yard B. Payment: Compensation in full shall be for the complete furnishing and installing of the import materials. This item shall include the cost of excavation, disposal of material, sub grade preparation, hauling, rolling and compaction of road base. This item shall also include compaction testing. Payment will cover the cost of all labor, materials, equipment, and tools to complete this item.		

Bid Item # 5	Base Course	CY
A. Measurement: Cubic Yard B. Payment: Payment shall be compensation in full for the complete furnishing and installing of the untreated base course. This item shall include the cost of excavation, disposal of material, sub grade preparation, hauling, rolling and compaction of base course according to UDOT standards and specifications. This item shall also include compaction testing. Payment will cover the cost of all labor, materials, equipment, and tools to complete this item.		

Bid Item # 6	Granular Borrow	CY
A. Measurement: Cubic Yard B. Payment: Payment shall be compensation in full for the complete furnishing and installing of the granular borrow according to UDOT standards and specifications. This item shall include the cost of excavation, disposal of material, sub grade preparation, hauling, rolling and compaction of road base. This item shall also include compaction testing. Payment will cover the cost of all labor, materials, equipment, and tools to complete this item.		

Bid Item #7	Concrete Pavement-Rapid Set	CY
A. Measurement: Cubic Yard B. Payment: Payment shall be compensation in full for the complete furnishing and installing of the concrete road surface according to UDOT standards and specifications. This item shall include the cost of saw cutting, excavation, disposal of material, sub grade preparation, and hauling. Payment will cover the cost of all labor, materials, equipment, and tools required to complete this item.		

Bid Item # 8	Lean Concrete	CY
A. Measurement: Cubic Yard B. Payment: Payment shall be compensation in full for the complete furnishing and installing of the lean concrete sub-surface according to UDOT standards and specifications. This item shall include the cost of excavation, disposal of material, sub grade preparation, hauling, and. Payment will cover the cost of all labor, materials, equipment, and tools required to complete this item.		

Bid Item # 9	Hot Mix Asphalt	Ton
A. Measurement: Ton B. Payment shall be compensation in full for installing the hot mix asphalt. Payment shall be made at the unit price bid per ton as identified in the bid schedule. Such payment shall be compensation in full for the complete furnishing and installing of the bituminous road surface material and tack coat. This item shall include the cost of all saw cutting, hauling, placing, rolling, and compaction of hot mix asphalt. Bituminous thickness shall be as specified in the plans. This item shall also include compaction testing and any restoration requirements required of the roadway excavation permittee. Payment will cover the cost of all labor, materials, equipment, and tools to complete this item.		

Bid Item # 10	Connect To Existing 48" J WVCD Main	LS
A. Measurement: Lump Sum B. Payment shall be compensation in full for all labor, materials, equipment and tools to complete this item including all cost of excavation, bedding material, welding, leveling, prefabricated shop special, reinforcement collar installation, proper disposal of existing materials, hot taps, and any equipment necessary to make connection.		

Bid Item # 11	24" Mag Meter	Each
A. Measurement: Per Each B. Payment shall be compensation in full for the installation and furnishing of the 24" mag meter according to JVWCD standards and specifications. Payment shall cover all labor, materials, equipment and tools to complete this item.		

Bid Item # 12	24" Check Valve	Each
A. Measurement: Per Each B. Payment shall be compensation in full for all necessary excavation, installation of the valve and all necessary incidentals to complete the work. The unit price bid for the single check valve shall include all materials, labor and incidentals necessary for the complete installation of each single check valve.		

Bid Item # 13, 14	Cast In Place Vaults	LS
A. Measurement: LS B. Payment shall be compensation in full for the installation of the cast in place vaults including costs for formwork, concrete, rebar, excavation, proper disposal of material, sump pump, pressure gauges, ventilation equipment, ladders, electrical connections and equipment, hose bibs/sampling taps, and all labor, materials, equipment and tools to complete this item.		

Bid Item #15,16,21,22	Ductile Iron Fittings	Each
A. Measurement: Per Each B. Payment shall be compensation in full for the furnishing and installation of ductile iron fittings. Payment shall cover all labor, materials, equipment and tools to complete this item.		

Bid Item # 17,18,19	Ductile Iron Pipe	LF
A. Measurement: Linear Feet B. Payment covers the cost of installing the pipe including all cost of excavation, bedding material, connections to existing pipes, any necessary fittings, locator wire, backfill and compaction of native material, and disposal of existing materials over the trench or on site. Payment will cover the cost of all labor, materials, equipment and tools to complete this item. C. Payment also covers the cost of pressure testing the pipes and disinfection of the culinary water line. D. Excavation and backfill shall include trench sections below roadway excavation depths. Costs included roadway excavation and backfill materials are included in other items. E. All costs for installing joint bonds and all efforts to maintain electrical continuity for the cathodic protection system shall be included in this item.		

Bid Item # 20	36" HDPE Pipe	Linear Feet
A. Measurement: Linear Feet B. Payment covers the cost of installing the pipe including all cost of excavation, bedding material, connections to existing pipes, any necessary fittings, locator wire, backfill and compaction of native material, and disposal of existing materials over the trench or on site. Payment will cover the cost of all labor, materials, equipment and tools to complete this item. C. Payment also covers the cost of pressure testing the pipes and disinfection of the culinary water line. D. Excavation and backfill shall include trench sections below roadway excavation depths. Costs included roadway excavation and backfill materials are included in other items.		

Bid Item # 23,34,25,26,27	Valves	Each
A. Measurement: Per Each B. Payment covers the cost of installing the valves, reducers, and fittings including all cost of excavation, bedding material, connections and fittings, valve boxes, Megalugs, thrust blocks, backfill and compaction of native material and proper disposal of existing materials over the trench or on site. Payment will cover the cost of all labor, materials, equipment, and tools to complete this item.		

Bid Item # 28 & 29	Combination Air Release/Vacuum Assemblies	Each
A. Measurement: Per Each B. Payment will be made at the unit price bid per station. Such payment will be compensation in full for the Contractor furnishing and installing the combination air release stations at the locations as shown in the plans and details, complete in place including furnishing and installing concrete vault or manhole sections, interior plumbing including pipe fittings, all concrete, bedding material, surveying, combination air vacuum, and air release valve, vent pipe, piping, fittings, grout, cover, ring and lid, grade rings, final grade adjustment, and commissioning air vac valve station, and all appurtenances or as shown on the plans.		

Bid Item # 30	9' Manhole	Each
A. Measurement: Per Each B. Payment will be made at the unit price bid per each unit. Payment covers the cost of furnishing and installing manholes and connections according to Draper City standards as shown in the Drawings. This item includes excavation, placement of bedding materials, furnishing and placing drain rock, and placement of backfill up to finished grade. Payment shall cover the cost of all Work required for a complete job including labor, materials, equipment, and tools for installation of the manhole vaults.		

Bid Item # 31	Tunneled I-15 Crossing	Linear Feet
A. Measurement: Lump Sum B. Such payment will be compensation in full for utility coordination, locating and potholing within pit and tunnel locations prior to starting construction operations; installation of jacking, tunneling and/or boring pits, intermediate jacking stations, and related equipment; design of bracing/shoring for all pits by an Engineer licensed in the State of Utah if required by OSHA; traffic control for operations near pits; dewatering and water control of pits; removal of shaft support systems; design of tunnel initial support and grouting operations as required; all equipment, labor, and materials necessary to complete installation of tunnel initial support, ground excavation, contact grouting, and installation of carrier pipe and backfill grout, supplementary subsurface investigation and testing prior to installation; installation, monitoring/recording, maintenance and removal upon completion of instrumentation and all related equipment and/or software; and site restoration for pit access locations		

Bid Item # 32	Remove and Replace Curb and Gutter	Linear Feet
A. Measurement: Linear Feet B. Payment shall be compensation in full for installation of the curb and gutter including all cost of saw cutting asphalt, excavation (including 6 inches of additional material beneath the curb and gutter), 6 inches of untreated base course, compaction, testing, forming, expansion joint, placing concrete, finishing surface, landscape restorations, transitioning curb shape to match existing curb, and disposal of existing materials. Payment will cover the cost of all labor, materials, equipment, and tools to complete this item.		

Bid Item # 33	Remove and Replace Existing 5' Sidewalk	Square Feet
A. Measurement: Square Feet. B. Payment shall be compensation in full for installation of new sidewalk, removal, and proper disposal of existing sidewalk including all cost of saw cutting concrete, excavation (including 6 inches of additional material beneath the sidewalk), 6 inches of untreated base course, compaction, testing, forming, placing concrete, expansion joint, finishing surface, landscape restorations and disposal of existing materials. Payment will cover the cost of all labor, materials, equipment, and tools to complete this item.		

Bid Item # 34	Natural Ground Repair	Square Feet
A. Measurement: Square Feet. B. Payment shall be compensation in full for restoring natural ground cover to conditions equal to or better than existing conditions. Restoration shall include replacing in situ topsoil and reseeding the affected area. Payment will cover the cost of all labor, materials, equipment, and tools to complete this item.		

Bid Item # 35, 36 & 37	Dismantling Joint	Each
A. Measurement: Square Feet. B. Payment shall be compensation in full for furnishment and installation of dismantling joints according to the plans, specifications and Draper City Standards. Payment will cover the cost of all labor, materials, equipment, and tools to complete this item.		

Bid item # 38	Cathodic Protection System	Lump Sum
A. Measurement: Lump Sum. B. Payment shall be compensation in full for all equipment, labor, and materials required to construct the corrosion protection station including, the rectifier and electrical disconnect, deep anode ground bed, and all associated connections, casings, wiring, junction, boxes, concrete, bollards and rails, testing, and other appurtenances required for a complete installation.		

SECTION- 00 35 00

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned,

_____ as Principal, and

_____ as Surety, are hereby Held and firmly

bound unto

_____ as Owner in the penal
sum of _____ for the payment of which,
well and truly to be made, we hereby jointly and severally bind ourselves, successors, and
assigns. Signed, this _____ day of _____, 2025. The Condition of the
above obligation is such that whereas the Principal submitted to _____ a
certain Bid, attached hereto and hereby made a part hereof to enter into a contract in writing, for
(5) percent of the total Bid.

NOW, THEREFORE,

- (a) If said Bid shall be rejected, or in the alternate.
- (b) If said Bid shall be accepted and the Principal shall execute and deliver a contract in the Form of Contract attached hereto (properly completed in accordance with said Bid) and shall furnish a bond for his faithful performance of said contract, and for the payment of all persons performing labor or furnishing materials in connection therewith, and shall in all other respects perform the agreement created by the acceptance of said Bid, then this obligation shall be void, otherwise the same shall remain in force and effect; it being expressly understood and agreed upon that the liability of the Surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its bond shall be in no way impaired or affected by any extension of the time within which the Owner may accept such Bid; and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

(Principal)

(Surety)

IMPORTANT - Surety companies executing bonds must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the project is located.

SECTION 00 35 60- NON-COLLUSION AFFIDAVIT

_____, being the first duly sworn, deposes and says that:

1. He/she is _____ of _____
(Owner, partner, etc.) (Company)
the Bidder that has submitted the attached Bid;

2. He/she is fully informed respecting the preparation and contents of the attached Bid and of all pertinent circumstances respecting such Bid;

3. Such Bid is genuine and is not a collusive or sham Bid;

4. Neither the said Bidder nor any of its officers, partners, owners, subcontractors, agents, representatives, employees or parties in interest including this affiant, has in any way colluded, conspired, connived or agreed, directly or indirectly, with any other Bidder, firm or person to submit a sham Bid in connection with the Contract for which the attached Bid has been submitted or to refrain from bidding in connection with such Contract, or has in any manner, directly or indirectly sought by agreement or collusion or communication or conference with any other Bidder, firm or person to fix price or prices in the attached Bid or of any other Bidder, or to fix overhead, profit or cost element of the bid price or the bid price of any other bidder, or to secure through any collusion, conspiracy, connivance or unlawful agreement and advantage against the City of Draper;

5. No member of the City Council, or other Officers of the City of Draper, or any person in the employ of the City is directly or indirectly interested in the bid, or the work to which it relates, or in any portion of the profits thereof; and,

6. The prices quoted in the attached Bid are fair and proper and are not tainted by any collusion, conspiracy, connivance or unlawful agreement on the part of the Bidder or any of its agents, representatives, owners, employees or parties in interest including this affiant;

7. I am/The Bidder is not indebted to the Draper City in any form or manner.

Signature: _____ Date: _____

Title: _____ Witness: _____

SECTION 00 36 00

NOTICE OF AWARD

To:

PROJECT Description: Draper City- THE POINT TRANSMISSION LINE PACKAGE 03, the installation of the point redevelopment transmission line from the JWCDA aqueduct to the tanks.

The OWNER has considered the BID submitted by you for the above described WORK in response to its Advertisement for Bids and Information for Bidders.

You are hereby notified that your BID has been accepted for items in the amount of \$_____.

You are required by the Information for Bidders to execute the Agreement and furnish the required CONTRACTOR'S Performance Bond, Payment Bond, and Certificates of Insurance within ten (10) calendar days from the date of this notice to you.

If you fail to execute said Agreement and to furnish said Bonds within ten (10) days from the date of this Notice, said OWNER will be entitled to consider all your rights arising out of the OWNER'S acceptance of your BID as abandoned and as a forfeiture of your Bid Bond. The OWNER will be entitled to such other rights as may be granted by law.

You are required to return an acknowledged copy of this Notice of Award to the OWNER.

Dated this _____ day of _____, 2025.

Owner

ACCEPTANCE OF NOTICE

By _____

Receipt of the above NOTICE OF
AWARD is hereby acknowledged

Title _____

By _____

this the _____ day of _____, 2025.

By _____

Title _____

SECTION 00 50 00

AGREEMENT

THIS AGREEMENT, made this _____ day of _____, 2025 by and between Draper City, hereinafter called "OWNER" and _____ doing business as a corporation hereinafter called "CONTRACTOR".

WITNESSETH: That for and in consideration of the payments and agreements hereinafter mentioned:

1. The CONTRACTOR will commence and complete construction of *The Point Redevelopment Transmission Line Package 03*.
2. The CONTRACTOR will furnish all of the material, supplies, tools, equipment, labor and other services necessary for the construction and completion of the project described herein.
3. The CONTRACTOR will commence the work required by the CONTRACT DOCUMENTS within 10 calendar days after the date of the Notice to Proceed and will complete the work required by the CONTRACT DOCUMENTS **and fully complete the project by April 30th 2026** after the issuance of the Notice to Proceed, unless the period for completion is extended otherwise by the CONTRACT DOCUMENTS.
4. The CONTRACTOR agrees to perform all of the WORK described in the CONTRACT DOCUMENTS and comply with the terms therein for the sum of \$_____.
5. The term "CONTRACT DOCUMENTS" means and includes the following:
 - (A) Advertisement for BIDS
 - (B) Instructions to BIDDERS
 - (C) Information Required of Bidder
 - (D) Bid
 - (E) Bid Bond
 - (F) E Verify Certification
 - (G) Non-Collusion Affidavit
 - (H) Agreement
 - (I) General Conditions
 - (J) Supplementary Conditions
 - (K) Special Provisions

- (L) Payment Bond
- (M) Performance Bond
- (O) Notice of Award
- (P) Notice to Proceed
- (Q) Work Directive Change
- (R) Change Order
- (S) Waiver of Lien
- (T) Specifications prepared or issued by Horrocks Engineers, dated May 2025.
- (U) Drawings prepared by Horrocks Engineers dated February 2025.
- (V) Addendum:
 - No. _____, DATED _____, 20____
 - No. _____, DATED _____, 20____

6. The OWNER will pay to the CONTRACTOR in the manner at such times as set forth in the General Conditions such amounts as required by the CONTRACT DOCUMENTS.

7. This Agreement shall be binding upon all parties hereto and their respective heirs, executors, administrators, successors, and assigns. IN WITNESS WHEREOF, the parties hereto have executed, or caused to be executed by their duly authorized officials, this Agreement in triplicate, each of which shall be deemed an original on the date first above written.

OWNER:

BY _____

(SEAL)

Name _____

ATTEST:

Title _____

Name _____

(please type)

Title _____

CONTRACTOR:

(SEAL)

BY _____

ATTEST:

Name _____
(please type)

Address _____

Name _____
(please type)

Title _____

SECTION 00 51 00

NOTICE TO PROCEED

To:

Date: _____

You are hereby notified to commence work in accordance with the Agreement dated
, 2025, on or before _____, and you are to complete by **April 30th 2026**.

Owner

ACCEPTANCE OF NOTICE

By _____

Receipt of the above NOTICE TO
PROCEED is hereby acknowledged

Title _____

By _____

this the ____ day of _____, 2025

By _____

Title _____

SECTION 00 60 00

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS: that

(Name of Contractor)

(Address of Contractor)

a _____, hereinafter called
(Corporation, Partnership, or Individual)
Principal, and

(Name of Surety)

(Address of Surety)

hereinafter called Surety, are held and firmly bound unto

(Name of Owner)

(Address of Owner)

hereinafter called OWNER, in the penal sum of _____

_____ Dollars (\$_____) in lawful money of the United States, for the payment
of which sum, well and truly to be made, we bind ourselves, successors, and assigns, jointly
and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into a
certain contract with the OWNER, dated the ____ day of _____, 20____, a copy of which is
hereto attached and made a part hereof for the construction of:

NOW THEREFORE, if the Principal shall promptly make payment to all persons, firms,
SUBCONTRACTORS, and corporations furnishing materials for or performing labor in the
prosecution of the WORK provided for in such contract, and any authorized extension or
modifica

tion thereof, including all amounts due for materials, lubricants, oil, gasoline, coal and coke, repairs on machinery, equipment and tools, consumed or used in connection with the construction of such WORK, and all insurance premiums on said WORK, and for all labor, performed in such WORK whether by SUBCONTRACTOR or otherwise, then this obligation shall be void; otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of UTAH CODE ANNOTATED SECTION 63G-6-505, as amended, and all liabilities on this bond shall be determined in accordance with said provisions to the extent as if it was copied at length herein.

PROVIDED FURTHER, that the said Surety for value received hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract or to the WORK to be performed thereunder or in the SPECIFICATIONS accompanying the same shall in any wise affect its obligation on this BOND, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the contract or to the work or to the SPECIFICATIONS.

PROVIDED FURTHER, that no final settlement between the OWNER and the CONTRACTOR shall abridge the right of any beneficiary, whose claim may be unsatisfied.

IN WITNESS WHEREOF, this instrument is executed in _____ counterparts, each one of which shall be deemed an original, this the ____ day of _____, 20____.

ATTEST:

Principal

Principal Secretary

By _____

Address

(Seal)

Witness as to Principal

Address

Surety

ATTEST:

_____	By _____
Witness as to Surety	Attorney in Fact
_____	_____
Address	Address
_____	_____

Note: Date of BOND must not be prior to date of Contract. If CONTRACTOR is Partnership, all partners should execute BOND.

IMPORTANT: Surety companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the State where the PROJECT is located.

SECTION 00 61 00

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS: that

(Name of Contractor)

(Address of Contractor)

a _____, hereinafter called
(Corporation, Partnership, or Individual)
Principal, and

(Name of Surety)

(Address of Surety)

hereinafter called Surety, are held and firmly bound unto

(Name of Owner)

(Address of Owner)

hereinafter called OWNER, in the penal sum of _____
_____ Dollars (\$_____) in lawful money of the United States, for the payment of
which sum well and truly to be made, we bind ourselves, successors, and assigns, jointly and severally,
firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into a certain
contract with the OWNER, dated the ____ day of _____, 20____, a copy of which is hereto attached and
made a part hereof for the construction of:

NOW, THEREFORE if the Principal shall well, truly and faithfully perform its duties, all the undertakings,
covenants, terms, conditions, and agreements of said contract during the original term thereof, and any
extensions thereof which may be granted by the OWNER, with or without notice to the Surety and during
the one year guaranty period, and if he shall satisfy all claims and demands incurred under such
contract, and shall fully indemnify and save harmless the OWNER from all costs and damages which it
may suffer by reason of failure to do so, and shall reimburse and repay the OWNER all outlay and
expense which the OWNER may incur in making good any default, then this obligation shall be void;
otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of UTAH CODE ANNOTATED SECTION 63G-6-505, as amended, and all liabilities on this bond shall be determined in accordance with said provisions to the extent as if it was copied at length herein.

PROVIDED FURTHER, that the said Surety for value received hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract or to the WORK to be performed thereunder or in the SPECIFICATIONS accompanying the same shall in any wise affect its obligation on this BOND, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the contract or to the work or to the SPECIFICATIONS.

PROVIDED FURTHER, that no final settlement between the OWNER and the CONTRACTOR shall abridge the right of any beneficiary, whose claim may be unsatisfied.

IN WITNESS WHEREOF, this instrument is executed in _____ counterparts, each one of which shall be deemed an original, this the ____ day of _____, 20__.

ATTEST:

_____	_____
Principal Secretary	Principal
(Seal)	By _____

	Address

_____	_____
Witness as to Principal	
_____	_____
Address	Surety

ATTEST:

_____	By _____
Witness as to Surety	Attorney in Fact
_____	_____
Address	Address
_____	_____

Note: Date of BOND must not be prior to date of Contract If CONTRACTOR is Partnership, all partners should execute BOND.

IMPORTANT: Surety companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the State where the PROJECT is located.

SECTION 00 70 00 – GENERAL CONDITIONS

The Utah Division of Facilities Construction and Management (DFCM) General Conditions apply and can be found at the following link:

<https://dfcm.utah.gov/wp-content/uploads/DFCM-General-Conditions.pdf>

SECTION 00 73 84 – MATERIALS DISPUTE RESOLUTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Procedures for disputing acceptance or verification test results for the following materials on Department projects:
 - 1. Section 03 30 40 – Portland Cement Concrete
 - 2. Section 03 61 00 – Grout
 - 3. Section 31 23 30 – Embankment, Borrow, and Backfill
 - 4. Section 32 11 23 – Untreated Base Course
 - 5. Section 32 12 16 – Hot Mix Asphalt
 - 6. Section 32 12 17 – Asphalt Material
- B. Procedures for requesting that rejected, non-conforming material be allowed to remain in place.

1.2 RELATED SECTIONS

- A. Section 03 30 40: Portland Cement Concrete
- B. Section 03 61 00: Grout
- C. Section 32 23 30: Embankment, Borrow, and Backfill
- D. Section 32 11 23: Untreated Base Course
- E. Section 32 12 16: Hot Mix Asphalt
- F. Section 32 12 17: Asphalt Material

1.3 REFERENCES

- A. AASHTO R 35: SuperPave Volumetric Design for Hot Mix Asphalt (HMA)
- B. AASHTO T 22: Compressive Strength of Cylindrical Specimens
- C. AASHTO T 24: Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- D. AASHTO T 121: Density, Yield, and Air Content of Concrete
- E. AASHTO T 152: Air Content of Freshly Mixed Concrete by the Pressure Method

- F. AASHTO T 193: The California Bearing Ratio
- G. AASHTO T 324: Hamburg Wheel-Track Testing of Compacted Hot-Mix Asphalt (HMA)
- H. AASHTO T 342: Determining Dynamic Modulus of Hot Mix Asphalt (HMA)
- I. ASTM C 457: Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
- J. UDOT Materials Manual of Instruction
- K. UDOT and Utah AGC Partnering Field Guide

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS

- A. Contractor's dispute of acceptance or verification test results.
 - 1. Submit the dispute for approval within one week of receipt of test results or at least 24 hours before performing any work that may prevent the evaluation, correction, or removal of the lot in question.
 - 2. Include information, engineering analysis, statistical analysis, and test results related to the dispute.
 - a. Reasons for disputing the acceptance or verification test results.
 - b. The Contractor's project quality control test results, including split sample test results.
 - 1) Test results must be from a Department-qualified laboratory using Department-qualified technicians.
 - 2) Include all supporting test data and calculations for reported values.
 - c. Successful laboratory correlation information when required by material specification.
 - d. Statistical analysis or identification of potential outliers.
 - e. Procedures or issues leading to disputed acceptance test results.
 - f. Incentive/Disincentive calculations based on both Contractor and Department test values, separately.
- B. Request to allow rejected material to remain in place
 - 1. Submit the request for approval within one week of receipt of test results or at least 24 hours before performing any work that may prevent the evaluation, correction, or removal of the lot in question.

2. Submit an engineering analysis.
 - a. Include reasons that the Department should consider allowing the rejected material to remain in place.
 - b. Include materials, durability, and long-term structural properties from a Department-qualified laboratory as appropriate. Testing may include:
 - 1) Hamburg Wheel Track Testing of Compacted Bituminous Mixtures – Refer to AASHTO T 324.
 - 2) PG Asphalt Binder Tests – Refer to Section 02745.
 - 3) SuperPave Volumetric Properties – Refer to AASHTO R 35.
 - 4) California Bearing Ratio – Refer to AASHTO T 193.
 - 5) In-place Concrete Properties for Concrete Pavement and Portland Cement Concrete – Refer to AASHTO T 22, T 24, T 121, T 152. Samples from reinforced structures may be taken only as approved by the Engineer.
 - 6) Air Void System in Hardened Concrete – Refer to ASTM C 457.
 - c. Include an engineering evaluation based on durability and serviceability relative to the specified product requirements. This includes expected performance compared to design life.

1.6 DISPUTE RESOLUTION PROCEDURE FOR ACCEPTANCE OR VERIFICATION TEST RESULTS

- A. The Contractor may dispute the validity of the Department's acceptance or verification tests.
 1. The option to dispute the validity of the Department's test results is forfeited if laboratory correlation testing is required by specification and is not performed.
- B. Contractor disputes will not change the Department-selected option for materials acceptance based on sampling and testing as outlined in the UDOT Materials Manual of Instruction Section 1011.
 1. Quality Control results may be used to dispute acceptance test results.
- C. The Department immediately reviews the submittal when the construction schedule and contractor information indicates that a rejected lot will be affected within 48 hours by work that may prevent the evaluation, correction, or removal of the lot in question.

1. The Department may suspend work related to the lot in question if merit is found in the engineering analysis.
- D. Resolve differences in test results prior to further production of the material type in question.
- E. The Department and Contractor immediately begin to investigate and review the engineering analysis and resolve the dispute if merit is found. The investigation includes the following.
 1. A test and calculation procedure review. Refer to this Section, Article 1.7.
 2. Validation testing as appropriate. Refer to this Section, Article 1.8.
 3. Third party testing and review as appropriate. Refer to this Section, Article 1.9.
- F. The Department may choose to evaluate the lot using appropriate test methods if significant errors are identified that cannot be corrected and the quality of the in-place material is in question.
- G. The Engineer reviews the analysis and notifies the Contractor in writing of their decision. The notification of rejection includes the following:
 1. Engineering basis for rejecting the Contractor's analysis including specific points of objection.
 2. Department data and analysis to justify Department position.
 3. Time frame for removal of material or pay adjustment to be applied to the lot.
- H. The Department will review the Contractor's schedule and make appropriate adjustments to contract time when significant errors are identified in the Department's testing results based on critical path analysis.
 1. Time lost due to a rejected analysis is not credited to the contract time.
- I. The Department's response concludes this materials dispute resolution process.
 1. Continuing disputes must be addressed and escalated as outlined in the UDOT and Utah AGC Partnering Field Guide.

1.7 TEST AND CALCULATION PROCEDURE REVIEW FOR DISPUTED ACCEPTANCE OR VERIFICATION TEST RESULTS

- A. The Department and Contractor immediately begin a review of the acceptance test results when the Department concludes the engineering analysis has merit and test procedures or calculations are in question. The review normally includes the following in an appropriate order:

1. A review of all equipment, procedures, and methods used for sampling, splitting, and testing.
 2. A review of the Department and Contractor's raw test data and calculations for documentation or calculation errors.
 3. Production and testing of additional correlation samples.
 4. Cross-witnessing of test procedures by Contractor Quality Control and Department personnel.
 5. Distribution of any other pertinent information.
 6. Discussion of other possible means for variation.
- B. The Department corrects the applicable test results and reapplies the acceptance determination and associated payment if equipment issues or errors in calculations or reporting are discovered.
- C. The Department evaluates the lot using the original test results if no significant errors are identified.

1.8 VALIDATION TESTING FOR DISPUTED ACCEPTANCE OR VERIFICATION TEST RESULTS

- A. Validation testing may be performed by the Department as follows:
1. Department personnel begin retesting on the material remaining from the original Department test.
 - a. The Contractor's representative may witness the testing.
 - b. The Department may perform the validation testing in the Department's Region or Central Materials laboratory.
 - c. Retest all samples in the lot.
 2. Retesting results are used to validate or invalidate original Department result.
 - a. Validation test results may not be used instead of acceptance results.
 - b. Results within two standard deviations of the original acceptance results are validated.
 - 1) Use the project acceptance results for the lot in question to determine the standard deviation.
 3. Invalidated test results are removed from acceptance lot and the lot is reevaluated based on the reduced sample size.
- B. The Department evaluates the lot using the original test results if no samples are invalidated.

1.9 THIRD PARTY TESTING AND REVIEW FOR DISPUTED ACCEPTANCE OR VERIFICATION TEST RESULTS

- A. Third Party testing may be performed as follows:
 - 1. Select an Independent Third Party agreed upon by the Department and the Contractor to witness sample splitting and testing by both the Contractor and the Department if errors in testing cannot be identified.
 - 2. The Independent Third Party identifies and obtains additional material for split-sample testing.
 - 3. The Independent Third Party witnesses split-sample testing in the Department and Contractor Laboratories, evaluates the test procedures, compares the results, determines if there are errors, and provides a report.
 - 4. The party responsible for the identified error pays for the services of the Independent Third Party.
- B. The Department evaluates the lot using the original testing results if no significant errors are identified.

1.10 REJECT MATERIAL

- A. The Contractor may request that rejected, non-conforming material be left in place at a reduced price. Include an engineering analysis.
- B. The Engineer determines whether the lot is to be removed or remain in place and the associated price reduction if other than specified in the contract

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

END OF SECTION

SECTION 00 75 00 – SPECIAL PROVISIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The Contractor shall furnish all labor, materials, and equipment necessary or required to complete the work in all respects as shown on the plans, as hereinafter specified, or both. If there is a conflict between requirements of this section and requirements of other sections of these specifications, then the requirements contained in the Special Provisions shall govern.
- B. The CONTRACTOR shall not award WORK to SUBCONTRACTOR(S) in excess of fifty (50%) percent of the CONTRACT PRICE, without prior written approval of the OWNER.
- C. Comply with R309-545-11. All interior surfaces and coatings shall comply with ANSI/NSF Standard 61 or other standards approved by the Director. This requirement applies to any pipes and fittings, protective materials (e.g., paints, coatings, concrete admixtures, concrete release agents, or concrete sealers), joining and sealing materials (e.g., adhesives, caulks, gaskets, primers and sealants) and mechanical devices (e.g., electrical wire, switches, sensors, valves, or submersible pumps) that may come into contact with the drinking water.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES Not Used

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS Refer to Specific Requirements below

1.6 PROGRESS OF CONSTRUCTION

- A. It is the intention of these contract documents that the progress of the work shall proceed in a systematic manner so that a minimum of inconvenience will result to the public in the course of construction.
- B. Clean-up of all construction debris, excess excavation, excess materials, and complete restoration of all fences, irrigation structures, ditches, culverts, and similar items shall be completed immediately following final grading. The Contractor shall stockpile the excavated material so as to do the least damage to adjacent grassed areas, or fences, regardless of whether these are on private property or public rights-of-way. All excavated materials shall be removed from grassed and planted areas, and these surfaces shall be left in a condition equivalent to their original surface and free from all rocks, gravel, boulders, or other foreign materials. All excavated material 3 inches and larger shall be removed or covered.

-
- C. Cleanup and grading shall be contingent with and carried on at the same time as pipeline installation, backfill, and excavation. Cleanup and grading activities shall not be further than 200 feet behind the excavation and pipe laying operations. Excavation and backfill and pipeline installation will not be deemed complete until cleanup and grading is approved and satisfactory to the Engineer and property owner.

1.7 CONSTRUCTION SEQUENCE

- A. The Contractor shall give special consideration to scheduling his work to allow traffic to be rerouted where the construction is located in the City's and County's Roads. Adequate signing will be required.

1.8 INTERFERING STRUCTURES AND UTILITIES

- A. The Contractor shall exercise all possible caution to prevent damage to existing structures and utilities, whether above ground or underground. An attempt has been made to show these structures and utilities on the plans. While the information has been compiled from the best available sources, its completeness and accuracy cannot be guaranteed, and it is presented simply as a guide to possible difficulties. The Contractor shall notify all utility offices concerned at least 48 hours in advance of construction operations in which a utility's facilities may be involved. This shall include, but not be limited to irrigation, water, telephone, electric, and gas.
- B. It shall be the responsibility of the Contractor to locate and expose all existing underground structures and utilities in advance of excavation. Any structure or utilities damaged by the work shall be repaired or replaced in a condition equal to or better than the condition prior to the damage. Such repair or replacement shall be accomplished at the Contractor's expense without additional compensation from the Owner.
- C. The Contractor shall remove and replace such small miscellaneous structures as fences and culverts at his own expense without additional compensation from the Owner. The Contractor shall replace these structures in a condition as good or better than their original conditions.
- D. If the Contractor encounters existing structures which will prevent construction and which are not properly shown on the plans, he shall notify the Engineer before continuing with the construction in order that the Engineer may make such field revisions as necessary to avoid conflict with the existing structures. The cost of waiting or "down" time during such field revision shall be borne by the Contractor without additional cost to the Owner. If the Contractor shall fail to so notify the Engineer when an existing structure is encountered, but shall proceed with the construction despite this interference, he shall do so at his own risk. In particular, when the location of a new construction, as shown on the Plans, will prohibit the restoration of existing structures to their original conditions, he shall notify the Engineer so a field relocation may be made to avoid the conflict.

1.9 FIELD RELOCATION

- A. During the progress of construction, it is possible that minor relocations may be necessary. Such relocations shall be made only by direction of the Engineer. Unforeseen obstructions encountered as a result of such relocations will not be subject to claims for additional compensation to the Contractor for any greater extent than would have been the case had the obstructions been encountered along the original location.

1.10 PUBLIC SAFETY AND CONVENIENCE

- A. The Contractor shall comply with all rules and regulations of the County and State authorities regarding the closing of public streets or highways to the use of the public traffic. No road shall be closed by the Contractor to the public except by express permission of the Engineer. Traffic must be kept open on those roads and streets where no detour is possible. The Contractor shall, at all times, conduct his work so as to assure the least possible obstructions to traffic and normal commercial pursuits. All obstructions within traveled roadways shall be protected by approved signs, barricades, and lights where necessary or ordered by the Engineer for the safety of the traveling public. The convenience of the general public and residents and the protection of persons and property is of prime importance and shall be provided for by the Contractor in an adequate and satisfactory manner.
- B. The Contractor shall use every reasonable precaution to safeguard the persons and property of the traveling public. Failure of the Engineer to notify the Contractor to maintain barricades, barriers, lights, flares, danger signals, or watchmen shall not relieve the Contractor from his responsibility. All barricades and obstructions shall be protected at night by signal lights which shall be suitably distributed across the roadway and kept burning from sunset to sunrise. Barricades shall be of substantial construction.
- C. Whenever the Contractor's operations create a hazardous condition, he shall furnish flagmen and guards as necessary or as ordered by the Engineer to give adequate warning to the public of any dangerous conditions to be encountered. He shall furnish, erect, and maintain approved fences, barricades, lights, signs, and any other devices that may be necessary to prevent accidents and to avoid damage and injury to the public. Flagmen and guards, while on duty and assigned to give warning to the public, shall be equipped with approved red wearing apparel and a red flag which shall be kept clean and in good repair.
- D. The Contractor will be required to confine construction operations within the dedicated rights-of-way for public thoroughfares or within areas for which construction easements have been obtained unless he has made special arrangements with the affected property owners in advance. The Contractor will be required to protect stored materials, cultivated trees and crops, and other items located adjacent to the proposed construction site. Property owners affected by the construction shall be notified by the Contractor at least 48 hours in advance of the time construction begins. During all construction operations, the Contractor shall construct and maintain such facilities as may be required to provide access

by all property owners to their property. No person shall be cut off from access to his residence or place of business for a period exceeding eight hours unless the Contractor has made special arrangements with the affected persons. The Contractor shall provide for access at all times for livestock through farm areas; specifically, no portion of farmlands in which livestock are pastured shall be cut from ready access by the farm animals.

1.11 EASEMENTS

- A. Portions of the construction may be located on private property. Easements and permits have been obtained by the Owner. Easements shall provide for the use of property for construction purposes to the extent indicated on the easements. Copies of these easements and permits are available at the office of the Owner for inspection by the Contractor. The Contractor shall confine his construction operations to within the easement limits or street right-of-way limits or make special arrangements with the property owners for the additional area required. Any damage to private property, either inside or outside the limits of the easements provided by the Owner, shall be the responsibility of the Contractor. Before final payment will be authorized by the Engineer at the completion of the construction, the Contractor shall obtain from the permit or easement grantors a release indicating that the work of restoration has been satisfactorily completed in accordance with the terms of the permit or easement. Should it be found impossible for the Contractor to obtain any of the required releases, either because of the absence of the grantors or because of impractical demand by the grantors, then the Engineer may waive this requirement, if, in his opinion, the Contractor has fulfilled his obligations.

1.12 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICES

- A. At points where the Contractor's operations are adjacent to or across properties of railway, telegraph, telephone, irrigation or canal, power, gas, and water, or adjacent to other property (damage to which might result in considerable expense, loss and inconvenience), no work shall be started until all arrangements necessary for the protection thereof have been made.
- B. The Contractor shall be solely and directly responsible to the Owners and operators of such properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of an injury or damage which may result from the carrying out of the work to be done under the contract.
- C. In the event of interruption to either domestic or irrigation water or to other utility services as a result of accidental breakage or as a result of being exposed or unsupported, the Contractor shall promptly notify the proper authority.
- D. He shall cooperate with the said authority in restoration of services as promptly as possible and shall bear all costs of repair. In no case shall interruption of any water, sewer, or utility service be allowed to exist outside working hours unless prior approval is received.

-
- E. The locations of the major existing water lines, as shown on the Plans, were taken from City maps, and preliminary investigations have indicated they are generally reliable. However, it should be expected that some location discrepancies will occur.
 - F. Neither the Owner nor its officers or agents shall be responsible for damages to the Contractor as a result of the locations of the utilities being other than those shown on the plans or for the existence of utilities not shown on the plans.

1.13 LAND MONUMENTS

- A. The Contractor shall preserve existing City, County, State, and Federal land monuments wherever possible. When these monuments cannot be preserved, the Contractor shall notify the Engineer in writing at least two (2) weeks in advance of the proposed construction in order that the Engineer will have ample opportunity to reference these monuments. The Contractor shall replace all monuments as directed by the Engineer.

1.14 SOURCE AND COST OF MATERIALS

- A. All materials furnished or incorporated in this project shall conform to the requirements of these Specifications hereof a part.
- B. The Owner may select areas for disposal of surplus material; however, said area must be approved by the Engineer, and the Contractor will be responsible for acquiring the necessary right, at his own expense, to use the property for such purpose.

1.15 STATE AND FEDERAL INSPECTING AGENCIES

- A. The site of construction is to be open at all reasonable times and places for inspection by accredited representatives of the State or Federal agencies who have regulatory or supervisory authority over any part of the work proposed or related thereto.

1.16 COMPLIANCE WITH SPECIFICATIONS OF MATERIALS OR EQUAL CLAUSE

- A. Unless otherwise specifically provided in the Specifications, all workmanship, equipment, materials, and articles incorporated in the work covered by this contract are to be of the best available grade of their respective kinds. Whenever in the Specifications any material, article, device, product, fixture, form, type of construction, or process is indicated or specified by patent or proprietary name, by name of manufacturer, or by catalog number, such Specifications shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the material or process desired, and shall be deemed to be followed by the words, "or approved equal," and the Contractor may in such case, after the Engineer's approval, purchase and use any time, type, or process which shall be substantially equal in every respect to that so indicated or specified. The Engineer shall be the sole judge as to the equality of the substituted article.

1.17 WATER AND POWER

- A. The Contractor shall be responsible to arrange for and pay all costs for water and power required.

1.18 LINES, GRADES, AND CONSTRUCTION STAKING

- A. All work under this contract shall be built in accordance with the lines and grades as indicated in the Contract Documents. Distances and measurements except elevations and structural dimensions are given and made on horizontal planes.
- B. Basic construction staking for the facilities will be performed by the Engineer. Line and grade stakes for pipelines will be set at a distance 100 foot spacing with an offset that is mutually agreeable to the Contractor and the Engineer. Centerline staking will be provided when warranted at 100 foot intervals and referenced for clearing and grubbing operation. Line and grade stakes for ditches will be set at 100 foot spacing with a mutually agreeable offset. Structures will be staked with two offset points locating two major external corners of the structure. Refer to Section 01 71 23 for additional requirements.
- C. The Contractor shall be responsible for setting any additional stakes as may be required for the performance of the work.
- D. The Contractor shall make every effort to maintain and protect the survey control points and the construction stakes. If control points or stakes are damaged, or destroyed they will be replaced by the Engineer at the Contractor's expense.

1.19 PERMITS

- A. The Contractor is responsible to obtain all additional required business licenses, building permits, and fees with respect to this Project. It shall be the Contractor's responsibility to notify the respective proprietor for each right-of-way at least 48 hours prior to beginning any work within their right-of-way. The Contractor shall provide bonds as are required by the proprietors of each right-of-way and the Contractor is responsible for fees or charges the proprietors may assess. The cost of the above mentioned items shall be included in the lump sum bid price.

1.20 CONSTRUCTION SCHEDULE AND SCHEDULE OF VALUES

- A. **CONSTRUCTION SCHEDULE.** The Contractor shall submit to the Engineer three (3) copies of a Critical Path Method, (CPM), type Construction Schedule generally as outlined in the Associated General Contractors Publication "The Use of CPM in Construction", within 15 days of the date of award of the contract. If revisions are required to this initially submitted schedule a revised schedule shall be re-submitted within 7 days after the Contractor receives the review copy.
 - 1. Prior to the award of the contract, the Contractor shall submit a written statement of his CPM capability, verifying that the Contractor has qualified CPM consultant.

-
2. The completed schedule shall include a graphic network and tabulated schedules with the graphic network displayed on a sheet with a minimum size of 11" x 17" and a maximum size off 36" x 60". The graphic network shall be the activity on arrow type form of a time scaled arrow diagram. It may be divided into two or more sheets, if necessary, provided that all sheets are properly referenced. Notation on each activity arrow shall include a brief work description and an estimate of the time duration of the work. A calendar shall be shown along the full length of each sheet. Each activity arrow shall be plotted so that the beginning and completion dates can be readily determined by comparison to the calendar scale. All activities shall be shown using symbols and/or color which clearly designate whether it is a critical path or non-critical activity. All non-critical path activities shall show estimated work time and free float time. Time shall be displayed at the top of the schedule, reading left to right, with no greater than weekly divisions.
 3. The schedule shall indicate dates for all important activities including:
 - a. Shop drawing submittals and reviews
 - b. Decisions
 - c. Product procurement and delivery
 - d. Beginning and completion of each element of construction
 - e. Critical coordination dates with Utility Companies, etc.
 - f. Submittal of Record Drawings and Equipment Manuals
 - g. Cleanup, Final Inspection, etc.
 4. Constraints between inter-related activities shall be shown.
 5. Where float time exists in activities, the activities shall be shown with early start/early finish times. Float time belongs to the Owner.
 6. The schedule shall include a title block with the project title, the Contractor's business name, the date of submittal or revision, and the signature of the Contractor's authorized representative.
 7. If the Contractor's progress has fallen behind the acceptable Construction Schedule, the Contractor shall take such steps as may be required, including but not limited to, increasing the number of personnel, shifts, overtime operations, days of work, and amount of construction equipment until such time as the work is back on schedule. All increased costs of any accelerated work program shall be paid for by the Contractor.

B. REVISIONS TO CONSTRUCTION SCHEDULE.

1. The Contractor shall submit a revised Construction Schedule by the third day of each month and within five days of the occurrence of any of the following:
 - a. When delay in completion of any activity or group of activities indicates an overrun of the Contract time or control point

requirement, by 10 working days or ten percent (10 percent) of the remaining duration, whichever is less.

- b. Delays in submittals, deliveries, or work stoppage are encountered which make replanning or rescheduling of the work necessary.
 - c. The schedule does not represent the actual prosecution and progress of the project as being performed in the field and progress for any activity is five working days behind the current schedule.
 - d. The Contractor will be performing work at an earlier date than is shown on the schedule and the work will require additional inspection and/or testing personnel.
- 2. Acceptance of the revised Construction Schedule and all supporting data is contingent upon compliance with other related requirements specified in the Special Conditions.
 - 3. The cost of revisions to the Construction schedule resulting from Contract changes will be included in the cost for the change in the work, and will be based on the complexity of the revision or Change Order, and the total cost of the change.
 - 4. The cost of revisions to the construction schedule not resulting from authorized changes in the work shall be the responsibility of the Contractor.

C. SCHEDULE OF VALUES.

- 1. In conjunction with the submittal of the Construction Schedule, the Contractor shall submit a cash flow projection indicating his estimated earnings by month during the entire contract period and a schedule of values of the work, using the attached form, or approved alternate, including quantities and unit prices. The aggregate of these extended prices shall equal the Lump Sum Contract Price. This schedule shall be satisfactory in form and substance to the Engineer and shall subdivide the work into the specified component parts. In addition, the schedule will be used as a basis for negotiating change orders. Upon approval by the Engineer, the schedule shall be incorporated into the form for Application for Payment, and shall become the basis for preparing monthly pay estimates.
- 2. Where so specified, a structure, system, or facility shall be broken down into components of work related to the Divisions of the Specifications. The cost for work specified in each Division shall be listed and the sum of the Division costs shall represent the total cost for such structure, system, or facility.

1.21 APPROVAL OF WORKING DRAWINGS

- A. The Contractor shall submit, in quadruplicate, to the Engineer for his approval such shop or working drawings and/or catalog cuts for fabricated items and manufactured items, including mechanical and electrical equipment, as may, in the

opinion of the Engineer be required for the construction of the work or any part thereof.

- B. Drawings shall be submitted sufficiently in advance to allow the Engineer not less than ten regular working days for examining the drawings.
- C. These drawings shall be accurate, distinct and complete and shall contain all required information, including satisfactory identification of items, units and assemblies in relation to the contract drawings and/or specifications.
- D. When the shop drawings are approved by the Engineer, two sets of prints will be returned to the Contractor. If changes or corrections are necessary, one set will be returned to the Contractor with such changes or corrections indicated by a brief statement and the Contractor shall correct and resubmit the drawings, in triplicate, when requested by the Engineer.
- E. The approval of such drawings and/or catalog cuts by the Engineer shall not relieve the Contractor from the responsibility for correctness of dimensions, fabrication details and space requirements, or for deviations from the contract drawings or specifications, unless the Contractor has called attention to such deviations in writing by a letter accompanying the drawings and the Engineer approves the change or deviations in writing at the time of submission; nor shall approval by the Engineer relieve the Contractor from the responsibility for errors in the shop drawings. When the Contractor does call such deviations to the attention of the Engineer, the Contractor shall state in his letter whether or not such deviations involve any deduction or extra cost adjustment.

1.22 MANUFACTURER'S DIRECTIONS

- A. All manufactured items, articles, materials, and equipment, shall be applied, installed, connected, erected, used, cleaned, and conditioned as directed by the manufacturer's written instructions, unless herein specified to the contrary.
- B. At the termination of the work, the Contractor shall submit three complete sets bound in the best grade, hard-backed binder of all operating and maintenance instructions presenting full details for care and maintenance of all visible surfaces and all mechanical and electrical equipment installed. The sets shall include the following information:
 - 1. Complete description of items including catalog numbers.
 - 2. Complete parts list for each item.
 - 3. Name and address of local supplier.
 - 4. Name and address of manufacturer.
 - 5. Complete operating instructions.
 - 6. Complete maintenance instructions.

1.23 EQUIPMENT AND MATERIALS SELECTION

- A. Equipment and materials specified by name in these specifications or on the plans have been investigated and found suitable for the service and/or construction conditions anticipated. However, names are given primarily as a guide; bidding is not intended to be restrictive only to the extent of obtaining equipment and materials which will properly and effectively do the job. Manufacturers of competitive equipment are invited to submit requests to the Engineer for permission to bid their equipment. Such requests must be received by the Engineer at least 2 days prior to the bid opening and must be complete with the information necessary to properly evaluate the ability of the alternate equipment to meet the requirements of the project. Information should include specification date, materials of construction, dimensions, performance curves and data, location of nearest representative and service personnel, and all other pertinent information. If alternative equipment or materials are approved, the Contractor shall, at his expense, make any changes in the structures, buildings, piping or other necessary to accommodate the alternate items.

1.24 ENGINEER

- A. Any reference in these specifications or on the plans to the "Engineer" shall be interpreted to mean "Horrocks", Consulting Engineers for the project. This may be a principal of the firm or an authorized representative.

1.25 INCIDENTAL WORK

- A. Work which is intended or required, whether described and detailed specifically in these specifications or not, but which is required to complete the work shall be paid for by the Contractor. Cost for incidental work shall be included in unit prices or lump sums bid according to the Bid Schedule.

1.26 GUARANTEE PERIOD

- A. Should any defect arise with the work such as leaks, breaks, etc., for a period of one (1) years from the date of project acceptance, the Contractor shall restore the work to the complete satisfaction of the Owner at the expense of the Contractor.
- B. In the event of settlement of trenches or excavated areas for a period of one (1) years after written acceptance of the work, the Contractor shall restore the work in accordance with these Specifications including importing select backfill, grading of trench areas and/or replacement of pavement to the satisfaction of the Owner.
- C. Performance bonds shall remain in full force and effect until expiration of the guarantee period and written release by the Owner.

1.27 COMPLIANCE WITH GOVERNMENTAL REGULATIONS

- A. The Contractor's equipment and operations shall comply fully with all applicable standards, regulations and requirements of existing Federal, Utah State and Local

governmental agencies. This shall include, but not necessarily be limited to, the following:

- B. UTAH OCCUPATIONAL SAFETY AND HEALTH ACT (1973) and EMPLOYER-EMPLOYEE SAFE PRACTICES FOR EXCAVATIONS AND TRENCHING OPERATIONS (Jan. 1, 1974) as published by Industrial Commission of Utah, including any and all amendments or revisions effective prior to performance of the work.
- C. In compliance with Section 34-30-1 and as revised in 71-10-1 of the Utah Code, in employing individuals to perform work under this contract, the contractor shall give preference to citizens of the United States or those having declared their intention of becoming citizens. If the contractor fails to comply with the requirements of Section 34-30-1 of the Utah Code, this contract shall be void.
- D. In compliance with Section 34-30-11 of the Utah Code, in employing individuals for work under this contract, the contractor shall give preference to honorably discharged veterans and unremarried surviving spouses of honorably discharged veterans, provided that such veterans or surviving spouses are qualified for the employment position and are residents of the State of Utah

1.28 UNEMPLOYMENT INSURANCE

- A. In addition to insurance elsewhere specified, the Contractor shall secure and maintain UNEMPLOYMENT INSURANCE to cover all persons he employs on the project.

1.29 EXAMINATION OF THE SITE

- A. The Bidder shall examine the site before submitting his proposal and inform himself regarding existing facilities and conditions affecting the proposed work. Failure to make such inspection shall in no way relieve the Contractor of any of the obligations or conditions of this specification or serve in any way as a basis for extra enumeration to the Contractor for conditions arising from unfamiliarity with the site or conditions affecting the work.

1.30 CONTRACT LIMITS

- A. "Qualified" or "All or nothing" type bids may be rejected by the Owner.
- B. The Contractor agrees that no additional compensation is due above and beyond what is represented in the Bid, whether optional bid items are included in the award of the project or not.
- C. Upon award of Contracts to more than one Contractor, it shall automatically become binding upon each Contractor or Subcontractor to coordinate his work with the other Contractor or Subcontractors. Each Contractor agrees, that upon signing a Construction Contract with the Owner, he will assume the responsibility of coordinating his part of the work with other Contractors, and that he will make no

charges against the Owner for delays resulting from lack of coordination and/or scheduling.

1.31 CONSTRUCTION SCHEDULING AND COMPLETION TIME

- A. The Contractor shall schedule his work in a manner to provide minimal disruption to all utilities and users on those systems, to the general public, and to neighboring property owners.. The Contractor shall propose an acceptable method of completing this task in the construction schedule.

1.32 LIQUIDATED DAMAGES

- A. If the work is not completed in accordance with the above schedule, the Contractor shall pay to the Owner, as fixed and agreed liquidated damages, the sum of \$2000 for each consecutive calendar day after the scheduled completion date.

1.33 INSPECTIONS

- A. The Contractor shall keep the Engineer informed a reasonable time in advance of the times and places at which he intends to do work in order that lines and grades may be furnished, that inspection may be provided, and that necessary measurements for record and payment may be made with the minimum of inconvenience to the Engineer or of delay to the Contractor. Prior to inspection the Contractor shall check his work to assure that quality and tolerances of work specified have been met.
- B. Prior to the construction of any phase or portion of work that will be a finished product, an inspection will be performed by the Engineer and the Engineer or his agent will sign an inspection report indicating location, time, date and any changes from the plans, that the Contractor is in compliance with the plans and specifications at this phase or portion of the work. If the Contractor's work is found not to be in compliance, corrections shall be made and the Engineer shall make another inspection.

1.34 PROJECT RECORD DOCUMENTS

- A. The Contractor shall maintain at the site, available to the Owner and Engineer, one copy of all Drawings, Specifications, Addenda, accepted Shop Drawings, Change Orders, and other modifications in good order and marked to record all changes made during construction. These shall be delivered to the Engineer for the Owner upon completion of the Project.

1.35 EXISTING SERVICE TO PROPERTY OWNERS

- A. Existing water service and access to all property owners shall be maintained and be uninterrupted as is possible.
- B. Before connections that require disruption of the water supply to all or part of the system users are made, 24 hour notice must be given to the Engineer and affected users. Disruptions shall not exceed 6 hours in length of time. Major disruptions,

as defined by the Engineer shall only be made between the hours of 11 p.m. and 5 a.m.

1.36 SUSPENSION OF WORK

- A. The Engineer shall have the authority to suspend the work wholly or in part, for such period as he may deem necessary, due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the work, or for such time as he may deem necessary due to the failure on the part of the Contractor to carry out orders given, or to perform any provisions of the Contract. The Contractor shall immediately comply with the written order of the Engineer to suspend the work wholly or in part. The suspended work shall be resumed when conditions are favorable and methods are corrected, as ordered or approved in writing by the Engineer.
- B. In case of suspension of work, the Contractor shall be responsible for all materials and shall properly store them as necessary.

1.37 CHARACTER OF WORKMEN

- A. Whenever, in the opinion of the Engineer any superintendent, foreman, or workman employed by the Contractor or his subcontractor is disrespectful, intemperate, disorderly, or otherwise objectionable, he shall, at the written request of the Engineer, be removed and not again be employed on the work without written consent of the Engineer.
- B. Convict labor shall not be used in State-assisted construction unless it is labor performed by convicts who are on work release, parole, or probation.

1.38 SANITARY FACILITIES

- A. The Contractor shall provide suitable chemical toilets or water closets at points acceptable to the Engineer for use of employees on this work. At the end of the job such toilets shall be removed completely.

1.39 PROTECTION OF ANTIQUITIES

- A. Attention is called to State and Federal laws pertaining to the protection and preservation of sites or objects of archeological, paleontological, or historic interest.
- B. It is a provision of this contract and shall be a provision of every subcontract that when features of archeological, paleontological, or historic interest are encountered or unearthed in material pits, the roadway prism, or other excavation the contractor shall stop work in the immediate vicinity of such feature, protect it from damage or disturbance, and report promptly to the state and local officials having jurisdiction.
- C. Work shall not be resumed in the immediate area until the contractor is advised by the authorities having jurisdiction that study and/or removal of the feature or

features has been completed. The contractor will be allowed an appropriate contract time extension as provided in the GENERAL CONDITIONS for construction time lost.

1.40 DUST CONTROL/PROJECT CLEANUP

- A. During the performance of work required by these specifications, or any operations appurtenant thereto, and whether on rights-of-way provided or elsewhere, comply with applicable Federal, State, and local laws and regulations, regarding the prevention, control, and abatement of dust pollution. Should a conflict exist in the requirements for dust abatement, the most stringent requirement shall apply. The Contractor is responsible for all damages resulting from dust originating from any construction operations under these Specifications.
- B. The Contractor shall provide all labor, equipment, and materials, and shall use efficient methods wherever and whenever required to prevent dust nuisance or damage to persons, property, or activities, including, but not limited to, crops, orchards, cultivated fields, wildlife habitats, dwellings and residences, agricultural activities, recreational activities, traffic and similar conditions. This will primarily consist of periodic watering of equipment staging areas and dirt roads used during construction. Methods of mixing, handling, and storing cement, pozzolan, and concrete aggregate shall include means of eliminating atmospheric discharges of dust.
- C. The Engineer has authority to stop any construction activity contributing to dust levels which are excessive or in violation of Federal, State, or local laws. All expenses resulting from such a work stoppage is the responsibility of the Contractor.
- D. Throughout the period of construction keep the work site free and clean of all rubbish and debris, and promptly remove from any portion of the site, or from property adjacent to the site of the work and properly dispose of, all unused materials, surplus earth and debris, excepting select material which may be required for refilling or grading. Comply with applicable Federal, State and local laws and regulations. Should a conflict exist in the requirements for cleanup and disposal of waste materials, the most stringent requirement shall apply. Roads shall be swept prior to completing each days construction activities by sweeping or other approved method.
- E. Contractor progress cleaning program will include using sweeper with vacuum truck as necessary to keep the streets clean. The OWNER or ENGINEER reserves the right to shut down the CONTRACTOR with no extension of time or cost to the contract if in their opinion the project progress cleaning is not being done satisfactorily.
- F. Upon completion of the work and prior to final acceptance of the project the Contractor shall remove from the vicinity of the completed work and properly dispose of all plant and other waste, surplus material, and equipment belonging to him or used under his direction during construction.

1.41 NOISE LEVELS IN THE CONSTRUCTION AREA

- A. Comply with applicable Federal, State, and local laws, orders, and regulations concerning the prevention, control, and abatement of excessive noise. The Contractor will monitor construction noise levels and will take corrective action if noise levels are greater than 85 dBA within the construction area.
- B. The location of “sensitive receptors” such as schools, churches, nursing homes, and residential areas will be considered when scheduling construction activities with significant noise levels, and in siting temporary and stationary post-project noise emission sources.

1.42 DRAINAGE CONTROL

- A. In excavation, fill, and grading operations care shall be taken to disturb the pre-existing pattern as little as possible. Particular care shall be taken not to direct drainage water onto private property or drainage ways inadequate for the increased flow.

1.43 TRAFFIC SAFETY SUPERVISOR

- A. The Contractor shall assign one person to be a traffic safety supervisor. The person’s primary responsibility shall be to ensure that traffic signals, signs, barricades, and any other traffic control devices are placed, moved, and maintained as needed. Refer to Section 015526.

1.44 COMPLIANCE WITH ENVIRONMENTAL REGULATIONS

- A. Comply with applicable Federal and State laws, orders, and regulations concerning the control and abatement of water pollution. This includes the following federal and state standards for water pollution control.
 - 1. UPDES Permits
 - a. Discharge of wastewater or other pollutants, as a result of construction activities, into navigable waters in Utah, requires a 402 or UPDES permit defined under Section 402 of the Clean Water Act, Public Law 92-500, as amended by Public Law 95-217. The UPDES permit process is administered by the State of Utah, Utah Department of Environmental Quality (UDWQ), Division of Water Quality, 288 North 1460 West, Salt Lake City, Utah 84116, (801) 538-6146.
 - b. Submit a Notice of Intent (NOI) to comply with the Federal Clean Water Act, Section 402 UPDES General Permit during the construction of the Project relating to discharges of groundwater from dewatering activities. The NOI shall be for groundwater discharge under the State of Utah general groundwater discharge permit. The Contractor shall complete any project specific permit applications and other requirements specified by UDWQ and obtain any project specific UPDES permits. No construction dewatering

may be performed until the project specific UPDES permit is obtained. The Contractor shall abide by the conditions and standards required by the UPDES General Permit and any UPDES project specific permit during all phases of construction. Sampling and testing of groundwater will be performed by the Owner up to once daily. The Contractor will be responsible for all other requirements, except that if treatment is required for any parameter besides total suspended solids (TSS) this treatment shall be negotiated with the Owner.

- c. Submit a Notice of Intent (NOI) to comply with the Federal Clean Water Act, Section 402 UPDES General Permit during the construction of the Project relating to discharge of storm water from Construction Activities. Prepare a Storm Water Pollution Prevention Plan (SWPPP) as required by the permit. Comply with all terms and conditions to obtain and maintain this general permit. Provide all monitoring and water treatment, if necessary, to achieve compliance with applicable Water Quality Standards, and shall provide the record keeping required by the general permit associated with construction activity.
2. Turbidity and pH Control – Turbid wastewater resulting from aggregate processing, excavation, dewatering, and other construction activities shall be treated prior to discharge into any watercourse by the use of methods approved by the Construction Manager and UDWQ. No discharge of human waste will be allowed; portable toilets shall be provided by the Contractor for workers. The portable toilets shall be serviced on a regular basis.
- a. Construction Activities. Excavation, road construction, stream diversion activities, and all other construction activities shall be conducted in a manner to prevent muddy water and eroded materials from entering other streams and rivers and tributaries, any watercourse, canal, ditch or storm drain facility by the construction of intercepting ditches, barriers, settling ponds, or other approved means. Provide sumps, pumps, and associated facilities, as described in Water Quality Management Plan. Excavated materials will be hauled to a storage area on the pipeline or canal alignments, out of the floodplain and not within 25 feet (7.6 meters) of wetlands. When necessary to perform required construction in the stream channel or in flowing water, such work will be conducted during periods of low flow. Work in the stream channel shall be scheduled and completed in the shortest practicable time period.
- Mechanized equipment shall not operate in flowing water except as necessary to construct crossings or to perform the construction. Such work shall be approved by the Engineer prior to the equipment entering a stream or other water body.
- The Contractor's methods of dewatering and stockpiling earth shall include preventive measures to control silting and erosion and to intercept any runoff originating in construction areas.

-
- b. Construction Wastewater. Construction wastewater resulting from materials processing, placement of concrete, dewatering, excavations, drainage at the excavated material disposal and storage sites, drainage water from constructing water control equipment, waste sludge, the cleaning of heavy equipment used in construction, and other construction operations shall be conveyed to the treatment facility prior to the discharge to waters of the United States, or to any storm drain collection system. Any such discharge of wastewater shall be treated by use of the proposed treatment facility described in this document. The Contractor may propose an alternative method of wastewater treatment. Alternative methods must be approved by Owner and UDWQ and shall be fully described in the Contractor's Storm Water Pollution Prevention Plan (SWPPP). All discharge shall be in compliance with the Federal Clean Water Act, Section 402 UPDES General Permit.

The acceptable water treatment method furnished shall have a minimum capacity to (1) treat up to a minimum of 5 cubic feet per second (cfs) (0.14 cubic meter per second) of wastewater, (2) be able to reduce the turbidity in the effluent to no more than 10 NTU over background levels of the receiving water, (3) be able to maintain a pH of the effluent between 6.5 and 9.0, and (4) be able to remove accumulations of oil or other petroleum products from the wastewater to a level of 10 parts per million (milligrams per liter).

Flows from the dewatering operation may require holding ponds to provide the necessary detention period. If construction wastewater can be contained in ponds or other holding facilities and allowed to seep into the ground or evaporate, then no treatment will be necessary.

The pond dikes shall be constructed of impervious materials and adequately compacted with 2 feet of freeboard to provide protection from accidental discharges. The location, size, and method of construction of ponds shall be submitted to the Engineer and the UDWQ as part of the Water Quality Management Plan. Construction of the ponds shall not commence until receipt of approval.

Any turbidity control methods shall be provided with bypass equipment to discharge clear wastewater flows to the stream if such water has turbidity levels less than 10 NTUs above background level of the receiving water and a pH value between 6.5 and 9.0. The decision to bypass water treatment facilities shall be subject to approval by the Engineer and UDWQ as provided in the UPDES permit.

All chemicals used for treating wastewater must be approved by the EPA for use in potable water. Also, the types and amounts of chemicals used in any approved method for the control of turbidity or pH shall not cause the effluent to be toxic or in any way harmful to terrestrial wildlife or aquatic life.

Skim and properly dispose of any oil or other petroleum product on any settling pond when an oil film on the surface of any pond covers more than one-third of the surface area of the pond. When sludge or settled materials in ponds accumulate so as to impair the effectiveness of the facilities, the materials shall be removed and transported to a waste disposal area.

Satisfactorily operate any wastewater treatment facilities such that they provide effluent that meets required UPDES permit limitations. The approval of the Contractor's proposal by the Engineer shall not be construed to relieve the Contractor from this responsibility. The Contractor shall repair, at his expense, any damage to or failure of the facilities and equipment caused by floods or storm runoff.

Should the wastewater discharge exceed a turbidity measurement (10 NTUs), or the pH limitations, or limitations on oil and grease within the general UPDES permit, the Construction Engineer will have the authority to immediately halt the discharge from the facilities until the effluent meets the limitations of the UPDES permit.

B. Stream Alteration Permit

1. A stream alteration permit if required for this project, will be furnished by the Owner.

C. Spill Prevention Control and Countermeasure (SPCC) Plan

1. Where the location of a construction site is such that inadvertent spills of petroleum or other toxic substances could reasonably be expected, a SPCC plan will be developed. These areas shall include, but not be limited to, fuel storage sites, equipment maintenance areas, and equipment fueling and lubricating sites.
2. The SPCC plan shall include as a minimum the following:
 - a. Agency Notification Requirements. A listing of persons and/or offices to be notified immediately following an oil spill together with the appropriate telephone numbers. The following agencies and/or individuals shall be included in that list:

Utah Department of Environmental Quality
Division of Environmental Response and Remediation
289 North 1950 West
Salt Lake City, Utah (801) 538-6146
24-hour Emergency Phone: (801) 536-4123

Environmental Protection Agency
Attn: Water Management Division
999 18th Street, Suite 500
Denver, Colorado 80202-2466
24-hour Emergency Phone: (800) 424-8802

(Failure to notify EPA of an accidental spill within 24 hours of its occurrence may result in the levying of a fine against the responsible party.)

U.S. Fish and Wildlife Service
145 East 1300 South, Suite 404
Salt Lake City, Utah 84115
(801) 524-5001

After hours contact National Response Center (800)424-8802

3. Spill Prevention Measures. Spill prevention measures shall include the following:
- a. A site plan indicating oil fuel storage areas, refueling areas, and other areas where oil and other petroleum products would be used or handled. The site plan will also show the distance to all watercourses (perennial or intermittent) or other bodies of water where oil could be directly or indirectly spilled. Oil and fuel storage areas and refueling areas shall not be located within the 200-foot (61 meter) buffer zone of any live or dry watercourse. No petroleum products (gasoline, oils, hydraulic fluid, lubricants, etc.) shall be stored within the area of construction or materials marshaling areas. Use a vehicle designed for refueling and lubricating construction equipment. During refueling, lubricating, and other maintenance, construction vehicles and equipment shall be moved at least 200 feet (61 meter) from the edge of any live or dry watercourse.
 - b. The plan shall include appropriate containment methods to prevent oil or other petroleum products from reaching any watercourse. At a minimum, the preventive system shall include:
 - 1) No oil, oil storage areas, or areas for refueling equipment will be located in construction and materials storage areas.
 - 2) Refueling and lubricating of equipment will be performed by a vehicle designed for this activity.
 - c. The plan shall include a complete discussion of conformance with the following guidelines:
 - 1) Job-site drainage system shall flow into ponds, lagoons, or other catchment basins that are not subject to periodic flooding and engineered to prevent oil from reaching any watercourse or adjacent shorelines in the event of equipment failures or human error.
 - 2) All oil or fuel leaks from equipment shall be promptly cleaned up.
 - d. Contingency and Countermeasures. In the event of an oil spill into a watercourse, other body of water, or adjacent shorelines of watercourses, contingency and countermeasures shall include as a minimum the following:

-
- 1) A commitment of manpower, materials, and equipment to expeditiously control and remove the spilled oil or fuel.
 - 2) A commitment to place all available manpower, materials, and equipment into immediate use to cleanup and restore the affected watercourses and their adjoining shorelines.
 - 3) A sampling-monitoring program to document the effectiveness of the spill cleanup program. Proper sampling equipment, sampling procedures, and name of the certified laboratory analyzing the samples shall be included.
- e. Sanitation and Potable Water Requirements. Provide portable toilets for workers. No discharge of human wastewater shall be allowed. Provide potable water for workers.
- 1) Prepare a Pollution Prevention Plan as required by the permit. Comply with all terms and conditions to obtain and maintain this general permit.
 - 2) Provide all monitoring and water treatment, if necessary, to achieve compliance with applicable Water Quality Standards, and provide the record keeping required by the general permit associated with construction activity.
- D. Water Quality Management Plan – Prepare a Water Quality Management Plan which shall include, but not be limited to, the following:
- 1. Identification of a Pollution Control and Water Quality Coordinator responsible for implementing the control measures in the management plan.
 - 2. Treatment of nonpoint discharges:
 - a. A list of materials, machinery, and manpower available for erosion control. Erosion control materials may include bales of straw, dikes, riprap, gabions, culverts, pipe, sandbags, gravel, plastic, and flexible downdrains. Quantities of material and equipment shall be included.
 - b. Site-specific control plan for:
 - 1) contractor's camps, yards, and all work areas
 - 2) equipment washing areas
 - 3) fueling
 - 4) excavated material storage areas and waste disposal areas
 - 5) stream diversion
 - c. Methods for diversion and care of stream during construction:
 - 1) projected schedule for all work in streams
 - 2) identification and location of stream diversion structures such as cofferdams and dikes

-
- 3) sources of materials for stream diversion structures
3. Treatment of point discharges:
- a. Methods for treatment of water used and/or encountered during construction.
 - b. Proposed plan for water treatment facilities including:
 - 1) location, capacity, size, and method of constructing ponds and water conveying system
 - 2) complete design and construction details of the water treatment plant, if proposed
 - 3) arrangement for the turbidity and pH control structures
 - 4) method for conveying untreated water to the control structures or treatment plant and water from these facilities to the authorized discharge point
 - 5) method of storing and disposing of sludge, settling pond residue, or backwater residue accumulation
 - 6) description of chemicals to be used in the water treatment facilities
 - 7) methods of handling and disposing of oil and other petroleum products, chemicals, and similar industrial wastes collected within the treatment facility
 - 8) other salient features
4. Monitoring Program. A complete description of a daily and weekly water quality monitoring program developed to meet the UPDES permit requirements.

1.45 TEMPORARY ACCESS ROADS AND BORROW AREAS

- A. Except for those access roads and borrow areas specifically covered in these specifications, the approval of the Engineer must be obtained in advance before locating additional access roads or borrow areas on any land. Mark on the ground proposed locations for approval by the Engineer in advance of construction.
- B. Temporary access road. To prevent excessive erosion, no grades in excess of 8 percent shall be used, except those which are approved in writing by the Engineer. Generally, back slopes of cut banks shall be stable and compatible with existing topography, except where rock is encountered and such slopes shall be flattened and rounded into the natural ground surface so far as practicable. Suitable devices and drainage structures shall be installed in sufficient number to prevent accumulation of excessive water and erosion of the road surface, drainage ditches, and scarred areas.
- C. Borrow areas for temporary access roads. Borrow areas shall be treated as follows: Topsoil shall be stripped from the excavated areas and deposited in storage piles apart from other excavated material. After the desired amount of

material has been removed, evenly grade and properly slope the sides and bottom of all borrow pits, as directed by the Construction Manager. Tracks or marks of heavy equipment or other disturbed earth shall be smoothed or filed to the surrounding level. After the pit has been graded and properly sloped, the stored topsoil shall be evenly spread over the subsoil exposed by the excavation. All materials unsuitable for construction purpose shall be disposed of as directed by the Engineer.

- D. Certain areas are reserved for recreational development. These areas are marked on the ground or indicated on drawings or maps. Do not operate mechanized equipment or vehicles within these restricted areas without written authorization from the Engineer. The Contractor is responsible for all restoration costs and all damages resulting from any unauthorized operations within these areas.

1.46 SPECIAL INSURANCE REQUIREMENTS

- A. Utah Department of Transportation (UDOT) – Contractor will be required to obtain an Encroachment Permit from UDOT for the work in 14600 South, I-15, Minuteman Drive, and Pony Express Road. All insurance required as part of the Encroachment Permit shall be provided at Contractor's expense.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

END OF SECTION

SECTION 01 10 00 – SUMMARY OF WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Provide the work of this Section in accordance with requirements of the Contract Documents.
- B. This Section includes but is not limited to:
 - 1. Project information
 - 2. Work covered by Contract Documents
 - 3. Phased construction and additional packages of Work
 - 4. Work by Owner
 - 5. Future work
 - 6. Purchase contracts
 - 7. Owner-furnished products
 - 8. Contractor-furnished, Owner-installed products
 - 9. Access to site
 - 10. Coordination with occupants
 - 11. Work restrictions
 - 12. Special security requirements
 - 13. Specification and drawing conventions
 - 14. Referenced Standards, Codes, and Criteria
 - 15. Miscellaneous provisions
 - 16. Miscellaneous Provisions
 - 17. Mechanical and Electrical Requirements of General Work
 - 18. Permits and Responsibilities

1.2 RELATED SECTIONS

- A. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 REFERENCES Not Used

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS Not Used

1.6 PROJECT INFORMATION

- A. Project Identification: The Point – Site Infrastructure Master Civil Design, Package 03 – Culinary Water Transmission Line
 - 1. Project Location: 14727 South Minuteman Drive, Draper, UT 84020
- B. Owner: Division of Facilities Construction and Management, 4110 State Office Building, Salt Lake City, Utah 84114
 - 1. Owner's Representative: Mike Ambre
- C. Engineer: Horrocks, 2162 W Grove Parkway, Suite 400, Pleasant Grove, Utah 84062
- D. Program Manager: Horrocks 2162 W Grove Parkway, Suite 400, Pleasant Grove, Utah 84062

1.7 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
 - 1. Construction of a 16-inch and 30-inch ductile iron pipelines and 48-inch steel casing under I-15 Work generally consists of excavation, boring, shoring, piping, site work, and associated appurtenances.

1.8 WORK BY OWNER

- A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.

1.9 WORK UNDER SEPARATE CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this

Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

1.10 ACCESS TO SITE

- A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
 - 1. During period of construction, the Owner will continue to perform normal activities in and adjacent to the Project Work areas. Contractor shall provide proper and safe access to the Owner-occupied areas at all times.
- B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 - 1. Driveways, Walkways and Entrances: Keep driveways serving premises clear and available to all other parties on the construction site, including emergency vehicles. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
 - 2. Contractor Parking: Limit vehicle parking for Contractor and construction personnel to locations indicated on the Drawings.
- C. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

1.11 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
- B. Controlled Substances: Use of controlled substances on Project site is not permitted.
- C. Employee Screening: Comply with Owner's requirements for drug screening of Contractor personnel working on Project site.
- D. Maintain list of approved screened personnel with Owner's representative.
- E. Contractor shall:
 - 1. Not unreasonably encumber site with materials and equipment.
 - 2. Not load structure with weight that will endanger structure.

3. Make deliveries of construction materials, equipment, supplies and similar products and make removals at the area designated by the Owner's Representative.
4. Assume full responsibility for protection and safekeeping of stored products.
5. Move stored products that interfere with operations of Owner and other contractors.
6. Obtain and pay for land required for additional storage or work areas to supplement on-site operations.
7. Cooperate with other contractors and coordinate Work with work under separate contracts, including access to the Work.

1.12 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.13 REFERENCED STANDARDS, CODES, AND CRITERIA

- A. Except as otherwise specified in the Contract Documents or otherwise directed by the Owner, references to standards, codes, or criteria, or to the latest version of

standards, codes, or criteria, shall mean the latest version in effect at the time of advertisement of the Contract.

- B. Adhere to the standard with the most stringent requirement when the Contract Documents conflict with a Referenced Standard, Code, or other Criteria.

1.14 MISCELLANEOUS PROVISIONS

- A. Construction Fence: Enclose active work areas, including staging areas, with a chain link fence as specified in Division 01 Section "Temporary Facilities and Controls." Maintain existing fencing boundaries along the roadway to prohibit the movement of wildlife and livestock. Provide in accordance with layout of construction limits shown on drawings. Maintain separate gates for personnel and vehicles. Provide locks for gates and hold under strict security control, locking gates at end of each working day.
- B. Construction Site Security: Provide maintenance and cleaning of entire construction site on a daily basis. Secure all construction equipment, machinery and vehicles, park and store only within fenced area, and render inoperable during non-work hours. Contractor shall assure that no construction materials, tools, equipment, machinery or vehicles can be used for unauthorized entry or other damage or interference to activities and security of existing facilities adjacent to and in the vicinity of construction site.
- C. Construction Site Lighting: During construction activities in darkness, provide area lighting for construction site, furnishing 1.5 footcandles of illumination at ground level. Provide 5.0 foot-candles of illumination at all gates and entrances to temporary buildings and new structures under construction. Make provisions for operation of lighting during power failures and include automatic re-start. Shield lighting to block glare from penetration into adjacent properties.
- D. Traffic Control: Posted speed limits and driving regulations will be strictly enforced by the Owner. The Owner reserves the right to take any action deemed appropriate regarding violations including, but not limited to, refusal to permit violators to enter upon or remain on the premises.
 - 1. Escort appropriately to and from the site all large crawler or mobile cranes operating on site and take all precautions necessary to prevent damage to the Owner's property during operation both on and off site.
 - 2. Obtain advance written authorization from authorities having jurisdiction for all road blocks, detours and other interruptions of normal traffic flow that may be needed to facilitate construction operations.

1.15 MECHANICAL AND ELECTRICAL REQUIREMENTS OF GENERAL WORK

- A. Electrical Requirements: Except as otherwise indicated, comply with applicable provisions of the National Electrical Code (NEC) and standards by National

Electrical Manufacturer's Association (NEMA), for electrical components of general work. Provide Underwriters Laboratories listed and labeled products where applicable.

1.16 PERMITS AND RESPONSIBILITIES

A. Permits: The Contractor shall, without additional expense to the Owner, be responsible for obtaining any necessary licenses, fees, inspections, and permits, and for complying with any federal, and municipal laws, codes, and regulations applicable to the performance of the work. The Contractor shall also be responsible for all damages to persons or property that occur as a result of the Contractor's fault or negligence, and shall take proper safety and health precautions to protect the work, the workers, the public, and the property of others. The Contractor shall also be responsible for all materials delivered and work performed until completion and acceptance of the entire work, except for any completed unit of work which may have been accepted under the contract.

B. Permits: The Contractor shall, without additional expense to the Owner except as noted below, be responsible for obtaining any necessary licenses, fees, inspections, and permits, and for complying with any federal, and municipal laws, codes, and regulations applicable to the performance of the work. The Contractor shall also be responsible for all damages to persons or property that occur as a result of the Contractor's fault or negligence, and shall take proper safety and

health precautions to protect the work, the workers, the public, and the property of others. The Contractor shall also be responsible for all materials delivered and work performed until completion and acceptance of the entire work, except for any completed unit of work which may have been accepted under the contract.

1. The Owner shall obtain and shall pay for the following for work included in the Contract Documents:
 - a. Building and Site Plan review fees
 - b. Floodplain Development Permit
 - c. USACE Section 404 Permit
 - d. Site and Building permits
 - e. UPDES Storm Water General Permit
2. The Contractor shall obtain and pay for the following:
 - a. Subcontractor's Trade Permits
 - b. All temporary utility costs, including but not limited to electrical, water, gas, and telephone. This specifically includes service to the Owner's and Contractor's trailer facilities
 - c. Communication service installation
 - d. Trailer permit

- e. All other construction related costs, except as noted above
- C. The Contractor shall not load or permit any part of the construction or site to be loaded so as to endanger its safety.
- D. The Contractor shall, without additional expense to the Owner, provide monetary deposits for the prosecution of the work, if required.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

END OF SECTION

SECTION 01 14 00 – WORK RESTRICTIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Limitation of Operations.
- B. Load Restrictions

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES Not Used

1.4 DEFINITIONS

- A. Holidays

Holiday Categories	
Category I	Category II
Martin Luther King, Jr. Day	New Year's Day
Presidents' Day	Memorial Day
Columbus Day	Independence Day
Veterans Day	Pioneer Day
	Labor Day
	Thanksgiving Day
	Christmas Day

Holidays that fall on a Saturday will recognize both the preceding Friday and the Saturday as holidays. Holidays that fall on Sunday will recognize both the Sunday and the following Monday as holidays.

- a. **Category I Holiday** – Holiday typically worked by Contractors.
- b. **Category II Holiday** – Holiday typically not worked by Contractors.

1.5 SUBMITTALS Not Used

1.6 LIMITATION OF OPERATIONS

- A. Minimize interference with traffic during performance of the work.
- B. UDOT MOT
- C. Sunday and Category I Holiday Work

1. Provide advance notice to the Engineer no later than noon on Wednesday, or four calendar days prior, whichever is greater before any Sunday or Category I holiday work, unless otherwise restricted in the contract.

D. Category II Holiday Work

1. Do not perform any work without approval except for repairing or servicing equipment, protecting work, maintaining or curing concrete, and maintaining traffic on Category II holiday.
2. Provide notice to the Engineer no later than noon on the Wednesday, or four calendar days prior, whichever is greater before any Category II holiday work, unless otherwise restricted in the contract.

E. Night Work

1. Notify the Engineer at least five calendar days before starting night work.
2. Provide adequate lighting for safely performing satisfactory inspection and construction operations.
3. Control noise.

1.7 LOAD RESTRICTIONS

- A. Observe legal load restrictions when hauling equipment or materials on public roads beyond project limits.
 1. A special permit does not relieve the Contractor of liability for damage.
- B. Do not exceed legal gross weight limits on any public roads, structures, or on any component of the pavement structure excluding granular borrow.
- C. Suspend construction operations when load restriction violations are observed until the Engineer authorizes corrective measures.
- D. The Engineer contacts the appropriate law enforcement agency if overweight load violations are suspected when public roads are used to haul any type of excavation, borrow, backfill, base, or surfacing material.
- E. Comply with the following for materials imported to the job site such as asphalt, cement, concrete, or steel:
 1. Provide the Engineer with invoices showing the gross and net load weights.
- F. The Department withholds payment for material used in the project if invoices are not provided.

PART 2 - PRODUCTS **Not Used**

PART 3 - EXECUTION **Not Used**

END OF SECTION

SECTION 01 22 00 – MEASUREMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Measuring and calculating pay item quantities.

1.2 RELATED SECTIONS

- A. Section 01 71 23 – Survey

1.3 REFERENCES

- A. Utah Code
- B. U.S. Bureau of Standards

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS Not Used

1.6 QUANTITY MEASUREMENT

- A. General
 - 1. The Department uses nominal weights and dimension, and industry-manufacturing tolerances unless otherwise specified
 - 2. The Department measures and determines quantities of material furnished and work performed according to the measurement and payment section of the contract.
 - 3. The Department identifies standard manufactured items by gauge, unit, weight, or section dimensions.
- B. Plan Quantity
 - 1. The calculated quantity in the Bidding Schedule is the quantity for which payment will be made.
 - 2. An adjustment to the final quantity for payment may be made if an error is discovered in the calculated quantity by either the Department or the Contractor. Refer to Section 00 99 00.
 - a. Provide all computations, plots, and supporting documentation necessary for the Engineer to verify the error and determine the final quantity for payment.
 - 1) Work required to provide computations, plots, and supporting documentation may be paid for as new work

when the final quantity differs from the calculated quantity by more than 10 percent.

- b. The Engineer may adjust the final quantity for payment by the amount of increase or decrease to the calculated quantity in the Bidding Schedule based on provided supporting documentation.

C. Lump Sum or Each

- 1. The Department measures the complete structure or structural unit, signal or lighting system, or other items of work specified in the Bidding Schedule to be measured by lump sum or each to include all necessary work, fittings, and accessories for a complete unit or system.
- 2. "Lump sum" or "each" includes all resources necessary to complete the work.

D. Length

- 1. Items measured by length are measured parallel with the base or foundations upon which the items are placed.
- 2. The term "station" is 100 linear feet when used as a definition or term of measurement.

E. Area

- 1. The Department uses horizontal longitudinal and plan (neat) transverse measurements unless otherwise specified.

F. Volume

- 1. The Department measures items using plan (neat) dimensions, or altered dimensions when approved by the Engineer to fit field conditions.
- 2. The Department uses average end area or computer generated Digital Terrain Model (DTM) method for computing volumes.
- 3. Materials specified to be measured by volume may be converted to unit weight for payment purposes when approved.
 - a. Obtain approval for all factors for conversion from volume to weight before using this method of measurement.

G. Weight

- 1. The term "ton" means 2,000 pounds avoirdupois.
- 2. Measure aggregate weight in the saturated surface dry condition.

H. Alternative methods of measurement

- 1. Refer to Section 01 71 23 Survey.

1.7 WEIGHING REQUIREMENTS AND PROCEDURES

- A. Weigh all materials that are measured or proportioned by weight, or contract items measured by the ton, such as aggregates and asphalt materials, on scales that have been approved, certified, and that meet specification requirements.
 - 1. Obtain certified haul truck tares at times as determined by the Engineer and place a legible identification mark on each truck.
 - 2. The Department may return to be reweighed any loads that appear to be deficient or questionable.
- B. Furnish, erect, certify, and maintain, or use permanently installed and certified commercial scales for weighing highway and bridge construction materials that are required to be proportioned or measured and paid for by weight.
 - 1. Scales must be accurate within the limits set by the laws of the State of Utah and meet requirements of the U.S. Bureau of Standards.
 - 2. Scales must bear a current seal of acceptance from the State of Utah Department of Agriculture, Division of Weights and Measures.
 - 3. Have the Utah State Department of Agriculture Division of Weights and Measures inspect and seal all scales at least once a year and after each setup before use, or as requested by the Engineer.
 - 4. Install and maintain platform scales with rigid bulkheads at each end. The platform must be level.
 - a. Platform scales must be of adequate size and capacity so the entire power unit and hauling unit can be weighed at the same time.
 - 5. Physically arrange electronic, beam, dials, platform, and other scale equipment for convenient and safe viewing by the operator and inspector.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

END OF SECTION

SECTION 01 29 00 – PAYMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Scope of Payment.
- B. Fuel Cost Adjustment.
- C. Asphalt Cost Adjustment.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES Not Used

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS Not Used

1.6 SCOPE OF PAYMENT

- A. Payment is full compensation for work described for each pay item according to the description, unit of measure, and price in the Bid Schedule.
 - 1. Payment for a pay item includes payment for work specified in the Section defining the work for that pay item including the work in referenced Sections.
 - 2. The cost of work required by the general specifications Section 00 10 00 is paid for in the appropriate pay items.
 - 3. Work paid for under one pay item is not paid for under another pay item.
- B. The Department will not pay the Contractor for:
 - 1. Work that is in excess of that contained in the contract.
 - 2. Removal and replacement of defective or nonconforming work.
 - 3. Loss of anticipated profits.
 - 4. Remedy of damage caused by the Contractor.
- C. Payment does not relieve the Contractor of the obligation to correct defective or nonconforming work.

1.7 FUEL COST ADJUSTMENT

- A. Fuel cost adjustment is intended to limit the risk to the Contractor from potentially unstable fuel prices that might occur during the contract.

1. This provision is not intended to estimate actual quantities of fuel used in construction operations or compensate for actual price variations experienced by the Contractor.
2. The Department determines adjustments under the provisions of this Section and presumes the Contractor has relied on these provisions when determining unit bid prices.
3. The Contractor may invoke this provision within the contract time by notification to the Engineer.
 - a. Adjustments are made on prior and future partial estimates.
 - b. This provision becomes effective when invoked by the Contractor and remains in effect for the duration of the contract.

B. Abbreviations and Terms

1. Estimate Price for fuel (EPf) – The fuel price established for the partial estimate period.
 - a. The Department determines the EPf on the first Monday of each month using the spot price per barrel for West Texas Intermediate (WTI) crude oil. Refer to <http://www.udot.utah.gov/go/standardsreferences>. This spot price is averaged with spot prices posted for the previous three Mondays to establish the EPf.
 - b. The EPf remains in effect until the first Monday of the following month and is used for regular partial estimates closed before the first Monday of the following month.
2. Base Price for fuel (BPf) – The contract base fuel price, equal to the EPf in effect on the date of the contract bid opening.
3. Fuel Factor (FF) – A combined diesel and gasoline usage factor established for purposes of calculating the Fuel Cost Adjustment.
 - a. Table 1 shows the items of work eligible for adjustment.
4. Fuel Cost Adjustment (FCA) – The fuel cost adjustment in dollars determined according to this article.

C. Determining FCA

1. FCA applies only to acceptable work performed on individual contract items in Table 1 with values of more than \$100,000 based on original contract quantities, unless otherwise specified in Table 1
2. FCA does not apply to work added by change order.
3. FCA may be positive or negative depending on the changes or differences between the BPf and the EPf.
4. Work performed after the expiration of contract time, the EPf will be limited to the lesser of:

- a. The EPf for the estimate period when the work was performed.
- b. The EPf for the last partial estimate period before the expiration of the contract time.

D. FCA Formula

When the EPf is more than 15 percent above the BPf

$$FCA = \frac{[(EPf - BPf) - 0.05 BPf] Q (FF)}{42}$$

When the EPf is more than 15 percent below the BPf

$$FCA = \frac{[(EPf - BPf) + 0.05 BPf] Q (FF)}{42}$$

Where:

- Q = Quantity of acceptable work performed
- FF = Fuel factor for Q
- 42 = Conversion of gallons of fuel per barrel of crude

- E. The Department determines the feasibility of proceeding with the remainder of the project and notifies the Contractor if the project is to be terminated if the EPf increases by more than 50 percent from the BPf for an eligible item of work.

Table 1

Items Eligible for FCA		
Item of Work	Quantity of Work (Q)	Fuel Factor (FF)
Roadway Excavation, Borrow, Granular Borrow, Top Soil	Ton Cubic Yard	0.25 0.45
Underdrain Granular Backfill	Cubic Yard	1.16
Untreated Base Course	Ton Cubic Yard	0.84 1.63
Hot Mix Asphalt	Ton Cubic Yard	3.60 6.80
Open Graded Surface Course	Ton Cubic Yard	3.60 6.80
Stone Matrix Asphalt (SMA)	Ton Cubic Yard	3.60 6.80
Other Asphalt Mix Products with Mix Design	Ton Cubic Yard	3.60 6.80
Rotomilling Profile Rotomilling In-Place Cold Recycled Asphaltic Base Recycled Surface	Sq Yd Sq Yd Sq Yd Sq Yd	0.03
Chip Seal Coat Microsurfacing	Square Yard	0.03
Portland Cement Concrete Pavement Lean Concrete Base Course	Sq Yd-In Sq Yd-In	0.214 0.048
Riprap	Cubic Yard Ton	0.57 0.25
Bridges exceeding \$500,000 Includes the following items: Structural Concrete, Piles, Reinforcing Steel, Prestressed Concrete Members, and Structural Steel 36 inch and larger pipe culvert – combined items exceeding \$200,000	\$	0.038

1.8 ASPHALT COST ADJUSTMENT

- A. Asphalt cost adjustment is intended to limit the risk to the Contractor from potentially unstable asphalt prices that might occur during the Contract.
1. This provision is not intended to estimate actual quantities of asphalt used or compensate for actual price variations experienced by the Contractor.
 2. The Department determines adjustments under the provisions of this article and presumes that the Contractor has relied on these provisions for adjustments when determining unit bid prices.

-
3. The Contractor can choose to opt out of the Asphalt Cost Adjustment (ACA).
 - a. Check the appropriate box on the bid proposal indicating the intent to opt out of the ACA.
 - b. The ACA cannot be reactivated on a project for which the Contractor has opted out.

 - B. The Department adjusts the price of asphalt materials for acceptable work performed on pay items that contain asphalt materials.

 - C. Abbreviations and Terms
 1. Estimate Price for asphalt (EPa) – The asphalt price established for the partial estimate period.
 - a. On the first Monday of each month, the Department determines the EPa using price values from the most recent Poten & Partners Asphalt Weekly Monitor and Argus Asphalt Report. The Department averages values for the following, eliminating the single highest and single lowest values, before averaging.
 - 1) The high reported selling price (per ton) of typical non-modified paving grades of asphalt from the Asphalt Weekly Monitor.
 - Arizona
 - Phoenix area
 - Flagstaff area
 - Tucson area
 - Idaho
 - Boise area
 - Eastern markets
 - Northern markets
 - Nevada
 - Las Vegas area
 - Reno area
 - New Mexico
 - Eastern markets
 - Western markets
 - Utah
 - Salt Lake City area
 - 2) The high reported wholesale asphalt price (per ton) from the Argus Asphalt Report for Rocky Mountain and West coast asphalt prices for:
 - Denver
 - Las Vegas
 - Montana
 - Phoenix

Salt Lake City
Utah
Wyoming

- b. This average value is then averaged with values obtained in the same manner for the previous three weekly reports to establish the EPa.
 - c. The EPa remains in effect until the first Monday of the following month and is used for regular partial estimates closed before the first Monday of the following month.
 2. Base Price for asphalt (BP_a) – The contract base asphalt price, equal to the EPa in effect on the date of the contract bid opening or other date where prices are submitted for the establishment of a contract such as the proposal submittal date for a design build project.
 3. Adjusted Base Price for asphalt (ABP_a) is 115 percent of the BP_a on the up side and 85 percent of the BP_a on the down side. No price adjustment will be paid when the EPa is between 85 percent and 115 percent of the BP_a.
 4. Asphalt cost adjustment (ACA) – The asphalt cost adjustment in dollars determined according to this article.
- D. Determining the ACA
 1. The provisions of this article become effective and remain in effect for the duration of the contract when the EPa of asphalt materials changes more than 15 percent from the BP_a.
 2. The Engineer determines ACA for each partial estimate following this provision becoming effective. The adjustment on each item is determined using the formula in this article.
 3. Adjustments in compensation may be either plus or minus depending on the differences between the ABP_a and the EPa.
 4. Work added by change order is not eligible for ACA.
 5. The EPa will be limited to the lesser of the following for work performed after the expiration of contract time and approved time extensions:
 - a. The EPa for the estimate period when the work was performed.
 - b. The EPa for the last partial estimate period before the expiration of the contract time.
- E. The Department determines the feasibility for proceeding with the remainder of the project if the Partial Estimate Base Price increases by more than 15 percent from the Contract Base Price for an adjustable pay item and notifies the Contractor if the project is to be terminated for cause.
- F. Adjustment Formula

When the EPa is more than 115 percent or less than 85 percent of the BPa

$$ACA = [(EPa - ABPa)] T$$

No price adjustment will be paid when the EPa is between 85 percent and 115 percent of the BPa.

Where:

T = Quantity in ton of Asphalt Binder Materials used

The Engineer determines T as follows:

1. PG asphalt binders
 - a. The target percentage of new (RAP binder not included) asphalt binder in the approved mix design for the quantity of placed material for:
 - 1) Hot Mix Asphalt (HMA).
 - 2) Stone Matrix Asphalt (SMA).
 - 3) Other mixed material using a mix design target for asphalt binder. Adjust the quantity from target to include only the residual asphalt when the mix design target is an emulsion.
 - b. The quantity of placed asphalt binder for:
 - 1) Open-Graded Surface Course (OGSC).
 - 2) Other mix material where asphalt binder is paid as a separate pay item from the mix.
2. The residual asphalt calculated from the quantity of placed material for Emulsified Asphalts.
3. The quantity of placed material for Cutback Asphalts.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

END OF SECTION

SECTION 01 30 00 – ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Coordination and project conditions.
- B. Coordination with private and public agencies.
- C. Field engineering.
- D. Preconstruction meeting.
- E. Progress meetings.
- F. Closeout meeting.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES Not Used

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS Not Used

1.6 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate scheduling, submittals, and Work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- C. Coordinate space requirements, supports, and installation of mechanical and electrical Work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

- E. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.

1.7 COORDINATION WITH PRIVATE AND PUBLIC AGENCIES

- A. Notify private and public agencies affected by the proposed construction, coordinate required adjustments, and arrange for all necessary adjustments of utilities within or adjacent to the limits of construction.
- B. Obtain utility locations from the one-call center (Blue Stake) or other utility coordination service 2 to 7 working days prior to any excavation. Locations must be updated every 14 days.
- C. All utilities and utility appurtenances within the limits of the Work which are to be relocated or adjusted shall be moved by the affected utility company, unless specified otherwise.
- D. Notify police, fire and transit authority.
- E. Coordinate with water master in maintaining adjacent land owner's irrigation water turns.

1.8 FIELD ENGINEERING

- A. Engineer will provide general survey control.
- B. Contractor shall locate and protect survey control and reference points. Promptly notify Engineer of any discrepancies discovered.
- C. Control datum for survey is that shown on Drawings.
- D. Verify set-backs and easements; confirm drawing dimensions and elevations.
- E. Provide field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.

1.9 PRECONSTRUCTION MEETING

- A. Engineer will schedule a meeting after Notice of Award.
- B. Attendance Required: Owner, Engineer, and Contractor.
- C. Agenda:
 - 1. Execution of Owner-Contractor Agreement.
 - 2. Submission of executed bonds and insurance certificates.
 - 3. Distribution of Contract Documents.

4. Submission of list of Subcontractors, list of products, schedule of values, and progress schedule.
 5. Designation of personnel representing the parties in Contract and the Engineer.
 6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 7. Scheduling.
- D. Engineer will record minutes and distribute copies within five days after meeting to participants.

1.10 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work on a weekly basis.
- B. Engineer will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.
- C. Attendance Required: Job superintendent, major subcontractors and suppliers, Owner, Engineer, as appropriate to agenda topics for each meeting.
- D. Agenda:
1. Review minutes of previous meetings.
 2. Review of Work progress.
 3. Field observations, problems, and decisions.
 4. Identification of problems which impede planned progress.
 5. Review of submittals schedule and status of submittals.
 6. Review of off-site fabrication and delivery schedules.
 7. Maintenance of progress schedule.
 8. Corrective measures to regain projected schedules.
 9. Planned progress during succeeding work period.
 10. Coordination of projected progress.
 11. Maintenance of quality and work standards.
 12. Effect of proposed changes on progress schedule and coordination.
 13. Other business relating to Work.
- E. Engineer will record minutes and distribute copies within five days after meeting to participants.

1.11 CLOSEOUT MEETING

- A. Schedule Project closeout meeting with sufficient time to prepare for requesting Substantial Completion. Preside over meeting and be responsible for minutes.
- B. Attendance Required: Contractor, major Subcontractors, Engineer, Owner, and others appropriate to agenda.
- C. Notify Engineer four days in advance of meeting date.
- D. Minimum Agenda:
 - 1. Start-up of facilities and systems.
 - 2. Operations and maintenance manuals.
 - 3. Testing, adjusting, and balancing.
 - 4. System demonstration and observation.
 - 5. Operation and maintenance instructions for Owner's personnel.
 - 6. Contractor's inspection of Work.
 - 7. Contractor's preparation of an initial "punch list."
 - 8. Procedure to request Engineer inspection to determine date of Substantial Completion.
 - 9. Completion time for correcting deficiencies.
 - 10. Inspections by authorities having jurisdiction.
 - 11. Certificate of Occupancy and transfer of insurance responsibilities.
 - 12. Partial release of retainage.
 - 13. Final cleaning.
 - 14. Preparation for final inspection.
 - 15. Closeout Submittals:
 - a. Project record documents.
 - b. Operating and maintenance documents.
 - c. Operating and maintenance materials.
 - d. Affidavits.
 - 16. Final Application for Payment.
 - 17. Contractor's demobilization of Site.
 - 18. Maintenance.
- E. Contractor Record minutes and distribute one copy to participants within two days after meeting, with one copy each to Engineer, Owner, and those affected by decisions made.

PART 2 - PRODUCTS **Not Used**

PART 3 - EXECUTION **Not Used**

END OF SECTION

SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Definitions.
- B. Submittal procedures.
- C. Construction progress schedules.
- D. Proposed product list.
- E. Product data.
- F. Shop Drawings.
- G. Samples.
- H. Other submittals.
- I. Test reports.
- J. Certificates.
- K. Manufacturer's instructions.
- L. Manufacturer's field reports.
- M. Erection Drawings.
- N. Contractor review.
- O. Engineer review.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES Not Used

1.4 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action.
- B. Informational Submittals: Written and graphic information and physical Samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.5 SUBMITTALS Not Used

1.6 SUBMITTAL PROCEDURES

- A. Transmit each submittal with Engineer-accepted form.
- B. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.
- C. Identify: Project, Contractor, Subcontractor and supplier, pertinent Drawing and detail number, and Specification Section number appropriate to submittal.
- D. Apply Contractor's stamp, signed or initialed, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is according to requirements of the Work and Contract Documents.
- E. Schedule submittals to expedite Project, and deliver to Engineer at business address. Coordinate submission of related items.
- F. For each submittal for review, allow 15 days excluding delivery time to and from Contractor.
- G. Identify variations in Contract Documents and product or system limitations that may be detrimental to successful performance of completed Work.
- H. Allow space on submittals for Contractor and Architect/Engineer review stamps.
- I. When revised for resubmission, identify changes made since previous submission.
- J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
- K. Submittals not requested will not be recognized nor processed.
- L. Incomplete Submittals: Engineer will not review. Complete submittals for each item are required. Delays resulting from incomplete submittals are not the responsibility of Engineer.

1.7 CONSTRUCTION PROGRESS SCHEDULES

- A. Comply with requirements in the General Conditions.

1.8 PROPOSED PRODUCT LIST

- A. Within 15 days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

- B. For products specified only by reference standards, indicate manufacturer, trade name, model or catalog designation, and reference standards.

1.9 PRODUCT DATA

- A. Product Data: Action Submittal: Submit to Architect/Engineer for review for assessing conformance with information given and design concept expressed in Contract Documents.
- B. Submit number of copies Contractor requires, plus two copies Engineer will retain.
- C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- E. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00 – Contract Closeout

1.10 SHOP DRAWINGS

- A. Shop Drawings: Action Submittal: Submit to Architect/Engineer for assessing conformance with information given and design concept expressed in Contract Documents.
- B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a professional Engineer responsible for designing components shown on Shop Drawings.
- D. Include signed and sealed calculations to support design.
- E. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
- F. Make revisions and provide additional information when required by authorities having jurisdiction.
- G. Submit number of opaque reproductions Contractor requires, plus two copies Engineer will retain.
- H. After review, produce copies and distribute according to "Submittal Procedures"

Article and for record documents described in Section 01 70 00 - Contract Closeout.

1.11 SAMPLES

- A. Samples: Action Submittal: Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.
- B. Samples for Selection as Specified in Product Sections:
- C. Submit to Architect/Engineer for aesthetic, color, and finish selection.
- D. Submit Samples of finishes, textures, and patterns for Engineer selection.
- E. Submit Samples to illustrate functional and aesthetic characteristics of products, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.
- F. Include identification on each Sample, with full Project information.
- G. Submit number of Samples specified in individual Specification Sections; Engineer will retain one Sample.
- H. Reviewed Samples that may be used in the Work are indicated in individual Specification Sections.
- I. Samples will not be used for testing purposes unless specifically stated in Specification Section.
- J. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00 – Contract Closeout.

1.12 OTHER SUBMITTALS

- A. Closeout Submittals: Comply with Section 01 70 00 – Contract Closeout.
- B. Informational Submittal: Submit data for Engineer's knowledge as Contract administrator or for Owner.
- C. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.

1.13 TEST REPORTS

- A. Informational Submittal: Submit reports for Architect/Engineer's knowledge as Contract administrator or for Owner.

- B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.14 CERTIFICATES

- A. Informational Submittal: Submit certification by manufacturer, installation/application Subcontractor, or Contractor to Architect/Engineer, in quantities specified for Product Data.
- B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or product but must be acceptable to Architect/Engineer.

1.15 MANUFACTURER'S INSTRUCTIONS

- A. Informational Submittal: Submit manufacturer's installation instructions for Architect/Engineer's knowledge as Contract administrator or for Owner.
- B. Submit printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, to Architect/Engineer in quantities specified for Product Data.
- C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.16 MANUFACTURER'S FIELD REPORTS

- A. Informational Submittal: Submit reports for Engineer's knowledge as Contract administrator or for Owner.
- B. Submit report within 5 days of observation to Engineer for information.
- C. Submit reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.17 ERECTION DRAWINGS

- A. Informational Submittal: Submit Drawings for Architect/Engineer's knowledge as Contract administrator or for Owner.
- B. Submit Drawings for information assessing conformance with information given and design concept expressed in Contract Documents.
- C. Data indicating inappropriate or unacceptable Work may be subject to action by Architect/Engineer or Owner.

1.18 CONTRACTOR REVIEW

- A. Review for compliance with Contract Documents and approve submittals before transmitting to Engineer.
- B. Contractor: Responsible for:
- C. Determination and verification of materials including manufacturer's catalog numbers.
- D. Determination and verification of field measurements and field construction criteria.
- E. Checking and coordinating information in submittal with requirements of Work and of Contract Documents.
- F. Determination of accuracy and completeness of dimensions and quantities.
- G. Confirmation and coordination of dimensions and field conditions at Site.
- H. Construction means, techniques, sequences, and procedures.
- I. Safety precautions.
- J. Coordination and performance of Work of all trades.
- K. Stamp, sign or initial, and date each submittal to certify compliance with requirements of Contract Documents.
- L. Do not fabricate products or begin Work for which submittals are required until approved submittals have been received from Architect/Engineer.

1.19 ENGINEER REVIEW

- A. Do not make "mass submittals" to Engineer. "Mass submittals" are defined as six or more submittals or items in one day or 15 or more submittals or items in one week. If "mass submittals" are received, Engineer's review time stated above will be extended as necessary to perform proper review. Engineer will review "mass submittals" based on priority determined by Engineer after consultation with Owner and Contractor.
- B. Informational submittals and other similar data are for Architect/Engineer's information, do not require Engineer's responsive action, and will not be reviewed or returned with comment.
- C. Submittals made by Contractor that are not required by Contract Documents may be returned without action.

- D. Submittal approval does not authorize changes to Contract requirements unless accompanied by Change Order.
- E. Owner may withhold monies due to Contractor to cover additional costs beyond the second submittal review.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

END OF SECTION

SECTION 01 35 43 – ENVIRONMENTAL COMPLIANCE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Compliance with federal and state environmental regulations.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. American National Standards Institute (ANSI)
- B. Clean Water Act
- C. Code of Federal Regulations (CFR)
- D. Rivers and Harbors Act
- E. U.S. Environmental Protection Agency (EPA) Regulations
- F. Utah Administrative Code (UAC)
- G. Utah Department of Environmental Quality (DEQ) Regulations
- H. Utah Pollutant Discharge Elimination System, Utah Construction General Permit (UCGP)
- I. Utah State Stream Alteration Program

1.4 DEFINITIONS

- A. Fugitive Dust – Small particles originating primarily from soil that are suspended in the air by the wind and by human activities.
- B. Noise Receptor – Property where frequent human use occurs and where a lowered noise level would be of benefit.
- C. Percussive Noise – Short bursts of noise including but not limited to blasting, pile driving, and jack-hammering.
- D. Sound Level – The average sound pressure level from concurrent construction activities related to the project as measured with a sound level meter using the A weighting network (ANSI S1.4). The standard notation is dB(A) or dBA.

1.5 SUBMITTALS

- A. Stormwater Pollution Prevention Plan (SWPPP) for approval.
- B. Signed copy of the Notice of Intent (NOI) for information.
- C. Signed copy of the Notice of Termination (NOT) for information.
- D. UDOT Environmental Control Supervisor (ECS) Certificate of Training for information.
- E. Fugitive Dust Control Plan for information.
- F. Documentation of environmental clearances for areas not previously cleared for review.

1.6 DISINCENTIVES

- A. Disincentives are assessed against the Contractor in the amount of \$1,000 for each calendar day or portion thereof the project is not in compliance with required permits and regulations.
 - 1. The disincentives assessed increase to \$2,000 per day if the Contractor remains in non-compliance after three days and increase to \$3,000 per day if the Contractor remains in non-compliance after seven days.
- B. Fines issued by regulatory agencies against the Department are added to the disincentives assessed to the Contractor.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION

3.1 HAZARDOUS WASTE

- A. Suspend work immediately in an area if abnormal conditions are encountered or exposed during construction that indicates the presence of a hazardous waste.
 - 1. Notify the Engineer.
- B. Do the following if a waste discovered or spilled on site is considered hazardous by meeting the definition for disclosure as defined in Title 40 CFR Part 261, Subpart D – Lists of Hazardous Wastes. Refer to <http://www.udot.utah.gov/go/standardsreferences> for a link to a list of hazardous wastes.
 - 1. Take appropriate actions to minimize the threat to human health and the environment.

2. Contact the Engineer and send notice if waste found on site is determined hazardous.
 3. Follow appropriate testing measures to determine if waste is considered hazardous.
 4. Notify DEQ, 24-hour Answering Service, (801) 536-4123
 5. Follow requirements in UAC R315.
- C. Coordinate with the Engineer to initiate development of a remediation plan according to DEQ and the EPA regulations and requirements.
1. Pay for costs to address hazardous waste discovery or spill cleanup when caused by Contractor's activities.
- D. Complete the work required by the remediation plan before resuming operations in the affected area.

3.2 SPILL OF PETROLEUM-BASED PRODUCT AND USED OIL

- A. Petroleum-Based product
1. Contact the Engineer if a spill occurs adjacent to waterbody or storm drain inlet.
 - a. Send notice following the discovery of the spill.
 - b. Notify DEQ, 24-hour Answering Service, (801) 536-4123.
 - c. Coordinate with the Engineer to remedy petroleum contaminated soils according to UAC R315-8.
- B. Used Oil product
1. Contact the Engineer if a spill occurs that exceeds 25 gallons, or that poses a potential threat to human health or the environment, such as discharging to groundwater, surface water or storm drain inlet.
 - a. Send notice following the discovery of the spill.
 - b. Notify DEQ, 24-hour Answering Service, (801) 536-4123.
 - c. Coordinate with the Engineer to develop a remediation plan for spilled used oil according to UAC R315-15.
- C. Cleanup petroleum-based or used oil product when caused by Contractor's activities.

3.3 WATER RESOURCE PERMITS

- A. Comply with the Utah State Stream Alteration Program.

- B. Comply with Section 10 of the Rivers and Harbors Act.
- C. Comply with Section 404 of the Clean Water Act.
- D. Comply with UCGP requirements for projects with one or more acres of soil disturbances (clearing, grading or excavating).
 - 1. Designate an individual, other than the Superintendent, as the Environmental Control Supervisor (ECS) with the following responsibilities:
 - a. Coordinate with the Engineer regarding UCGP requirements and environmental commitments.
 - b. Manage implementation, modification and record keeping of the project SWPPP.
 - c. Supervise the installation, maintenance and removal of Best Management Practices (BMPs).
 - d. Conduct SWPPP inspections.
 - e. Be available 24 hours a day, seven days a week and can be on-site within a reasonable amount of time from notification as determined by the Engineer.
 - 2. Complete the draft SWPPP for the project.
 - 3. Submit the Notice of Intent (NOI) to the Utah Division of Water Quality (DWQ), after the SWPPP has been signed by the Engineer.
 - 4. Conduct SWPPP inspections at least once a week and within 24 hours following a storm event with a total rainfall amount of ½ inch or greater once earth-disturbing activities have begun.
 - 5. Coordinate with the Engineer to determine if the project has met UCGP requirements before submitting the Notice of Termination (NOT) to DWQ.
- E. Comply with the National Flood Insurance Program for a project within a Special Flood Hazard Area (SFHA), as defined by the Federal Emergency Management Agency (FEMA).

3.4 OPEN BURNING

- A. Do not conduct open burning along highway right of way without approval from the Utah Department of Air Quality (DAQ).

3.5 FUGITIVE DUST

- A. Submit a Fugitive Dust Control Plan (FDCG) to DAQ for construction activities as defined in UAC R30, such as:
 - 1. Disturbing a ground surface greater than ¼ acre in size.

2. Demolition activities including razing homes, buildings, or other structures.
 3. Material storage, hauling, or handling operations.
- B. Minimize fugitive dust from construction activities using methods such as watering and chemical stabilization of potential fugitive dust sources or other methods approved by the DAQ.
1. Do not exceed 10 percent opacity caused by fugitive dust at the project boundary and 20 percent within the project site. This requirement does not apply when wind speeds exceed 25 MPH and the operator is taking appropriate actions to control fugitive dust.
 2. Conduct opacity observations according to EPA Method 9 for stationary sources. Refer to <http://www.udot.utah.gov/go/standardsreferences>.
 3. Use procedures similar to EPA Method 9 to conduct opacity observations for intermittent and mobile sources.
 - a. The requirement for observations to be made at 15 second intervals over a six minute period does not apply.
- C. Minimize fugitive dust from material storage, handling, or hauling operations through the use of covers, stabilization, or other methods approved by the DAQ.

3.6 NOISE CONTROL

- A. Avoid construction activities causing sound levels to exceed 95 dBA in daytime (7:00 a.m. – 9:00 p.m.) or 55 dBA in nighttime (9:00 p.m. – 7:00 a.m.) within 10 ft of the nearest noise receptor.
- B. Schedule work to minimize noise disturbance on Sundays and Holidays in areas with noise receptors.
- C. Percussive Noise
1. Notify the Engineer, the affected noise receptors and the local government authority (if applicable) at least two weeks in advance of percussive noise activity.

3.7 ENVIRONMENTAL CLEARANCE BY THE CONTRACTOR

- A. Obtain authorization before starting any ground disturbing activity not previously cleared by the Department such as wasting project-generated material, excavating borrow material, locating equipment, storage areas, office sites, utility lines, or holding ponds.

1. Cultural and Paleontological – Perform and provide a cultural survey as determined by the Engineer to verify no cultural or paleontological resources are affected by the activity.
 2. Threatened or Endangered Species – Perform and provide a wildlife survey as determined by the Engineer to verify no threatened or endangered or other sensitive species are affected by the activity.
 3. Federal or State regulated waters – Provide documentation as determined by the Engineer to verify no WoUS and State of Utah waters are impacted by the activity.
 4. FEMA Floodplains – Provide documentation as determined by the Engineer to verify no FEMA Special Flood Hazard Areas (SFHA) are impacted by the activity.
 5. UCGP – Provide a separate SWPPP for UCGP compliance as determined by the Engineer when disturbing more than one acre of soil off the project site.
- B. The Contractor is responsible for costs of pursuing and obtaining clearances for areas not previously cleared and is not entitled to time extension for delays encountered in obtaining these clearances.
- C. Environmental clearances are required regardless of the property ownership.

3.8 DISCOVERY OF HISTORICAL, ARCHAEOLOGICAL, OR PALEONTOLOGICAL OBJECTS, FEATURES, SITES, OR HUMAN REMAINS

- A. Suspend work within the vicinity if historical, archaeological or paleontological objects, features, sites or human remains are discovered during construction:
1. Provide a 100 ft minimum buffer around the perimeter of the discovery.
 2. Protect the discovery area.
 3. Contact the Engineer and send notice of the nature and exact location of the discovery.
 4. Provide written documentation to the Engineer within two calendar days of discovery.
- B. Do not recommence work within the area of discovery until the Engineer provides notice.

3.9 POLLUTION PREVENTION AND GENERAL HOUSEKEEPING

- A. Concrete Washout
1. Provide a watertight container on site before concrete placement activities begin and where concrete trucks, tools and equipment are to be washed.

- a. Size the container to prevent overflows
 - b. Do not place within 50 ft of storm drain inlets, open ditches or watercourses.
- 2. Remove and properly dispose of concrete waste and washout water.
- B. Maintain active traffic lanes free from debris, such as mud, dirt, gravel and other material.
- C. Prevent material from entering in storm drain inlets and drainage pipes.

PART 4 - PRODUCTS Not Used

PART 5 - EXECUTION Not Used

END OF SECTION

SECTION 01 43 33 – MANUFACTURER’S SERVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manufacturer’s services necessary to implement the work.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES Not Used

1.4 DEFINITIONS

- A. Person-Day: One person for 8 hours within regular Contractor working hours.

1.5 SUBMITTALS

- A. Informational Submittals:
 - 1. Training Schedule: Submit not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.
 - 2. Lesson Plan: Submit proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION

3.1 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

- A. Furnish manufacturers’ services when required by an individual specification section, to meet the requirements of this Section.
- B. Where time is necessary in excess of that stated in the Specifications for manufacturers’ services, or when a minimum time is not specified, the time required to perform the specified services shall be considered incidental.
- C. Schedule manufacturer’ services to avoid conflict with other onsite testing or other manufacturers’ onsite services.
- D. Determine, before scheduling services, that all conditions necessary to allow successful testing have been met.
- E. Only those days of service approved by Construction Manager will be credited to fulfill the specified minimum services.

- F. When specified in individual specification sections, manufacturer's onsite services shall include:
1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
 2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
 3. Copies of all manufacturers' representatives field notes and data to Construction Manager on a daily basis.
 4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Construction Manager.
 5. Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.
 6. Assistance during functional and performance testing, and facility startup and evaluation.
 7. Training of Owner's personnel in the operation and maintenance of respective product as required.
 8. Additional requirements may be specified elsewhere.

3.2 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

- A. When so specified, a Manufacturer's Certificate of Compliance, a copy of which is attached to this section, shall be completed in full, signed by the entity supplying the product, material, or service, and submitted prior to shipment of product or material or the execution of the services.
- B. Construction Manager may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.
- C. Such form shall certify that the proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.
- D. May reflect recent or previous test results on material or product, if acceptable to Construction Manager.

3.3 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

- A. When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by the equipment manufacturer's representative.
- B. Such form shall certify that the signing party is a duly authorized representative of

the manufacturer, is empowered by the manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to assure that the equipment is complete and operational.

3.4 TRAINING

A. General:

1. Furnish manufacturers' representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, or component) and as may be required in applicable Specifications.
2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner and familiar with operation and maintenance manual information.
3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.

B. Training Schedule:

1. List specified equipment and systems that require training services and show:
 - a. Respective manufacturer.
 - b. Estimated dates for installation completion.
 - c. Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.

C. Lesson Plan: When manufacturer or vendor training of Owner personnel is specified, prepare for each required course, containing the following minimum information:

1. Title and objectives.
2. Recommended types of attendees (e.g., managers, engineers, operators, maintenance).
3. Course description and outline of course content.
4. Format (e.g., lecture, self-study, demonstration, hands-on).
5. Instruction materials and equipment requirements.

- 6. Resumes of instructors providing the training.
- D. Pre-startup Training:
 - 1. Coordinate training sessions with Owner's operating personnel and manufacturers' representatives, and with submission of operation and maintenance manual.
 - 2. Complete at least 21 days prior to beginning of facility startup.
- E. Post-startup Training: If required in Specifications, furnish and coordinate training of Owner's operating personnel by respective manufacturer's representatives.

3.5 SUPPLEMENTS

- A. The supplements listed below, following "End of Section", are part of this Specification.
 - 1. Form: Manufacturer's Certificate of Compliance.
 - 2. Form: Manufacturer's Certificate of Proper Installation.

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER:

PRODUCT, MATERIAL, OR SERVICE
SUBMITTED:

PROJECT NAME:

PROJECT NO:

Comments: _____

I hereby certify that the above-referenced product, material, or service called for by the contract for the named project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the contract requirements, and are in the quantity shown.

Date of Execution: _____, 20____

Manufacturer: _____

Manufacturer's Authorized Representative (*print*): _____

(Authorized Signature)

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Installed in accordance with Manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical & mechanical connections meet quality & safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ Functional tests.
- ☐ System has been performance tested & meets or exceeds specified performance requirements. (When complete system of one mfr.)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20____

Manufacturer: _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

END OF SECTION

SECTION 01 45 00 - TESTING AND PROCESS CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section defines the responsibility of the Contractor and the Engineer to adequately test native materials and construction materials, and to furnish the Engineer with manufacturer's certifications of material quality.

1.2 QUALITY ASSURANCE

- A. The Contractor shall be responsible for all sampling, delivery of samples to a qualified testing agency, testing, and delivery of test results or materials certifications to Engineer at no charge to the Engineer. Testing and certifications reports shall be approved by the Engineer as to conformance to Engineer standard specifications prior to final inspection and/or acceptance by the Engineer of any materials or workmanship.

1.3 SUBMITTALS

- A. Field Test Report: When possible submit original report immediately to Engineer or inspector, but in no case later than end of current day.
- B. Laboratory Test Report: Submit original report to Engineer within 48 hours after test results are determined.

PART 2 - EXECUTION

2.1 SAMPLING

- A. Sampling of materials shall be as specified in each test.
- B. The Engineer may require that sampling be performed in their presence, in which case the Developer or Contractor shall be notified of this requirement in writing at the time the building permit is issued, or at the preconstruction meeting, or when construction drawings are released by the Engineer for construction, as applicable.
- C. The presence of the Engineer shall not relieve the Developer/Contractor of any requirement in this Section.
- D. Each sample or test shall be accompanied by the following written data, which shall be reported to the Engineer with test results:
 - 1. Name of Project
 - 2. Name of Contractor

3. Project Street Address
4. Appropriate Test Name
5. Date of Sampling
6. Sample Number (if more than one sample per day)
7. Name of technician who performed the testing
8. Location of sample

2.2 TESTING AGENCY

- A. All materials testing, whether in a laboratory or in the field, shall be conducted by a testing agency approved by Engineer.

2.3 SOIL CLASSIFICATION TEST

- A. The soil classification test shall be conducted to determine the suitability of native soils for road subbase and building foundations.
- B. The soil classification test shall conform to AASHTO M-146 of latest revision.
- C. The soil shall be classified according to AASHTO soil classifications.
- D. One soil classification test shall be required for each test area. A test area shall be limited to one parcel of one soil type, a maximum 1,000 feet long and maximum 5 acres.
- E. In test areas of less than 2 acres, the Engineer may waive this requirement.
- F. The soil sample shall be taken from a test area at a minimum depth of 24 inches below the future design grades, of native soil, and shall be free from foreign material, asphalt, concrete, ice or manmade materials.
- G. Where deep footings or pile foundations are proposed, soil classification tests at several depths may be required in each test area.
- H. Soil Classification testing shall be performed by the Engineer.

2.4 COMPACTION TEST OF SOIL AND UNTREATED BASE COURSE

- A. Laboratory tests to establish maximum laboratory density shall be determined in accordance with AASHTO T-180, Method D for A-1 classification soils and AASHTO T-99, Method D for all other soils.

- B. Samples to determine laboratory density shall be taken from the stockpiled backfill or from the uncompacted base course in place.
- C. The acceptance of soil and base course with respect to compaction, shall be based upon the average density of all density tests made in a lot.
 - 1. Field density tests shall be as specified by AASHTO T-191 or by use of a portable nuclear density testing device. Field density tests shall be taken at a depth equal to $\frac{1}{2}$ the maximum depth of the lift tested.
 - 2. A lot shall equal the amount of soil or untreated base course compacted in each production day.
 - 3. A test lot shall be divided into sublots and one density test shall be taken within each subplot.
 - 4. The location of sampling sites within the subplot shall be chosen on a random basis by use of a suitable random number table.
 - 5. Each test lot shall have a minimum of two (2) sublots. A subplot shall be no larger than 1,000 cubic yards for embankment, no larger than 200 cubic yards for backfill over pipe or against structures and no larger 1,000 cubic yards for untreated road base.
- D. The test results of all samples tested shall be reported to the Engineer. A test lot shall be accepted when the average of the density determinations is not less than the density required for that improvement in these specifications and when no one density determination is less than 95% of the density required by these specifications.
- E. Compaction testing of soil and untreated base coarse shall be performed by the Engineer.

2.5 GRADATION TEST OF UNTREATED BASE COURSE

- A. The gradation of untreated base course shall be determined in accordance with AASHTO T-27.
- B. The total amount of material passing the No. 200 sieve shall be determined by washing in water in accordance with AASHTO T-11.
- C. The acceptance of road base with respect to gradation shall be based upon the average of all determinations in a lot. A lot shall be limited to one source of borrow and limited to one subdivision plat or one development. One sample shall be required for each 1,000 tons of untreated base course in a test lot. When the test lot is less than 100 tons, the requirement for the gradation test may be waived by the Engineer.

- D. The location of sampling sites within a test lot shall be chosen on a random basis by a suitable random number table.
- E. All material not conforming to the specified gradations may be rejected at the Contractor's expense
- F. Gradation tests of untreated base coarse shall be performed by the Engineer.

2.6 EXTRACTION - GRADATION TESTING OF BITUMINOUS SURFACE COURSE

- A. Samples of the bituminous surface course or asphalt concrete shall be tested with respect to gradation and bitumen content in accordance with Utah Department of Highways Test Procedure 8-946 and 8-947 if required by the Engineer.
- B. Mix design shall be submitted to the Engineer for approval 5 days before work is to begin.
- C. Acceptance of bituminous surface course with respect to gradation and bitumen content shall be based upon the average of the determinations made in a lot.
 - 1. A lot shall equal the amount of bituminous surface course placed in each production day.
 - 2. When a lot exceeds 1,000 tons, a minimum of three (3) samples shall be taken in each lot.
 - 3. When a lot is 1,000 tons or less, a minimum of two (2) samples shall be taken.
 - 4. Samples shall be taken at the time of lay-down of bituminous surface course and before compaction. Samples shall be taken from the mat behind the lay-down machine.
 - 5. Sampling shall be timed to represent the entire production day. The time of day, date of sample, station and offset location shall be clearly marked with the sample.
 - 6. If the average oil is less than 2.5% of optimal content, the Contractor may be required to lay an additional lift or slurry seal, based on the Engineer's recommendation.
- D. Extraction - Gradation testing of bituminous surface coarse material shall be performed by the Engineer.

2.7 COMPACTION TESTING OF BITUMINOUS SURFACE COURSE

- A. Laboratory tests to establish the maximum laboratory density of bituminous surface course shall be determined by the "Marshall Test" in accordance to ASTM D-1559.
- B. Samples to determine maximum laboratory density shall be taken at the time of lay-down of bituminous surface course and before compaction.
- C. Acceptance of bituminous surface course with respect to compaction shall be based upon the average determination of field density tests made in a lot.
 - 1. Field density tests shall be by a portable nuclear density testing device or by laboratory density analysis of core samples.
 - 2. A test lot shall be the quantity of surface course placed and compacted in each construction day.
 - 3. The test lot shall be subdivided into subplot(s) of approximately equal size and no larger than 1,600 square yards in area.
 - 4. One field density test shall be taken in each subplot, randomly located in the test lot by use of a suitable random number table.
- D. The test lot shall be accepted with respect to density when the average of all density determinations is not less than the density required by the applicable asphalt specification.
- E. Core Tests
 - 1. Acceptance of the completed bituminous surface course with respect to thickness shall be based on the average thickness of a test lot.
 - a. A test lot shall equal approximately 4,000 square yards of completed roadway.
 - b. A lot shall be divided into sublots of approximately 2,000 square yards.
 - 2. One thickness test, randomly selected by use of a random number table, shall be taken within each subplot. A minimum of three core tests will be taken.
 - 3. A lot shall be accepted when the average thickness of all sublots is not less than 3/8 inch the total designated bituminous surface course thickness and when no individual subplot shows a deficient thickness of more than 1/2 inch.
 - 4. Lots or sublots that are not acceptable because of deficient thickness shall be brought into compliance by placing additional surface course as directed by the Engineer.
 - 5. The removed core will be replaced with low strength concrete.

- F. Compaction testing of Bituminous surface coarse shall be performed by the Engineer.

2.8 COMPRESSIVE STRENGTH TESTING OF CONCRETE CYLINDERS

- A. Samples of concrete shall be taken at the construction site, molded in standard cylinder shapes, allowed to cure, and tested with respect to comprehensive strength when required by the Engineer.
- B. All samples of concrete shall be taken in conformance to AASHTO T-141 of the latest revision.
- C. Acceptance of concrete with respect to compressive strength shall be based upon the average determination of all "strength tests" made in a lot.
 - 1. A test lot shall be the quantity of concrete placed at one job in a construction day.
 - 2. For each 50 cubic yards of concrete in a test lot, three (3) compressive "strength tests" shall be run, except that for lots of less than 5 cubic yards, the number of "strength tests" per lot shall be the average strength of three standard cylinders.
 - 3. The making, curing and compressive strength testing of concrete cylinders shall conform to AASHTO T-22 and AASHTO T-23.
- D. Concrete may be rejected, if desired strengths are not obtained, at the Contractor's expense.
- E. Compressive strength testing of concrete cylinders shall be performed by the Engineer.

2.9 ADDITIONAL CONCRETE TESTING

- A. Slump Test: Determine slump in accordance with ASTM C 231.
- B. Air Test: Determine normal weight concrete air content; ASTM C 231 and light weight concrete air content; ASTM C 173.
- C. When requested by Engineer, test concrete in place by impact hammer, sonoscope, or other nondestructive device:
 - 1. To determine relative strengths in various locations in Work.
 - 2. To aid in evaluating concrete strength.
 - 3. To select areas to be cored.

- D. Additional concrete testing shall be performed by the Engineer.

2.10 CERTIFICATIONS FOR WATER SYSTEM VALVES

- A. In certain water system equipment, steel items and pipe listed below, a manufacturer's certificate shall be furnished with each unit of equipment, certifying conformance to the applicable requirements of Standard Specifications:
1. Gate Valves
 2. Butterfly Valves
 3. Steel Reinforcing Bars
 4. Structural Steel
 5. Corrugated Metal Pipe
 6. Polyvinyl Chloride Pipe
 7. ABS Composite (Truss) and Solid Wall Pipe

2.11 SUMMARY TABLE OF TESTS AND CERTIFICATIONS

- A. The following is a summary of the tests, number of samples per test and certificates that are required for construction work. This summary is provided as a reference guide. For details governing each item, refer to the appropriate test specification herein.

Test Subject	Specific Test	Number of Tests
Soil Classification	AASHTO M-145	1 test per test area of uniform soil type and 5 acres maximum.
Compaction of Soil & Base Course	Lab Density- AASHTO T-99 Method D or AASHTO T-180 Method D	As needed to establish laboratory density
	Embankment & Base Course Field Density- Portable Nuclear Equipment or AASHTO T-191	1 test plus minimum one test per 1,000 cu.yds.
	Backfill Field Density- Portable Nuclear Equipment or AASHTO T-191	1 test plus minimum one test per 200 cu.yds.

Test Subject	Specific Test	Number of Tests
Base Course Gradation	Sieve Analysis- AASHTO T-27 Passing No. 200 Sieve- AASHTO T-11	1 test per 1,000 tons
Extraction-Gradation Test of Bituminous Surface Course	UDOT Test Procedure 8-946 & 8-947	3 tests per pavement construction day
Compaction of Bituminous Surface Course	Lab Density- Marshall Test, ASTM D-1559 Field Density- Portable Nuclear Equipment	1 test per pavement construction day 1 test per 1600 square yards subplot
Core Tests	4" Core Sample	1 thickness test per 2,000 square yards or 3 test minimum
Concrete Test Cylinders	AASHTO T-23	3 cylinders per 50 cubic yards or minimum of 3 cylinders on placements less than 50 cubic yards
Pressure Reducing & Regulating Valves	Manufacturer's Certificate	1 for each valve
Gate Valve	Manufacturer's Certificate	1 for each valve over 12" diameter
Butterfly Valves	Manufacturer's Certificate	1 for each valve
Steel Re-Bar	Manufacturer's Certificate	1 for each 1,000 pounds of one grade
Structural Steel	Manufacturer's Certificate	1 for each lot of one shape, one grade
Corrugated Metal Pipe	Manufacturer's Certificate	1 for each 500 lineal feet of one size, one class
Polyvinyl Chloride Pipe	Manufacturer's Certificate	1 for each 500 lineal feet of one size, one class
A.B.S. Pipe	Manufacturer's Certificate	1 for each 500 lineal feet of one size, one class

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 01 45 13 – MATERIALS QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Materials Acceptance
- B. Aggregate source sites

1.2 RELATED SECTIONS

- A. Section 32 92 19 – Seeding

1.3 REFERENCES

- A. UDOT Materials Manual of Instruction
- B. UDOT Minimum Sampling and Testing Requirements
- C. Code of Federal Regulations (CFR)

1.4 DEFINITIONS **Not Used**

1.5 SUBMITTALS

- A. Copies of test reports for all aggregate sources for approval – Refer to this Section, Articles 1.8B and 1.9B.
 - 1. Required tests are listed in the technical specifications.
- B. Materials site plan for approval for Department furnished aggregate sources. Refer to this Section, Article 1.8C.
- C. Property owner releases before physical completion. Refer to this Section, Article 1.10.
- D. Permission agreements for storing materials on private property. – Refer to this Section, Article 1.12D.

1.6 MATERIALS ACCEPTANCE

- A. Acceptance of the work is based on a combination of inspection, sampling and testing, and manufacturer information.
 - 1. Acceptance of a material does not occur until all requirements have been met and verified.
- B. Sampling and Testing

1. The Department verifies certain properties of work for acceptance using sampling and testing.
2. Only those properties determined by a certain test are considered accepted by that test.

C. Quality Management Plans

1. The Department pre-qualifies suppliers using the requirements in Quality Management Plans (QMP). A list of pre-qualified suppliers is maintained by the Department. Products delivered by suppliers who are not qualified or who lose qualification during the project, will be rejected.
 - a. Use a pre-qualified supplier according to the QMP listed for the following materials:
 - 1) Cement – QMP 502
 - 2) Reinforcing Steel Epoxy – QMP 503
 - 3) Reinforcing Steel – QMP 504
 - 4) Precast / Prestressed Concrete Structures – QMP 505
 - 5) Ready Mix Concrete – QMP 506
 - 6) Flyash and Pozzolon – QMP 507
 - 7) Asphalt Emulsion – QMP 508
 - 8) Asphalt Binder – QMP 509
 - 9) Hydrated Lime – QMP 510
 - 10) Reinforcing Steel Galvanized Coating – QMP 512
 - 11) Pavement Marking Paint – QMP 513

D. Manufacturer Information

1. Certificates of Compliance
 - a. The contract designates manufactured materials and assemblies that can be incorporated in the work if accompanied by a manufacturer's Certificate of Compliance that includes the following:
 - 1) Project number and description, location, and Contractor's name;
 - 2) Manufacturer's name, along with the material source location and point of manufacture or assembly;
 - 3) Identification of the party the material was sold or supplied to;
 - 4) Lot identification or manufacturer's identification of the certified materials or assemblies delivered to the project;

- 5) Reference to the technical section or requirement of the contract specifications fulfilled through certification along with test reports, when applicable; and
 - 6) Statement that the material or assemblies comply with the particular requirements of the contract cited above and signed by a manufacturer's representative in a position to legally bind the manufacturer.
- b. The Department may sample and test materials or assemblies used on the basis of Certificates of Compliance and reject if determined not to meet contract requirements.
- 2. Manufacturer's product data sheets and installation instructions
 - a. The contract defines materials that may be incorporated into the project based on information provided through manufacturer's product data sheets and installation instructions.
 - b. Provide sufficient information to demonstrate conformance with product requirements before incorporating the product into the work
 - c. Installation instructions supplement Part 3 Execution requirements of technical Sections; in cases of conflict, the more stringent requirements apply.
 - d. The Approved Products List (APL) Compliance Form may be submitted in lieu of product data sheets and installation instructions if the product is listed in the Department's APL, except when product requirements have been modified by special provision.
- 3. Other
 - a. Materials and products of work where method for verification for acceptance is not defined in the technical specification may be verified for conformance by any of the methods listed in this article, as determined by the Engineer.
- E. The Materials Manual of Instruction defines procedures for anyone performing certain tests for acceptance.
- F. The Department does not allow contract time extension for or as a result of testing.
- G. The Department may deduct costs for retesting of materials made necessary by the Contractor's activities from payment due.
- H. Laboratories and technicians must be qualified according to the requirements of the UDOT Materials Manual of Instruction to perform material sampling and testing.

1.7 SUPPLY SOURCE AND QUALITY REQUIREMENTS

- A. Notify the Engineer of the proposed source of materials to be used before their delivery.
- B. The Department encourages the re-use of industrial byproducts that meet contract requirements.
 - 1. Use new materials for the work in cases where industrial byproducts do not meet contract requirements.
- C. Required testing for aggregate sources will be deemed invalid unless testing occurred within a year of submittal.

1.8 CONTRACTOR FURNISHED AGGREGATE SOURCES

- A. Acquire the rights to remove materials and enter into agreement with owner that specifies requirements for grading and reclamation after removing materials.
- B. Perform required quality tests using a laboratory qualified by the Department.
 - 1. The Engineer may require additional samples for inspection and testing before authorizing use of the material.
- C. Meet the requirements established by Utah Division of Oil, Gas, and Mining and other agencies having jurisdiction over the operation of commercial material source sites.
- D. Strip and stockpile topsoil before removing any materials.

1.9 FINISHING AGGREGATE SOURCE SITES

- A. Finish all public and private material source sites to the satisfaction of the Engineer.
- B. Grade to drain without causing excessive erosion and without altering the natural drainage courses.
- C. Locate aggregate waste sites in areas that are least visible from public view.
 - 1. Spread aggregate waste material to obtain a natural appearance.
- D. Remove trash.
 - 1. Remove, bury, or distribute excess materials over the disturbed areas when excavation has been completed.

- E. Perform required grading and reclamation, as required under the agreement with the property owner, when removal of material is complete and before spreading topsoil.
 - 1. Avoid vertical cuts and sharp corners.
 - 2. Grade side slopes to achieve a natural appearance.
 - 3. Abandon and obliterate haul roads.
 - 4. Obtain release from property owner indicating that all conditions of the agreement between the Contractor and property owner are satisfied.
- F. Spread topsoil over the excavated area disturbed by construction operations including obliterated haul roads and seed all areas with grass or grasses adaptable to the area.
 - 1. Obtain required seed mix from Engineer.
 - 2. Seed and mulch according to Section 32 92 19 – Seeding.

1.10 PLANT INSPECTION

- A. The Department may inspect and test materials at the acquisition, manufacturing, or supplying source for compliance with specified manufacturing methods.
- B. Cooperate fully and assist the Engineer during the inspection and testing.
 - 1. Allow the Engineer full access to all parts of the plant used to manufacture or produce materials.
 - 2. Provide and maintain adequate safety measures.
 - 3. Provide mechanisms for providing samples during inspections.
 - a. Equip crushing or screening facilities with automatic or semiautomatic mechanical sampling devices.

1.11 MATERIAL STORAGE AND HANDLING

- A. Store and handle materials according to manufacturer requirements.
- B. Transport bulk materials in a manner to prevent loss or segregation after loading and measuring.
- C. Store materials so they can be easily inspected and tested.
- D. Furnish copies of the permission agreements to store materials on private property to the Engineer if requested.
- E. Restore storage and plant sites to their original condition.

- F. Do not store materials and equipment on bridge decks and in areas that add loads to bridge elements.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

END OF SECTION

SECTION 01 50 00 – TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Temporary Utilities:
 - 1. Temporary electricity.
 - 2. Temporary heating.
 - 3. Temporary ventilation.
 - 4. Communication services.
 - 5. Temporary water service.
- B. Temporary sanitary facilities.
 - 1. Construction Facilities:
 - 2. Vehicular access.
 - 3. Parking.
 - 4. Progress cleaning and waste removal.
 - 5. Fire-prevention facilities.
- C. Temporary Controls:
 - 1. Security.
 - 2. Water control.
 - 3. Dust control.
 - 4. Erosion and sediment control.
 - 5. Noise control.
- D. Removal of utilities, facilities, and controls.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. ASTM International:
 - 1. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

3. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS Not Used

1.6 TEMPORARY ELECTRICITY

- A. Provide and pay for power service required from local source as needed for construction operation.
- B. Provide temporary electric feeder from electrical service at location as approved by Engineer. Do not disrupt Owner's use of service.

1.7 TEMPORARY HEATING

- A. Provide and pay for heating devices and heat as needed to maintain specified conditions for construction operations.
- B. Before operating permanent equipment for temporary heating purposes, verify installation is approved for operation, equipment is lubricated, and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts. Replace filters at Substantial Completion.

1.8 TEMPORARY VENTILATION

- A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

1.9 COMMUNICATION SERVICES

- A. Telephone Service: Provide, maintain, and pay for telephone service to field office at time of Project mobilization and until completion of Work.
- B. Facsimile Service: Provide, maintain, and pay for facsimile service to field office at time of Project mobilization and until completion of Work.
- C. Internet Service: Provide, maintain, and pay for broadband Internet service to field office at time of Project mobilization. Provide desktop computer with Microsoft operating system and appropriate office function software, modem, and printer.

1.10 TEMPORARY WATER SERVICE

- A. Provide suitable quality water service as needed to maintain specified conditions for construction operations.

1.11 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Existing facility use is not permitted. Provide facilities at time of Project mobilization.

1.12 VEHICULAR ACCESS

- A. Construct temporary all-weather access roads from public thoroughfares to serve construction area, of width and load-bearing capacity to accommodate unimpeded traffic for construction purposes.
- B. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage.
- C. Extend and relocate vehicular access as Work progress requires and provide detours as necessary for unimpeded traffic flow.
- D. Locate as indicated on Drawings or as approved by Engineer.
- E. Provide unimpeded access for emergency vehicles. Maintain 20 -wide driveways with turning space between and around combustible materials.
- F. Provide and maintain access to fire hydrants free of obstructions.
- G. Provide means of removing mud from vehicle wheels before entering streets.

1.13 PARKING

- A. Arrange for or Provide temporary gravel surface parking areas to accommodate construction personnel.
- B. If Site space is not adequate, provide additional off-Site parking.
- C. Tracked vehicles are not allowed on paved areas.
- D. Permanent Pavements and Parking Facilities:
 - 1. Avoid traffic loading beyond paving design capacity. Tracked vehicles are not allowed.
- E. Maintenance:
 - 1. Maintain traffic and parking areas in sound condition free of excavated material, construction equipment, products, mud, snow, ice, and the like.
 - 2. Maintain existing paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original condition.
- F. Removal, Repair:

1. Remove temporary materials and construction at Substantial Completion.
 2. Repair existing facilities damaged by use, to original condition.
- G. Mud from Site vehicles: Provide means of removing mud from vehicle wheels before entering streets.

1.14 PROGRESS CLEANING AND WASTE REMOVAL

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain Site in clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, before enclosing spaces.
- C. Broom and vacuum clean interior areas before starting surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and rubbish from Site periodically and dispose of off-Site.
- E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.15 FIRE-PREVENTION FACILITIES

- A. Portable Fire Extinguishers: NFPA 10; 10-pound capacity, 4A-60B: C UL rating.
 1. Provide minimum of one fire extinguisher in every construction trailer and storage shed.

1.16 SECURITY

- A. Security Program:
 1. Protect Work from theft, vandalism, and unauthorized entry.
 2. Initiate program at Project mobilization.
 3. Maintain program throughout construction period until Engineer.

1.17 WATER CONTROL

- A. Grade Site to drain. Maintain excavations free of water. Provide, operate, and maintain necessary pumping equipment.
- B. Protect Site from puddles or running water. Provide water barriers as required to protect Site from soil erosion.

1.18 DUST CONTROL

- A. Execute Work by methods that minimize raising dust from construction operations.
- B. Provide positive means to prevent airborne dust from dispersing into atmosphere.

1.19 EROSION AND SEDIMENT CONTROL

- A. Plan and execute construction by methods to control surface drainage from cuts and fills from borrow and waste disposal areas. Prevent erosion and sedimentation.
- B. Minimize surface area of bare soil exposed at one time.
- C. Provide temporary measures including berms, dikes, drains, and other devices to prevent water flow.
- D. Construct fill and waste areas by selective placement to avoid erosive surface silts and clays.
- E. Periodically inspect earthwork to detect evidence of erosion and sedimentation. Promptly apply corrective measures.
- F. Comply with sediment and erosion control plan if indicated on Drawings.

1.20 NOISE CONTROL

- A. Provide methods, means, and facilities to minimize noise produced by construction operations.

1.21 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, and materials before Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary Work.
- C. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

END OF SECTION

SECTION 01 55 26 – TRAFFIC REGULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Procedures for traffic regulation during construction of the Project.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES Not Used

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS

- A. Submit traffic control plan in accordance with the Supplemental General Conditions and UDOT State Specifications. Any traffic control concept shown on the plans is for bidding purposes and is intended to serve as a guideline only. The Contractor shall be responsible for the preparation and adequacy of any traffic control plan utilized, including a suggested plan, and shall submit the final traffic control plan (prepared, signed and sealed by a Utah licensed professional engineer) in drawing form to the Engineer.
- B. Submit to the Engineer a detailed signing and traffic detouring plan in drawing form for each phase for approval. Post detour routes to provide clear guidance to traffic as approved by the Engineer.

1.6 GENERAL

- A. Control traffic at those locations indicated and in conformance with the Plans and as approved by the Engineer.
- B. Furnish, install, construct, maintain, and remove detours, road closures, lights, temporary signals, signs, barricades, K-rail, fences, flares, miscellaneous traffic devices, flagmen, drainage facilities, paving, and such other items and services as are necessary to adequately safeguard the public from hazard and inconvenience. All such work shall comply with the ordinances, directives, and regulations of authorities with jurisdiction over the public roads in which the construction takes place and over which detoured traffic is routed by the Contractor.
- C. After devices have been installed, maintain and keep them in good repair and working order until no longer required. Replace such devices that are lost or damaged, to such an extent as to require replacement, regardless of the cause of such loss or damage.
- D. Prior to the start of construction operations, notify the Engineer and Draper City police and fire departments in whose jurisdiction the project lies, giving the

expected starting date, completion date, and the name and telephone number of a responsible person who may be contacted at any hour in the event of a condition requiring immediate correction.

1.7 TRAFFIC CONTROL DEVICES AND SIGNS

- A. Construction signing, striping, barricades, and other traffic control devices used for handling traffic and public convenience shall conform to the latest edition of the Federal Highway Administration "Manual on Uniform Traffic Control Devices for Streets and Highways" (MUTCD).
- B. Signs shall be reflectorized when they are used during hours of darkness. Provide cones, pylons, barricades, or posts used in the diversion of traffic with flashers or other illumination if in place during hours of darkness.
- C. Maintain a 24-hour emergency service to remove, install, relocate, and maintain warning devices and furnish to the authority having jurisdiction names and telephone numbers of three persons responsible for this emergency service. In the event these persons do not promptly respond or the authority having jurisdiction deems it necessary to call out other forces to accomplish emergency service, the Contractor will be held responsible for the cost of such emergency service.
- D. During the duration of a detour, cover all signs not in accordance with the traffic control plan. Relocate existing signs to provide visibility from all relocated traffic lanes.
- E. Temporary traffic striping, where used, shall be removable pavement marking tape. Pavement markings shall be white or yellow, weather and traffic resistant reflective film on conformable backing and pre-coated with a pressure-sensitive adhesive that does not require an activation process.
- F. Temporary pavement markings shall conform to the following minimum reflective values as specified. Express reflective values as candlepower per foot candle per square foot measured on a 1 foot by 2 foot (0.3 m by 0.6 m) panel at 86 degrees incidence.

Divergence

<u>Angle</u>	<u>White</u>	<u>Yellow</u>
0.2°	0.20	0.18
0.5°	0.18	0.16

- G. Supply striping tape in rolls ready for application. Use pavement message tape 20 to 30 mils (0.5 to 0.7 mm) thick, that does not shrink or release prematurely, and that has an easily removable liner.
- H. At the end of each workday, place temporary pavement markers on any roadway surfaces open to traffic. Apply pavement markers to a clean and dry surface during daylight hours. During winter shut-down, place permanent paint striping and pavement messages.

- I. Press the tape into the surface until it adheres to the pavement surface.

1.8 PORTABLE TEMPORARY TRAFFIC SIGNALS

- A. Provide a portable temporary traffic signal system for a one-lane/two-way temporary traffic signal. This work is to provide greater advance visibility to the flagging operation.
- B. Provide a system meeting the following equipment requirements:
 - 1. Two or more self-contained trailer mounted units each consisting of one or two signal heads.
 - a. Single-signal head system: signal head positioned on each side of the roadway.
 - b. Two-signal head system: one signal head mounted on a mast arm capable of extending over the center of the travel lane and the other signal head mounted on the same trailer.
 - 2. Meet the physical display and operational requirements of conventional traffic signals according to Part 4 of the MUTCD.
 - 3. Signal heads equipped with visors and back plates
 - 4. The operating temperature range at least -30°F to 120°F
 - 5. A solar cell system to facilitate battery charging.
 - 6. A minimum of 20 hours backup reserve battery supply and the capacity of operating with a 120 volt power supply from a generator or electrical service.
- C. During construction follow the requirements below:
 - 1. Notify the Engineer at least 48 hours prior to the use of the signals for timing approval and verification. Have a qualified vendor representative on site to perform the initial set up and enter the timing parameters.
 - 2. Set up and level the portable traffic signal installations in a manner the Engineer approves.
 - 3. Program all portable traffic signals for red flash upon startup, conflict, or power failure. Program the portable traffic signal system to dwell in all-red.
 - 4. Comply with the following:
 - a. Signal heads positioned over a road surface are mounted a minimum of 15 feet from the bottom of the signal head to the top of the road surface.
 - b. All other signal heads are mounted at a minimum of 8 feet from the bottom of the signal head to the top of the ground surface.

- c. The flaggers at each end of the work area control the portable traffic signals. The flagger can only activate or extend the green indication.
 - d. The yellow indication is approximately 4 seconds.
 - e. The minimum green time is 20 seconds. The green time can be extended in 2.5 second intervals by the flagger to allow the entire traffic queue to travel through the flagging operation.
 - f. Timing may need to be adjusted during construction to provided adequate wait times for traffic. Engineer or City has authority to have times adjusted.
- 5. In the event of a traffic signal malfunction or a continuous red flash mode, have flaggers perform on a 24 hour, 7 day a week basis until repairs are made and the traffic signals are fully functional.
 - 6. Set signals 1,500 feet apart to provide clearance of 500 feet of open trench for water line construction.

1.9 PORTABLE CHANGEABLE MESSAGE SIGNS (PCMS)/VARIABLE MESSAGE SIGN (VMS)

- A. Provide a PCMS with the following equipment requirements:
 - 1. The message displayed on the sign is visible for one-half mile (800 m) and legible at 650 ft (198 m) during both daytime and nighttime operation.
 - 2. The sign is capable of presenting three lines of message copy.
 - 3. Each line is capable of displaying eight (8) characters in various alpha, numeric, and alphanumeric combinations.
 - 4. The sign is capable of displaying at least three messages sequentially.
 - 5. The entire message cycle is readable at least twice by the motorists when traveling at the posted speed limit.
 - 6. Messages are displayed in preferably one phase but no more than two phases. Use of a message that requires more than two phases to convey the message shall have the prior approval of the Engineer.
 - 7. The legend for each line of the message board is a minimum of 17 in. (430 mm) in height, single stroke, and proportionally spaced.
 - 8. The bottom of the sign face is 7 ft. (2.1 m) from the ground when operating.
 - 9. The complete message sign unit is designed and certified to operate in ambient air temperatures ranging from -20°F (-29°C) to 140°F (60°C). The sign unit and its operation is not affected by adverse weather conditions.
 - 10. The sign is capable of operating for twenty-four (24) hours a day for two weeks continuously without interruption of service and without the need for auxiliary power sources. Power sources requiring the use of fuel have

-
- sufficient storage capacity for forty-eight (48) hours of continuous operation without refueling
11. The message board has a dark background with lamps, discs, light emitting diodes (LED's), or other approved illumination for displaying the message.
 - a. The light source does not alter the yellow color for flip-disc type signs or change the appearance of the background.
 - b. The message board is shielded or shaded from direct sunlight to ensure readability of the message.
 - c. The sign has both automatic and manual dimming capabilities for the light sources to maintain proper intensity for day and night operation.
 12. The controller is mounted in a lockable, weatherproof cabinet secured to the trailer and easily removed for service via plug-in connections.
 13. The entire sign is shielded from interference from mobile radio and cell phone transmissions
 14. The PCMS is entirely mounted on a trailer. Additional trailer requirements:
 - a. The trailer and the components of the sign is designed to allow one person to perform all transporting and operating functions without assistance.
 - b. The trailer is designed for unlimited on-highway travel at 70 mph (110 kph).
 - c. The trailer has a minimum of four outrigger type leveling jacks, one at each corner of the trailer deck.
 - d. The jacks are mounted to allow them to swivel into a locked position for secure storage during travel.
 - e. The trailer and all mounted equipment are structurally adequate for unlimited normal operation in wind velocities up to 80 mph (130 kph)
- B. During Construction follow the requirements below:
1. Use PCMS on all other types of roadways according to the traffic control plan or as directed by the Engineer.
 2. Display a message that is both concise and meaningful. Obtain the Engineer's approval for messages used on the PCMS.
 3. Include the location of the PCMS and any message to be displayed on the PCMS in the approved traffic control plan required.
 4. For emergency situations, PCMS that are smaller in size and do not have all of the capabilities outlined in this Specification, may be used until a PCMS that meets these requirements can be located and placed in operation at the site. (The Engineer will determine when conditions and situations are to be considered emergencies and will regulate the length of

time that non-specification PCMS may be used. Provide the Engineer written notification when non-specification PCMS signs are in use on the work.)

C. PCMS Phase Messages

1. Refer to project plans for Message requirements.
2. Do not use messages such as USE/CAUTION; HAZARD/AHEAD; or DANGER which are confusing and give no guidance to the motorist. Also, do not use messages such as BUCKLE/UP or DRIVE/SAFELY which diminish the impact of important and relevant messages.

D. Protection

1. Unless a PCMS is protected by positive barrier such as guardrail or temporary concrete median barrier, place a minimum of three (3) drums on the approaching traffic side of the PCMS to delineate the base of the sign.
2. Remove PCMS from the roadway when not in use unless the sign is located a minimum of 34 ft. (10.4 m) from the edge of the travel way or protected by positive barrier. When a PCMS is not displaying a message, turn the message panel away from the approaching traffic.

E. Contractor Warranty and Maintenance

1. Keep the units in good repair and neat and clean in appearance. If the unit fails, malfunctions, or is damaged, immediately repair the unit and furnish flaggers or other approved means to safely control the traffic until the units are back in service. Make repairs or replace the unit within 24 hours. Maintenance also includes periodically cleaning the units.

1.10 VEHICULAR TRAFFIC CONTROL

Reduce speed limit through the construction zone to 25 mph and post accordingly.

Traffic lane transitions from permanent lanes to construction zone patterns shall be transitioned in accordance with the requirements for the normal posted speed limit and as shown on the plans.

Where traffic is directed around or adjacent to the construction area, the contractor shall provide, install, maintain, and remove delineators, barricades, lights, signs, and other devices required for the control of traffic as required by UDOT traffic regulations and said "Manual on Uniform Traffic Control Devices". The Engineer shall have the right to relocate or direct the Contractor to relocate traffic control devices.

All roadways and sidewalks shall be returned to unrestricted vehicle and pedestrian usage when construction is not underway. Truck operations in and out of construction and staging areas shall be controlled by flagmen at all times.

- A. Perform work with minimal obstruction to traffic.
- B. The maximum delay to the public due to Contractor construction activities is four hours.
- C. Construction in Intersections: The Contractor shall maintain one lane of traffic through the construction area at all times, or single blocks shall be closed at a time if suitable detours can be made. Access to residences shall be made at the conclusion of the day's work.

1.11 PEDESTRIAN TRAFFIC CONTROL

- A. Place and maintain warning signs according to the authorized Traffic Control Plan.
- B. Provide ADA compliant access in areas where construction interferes with existing access.

1.12 ACCESS TO ADJACENT PROPERTIES

- A. General: Maintain reasonable access to all adjacent properties at all times during construction. Prior to restricting normal access from public streets to adjacent properties, notify each property owner or responsible person, informing him of the nature of the access restriction, the approximate duration of the restriction, and the best alternate access route for that particular property.

1.13 CONSTRUCTION PARKING CONTROL

- A. Control vehicular parking. Do not interfere with public traffic or parking, access by emergency vehicles, Owner's operations, or construction operations.
- B. Monitor parking of private vehicles.
 - 1. Maintain free vehicular access to and through parking areas.
 - 2. Prohibit parking on or adjacent to access roads, or in non-designated areas.
 - 3. Maintain fire and emergency vehicle access.

1.14 OPEN PROJECT SECTIONS TO TRAFFIC

- A. The Engineer may direct certain sections of work opened to traffic before completion or acceptance of the work.
- B. Directing a section of work does not constitute acceptance of the work or a waiver of any contract provisions.
- C. Maintain any section of roadway opened to traffic at the direction of the Engineer.

1. Contractor is paid according to Section 01 29 00 Payment when the section of roadway opened to traffic is not the result of Contractor fault or inactivity.
- D. The Engineer gives notice establishing a time period for completing features of the work for which the Contractor has not met contractual milestone dates.
 1. Engineer may order all or a portion of the project opened to traffic if the Contractor does not complete or make a reasonable effort to complete the late work.
- E. Assume responsibility for maintaining the work and conduct the remaining construction operation with minimum interference to traffic.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

END OF SECTION

SECTION 01 57 13 – TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Temporary environmental controls to control erosion and prevent sediment laden runoff from leaving the construction site and areas under the Contractor's control.

1.2 RELATED SECTIONS

- A. Section 31 35 00 – Geotextiles

1.3 REFERENCES

- A. AASHTO M 288: Geotextile Specifications for Highway Applications
- B. AASHTO Construction Stormwater Field Guide
- C. ASTM D 4355: Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
- D. ASTM D 4491: Water Permeability of Geotextiles by Permittivity
- E. ASTM D 4751: Determining Apparent Opening Size of a Geotextile
- F. Utah Pollutant Discharge Elimination System, Utah Construction General Permit (UCGP)

1.4 DEFINITIONS

- A. Check Dam – A fiber roll or stone structure placed across a roadside ditch to temporarily protect ditch from channel erosion by slowing velocity of stormwater runoff and intercepting and trapping sediment.
- B. Disturbed Area – Areas within a construction site where existing vegetative cover, or existing stabilized areas, have been removed or altered and exposed soils are susceptible to increased erosion and sedimentation.
- C. Drop-Inlet Barrier – A barrier placed around a storm drain inlet grate, situated outside of roadway pavement condition that is designed to intercept and trap sediment-laden runoff before entering the storm drain system.
- D. Fiber Roll – Wood excelsior, rice or wheat straw or coconut fibers rolled or bound netting to form a tube-like structure used to intercept and trap sediment.
- E. Final Stabilization – Procedures and controls completed as the final measure to protect disturbed areas of a construction site from erosion and sedimentation until

vegetation regrowth occurs to provide ultimate erosion protection.

1. Includes work within areas to be vegetated such as establishing final grades, placing topsoil, incorporating seed; roughening slopes by walking track-mounted equipment up and down slopes; applying mulch, erosion control blanket, flexible channel liner; and installing other landscape treatments to protect exposed soils from erosion.
 2. Includes work within areas intended to remain unvegetated such as placing final pavement; installing stone, gravel and other stable material that will prevent erosion of underlying soil.
- F. Gutter-Inlet Barrier – A device designed and prefabricated to secure to the top, envelop or hang below a storm drain inlet grate, situated within roadway pavement condition that keeps sediment and debris from entering the storm drain system.
- G. Pipe-Inlet Barrier – A barrier placed at a pipe inlet that intercepts and traps sediment before entering the pipe.
- H. Sediment Trap – A small temporary excavated basin installed at low points on a construction site designed to trap sediment-laden runoff to allow sediment to settle out before leaving site.
- I. Silt Fence – A geotextile fabric fence used to intercept and trap sediment in a sheet flow situation, along the perimeter of a disturbed area.
- J. Slope Drain – A polyethylene pipe temporarily placed on a slope to collect and transport storm runoff down the face of a slope until permanent drainage facilities are installed or vegetation growth is adequate.
- K. Stabilized Construction Entrance – A layer of stone, underlined with a geotextile fabric, placed at a construction site entrance or exit used to reduce the amount of sediment or mud tracked onto adjacent paved roadways by vehicles leaving the construction site.
- L. Straw-Bale Barrier – Temporary barrier installed by placing straw bales end to end along perimeter of a disturbed area designed to intercept and slow sediment laden runoff before it leaves a construction site.
- M. Temporary Berm – A ridge of compacted soil with or without a shallow ditch that diverts stormwater runoff from a slope to a controlled release point.
- N. Temporary Environmental Fence – A high-visibility fence barrier used to delineate and prevent encroachment on sensitive areas.

1.5 SUBMITTALS

- A. Manufacturer's product data sheets and recommended installation instructions.

PART 2 - PRODUCTS

2.1 FIBER ROLL

- A. Diameter (minimum weight per linear foot)
 - 1. 18 inch (3 lb per linear foot)
 - 2. 12 inch (2 lb per linear foot)
 - 3. 9 inch (1 lb per linear foot)
- B. Functional Longevity – 24 months minimum (includes netting material).
- C. Matrix material – Wood excelsior, rice or wheat straw, and coconut fibers (coir) or in combination.
 - 1. Material must be weed free.
- D. Netting – UV stabilized synthetic or coir material, with 1 inch maximum opening size, secured at end for matrix containment.
- E. Wood Stakes
 - 1. 18 inch Fiber Roll – $\frac{3}{4}$ inches and 1½ inches by 3 feet minimum dimensions.
 - 2. 12 inch Fiber Roll – $\frac{3}{4}$ inches and 1½ inches by 18 inch minimum dimensions.
 - 3. 9 inch Fiber Roll – $\frac{3}{4}$ inches and 1½ inches 18 inch minimum dimensions.

2.2 SILT FENCE

- A. Silt Fence Fabric – 3 foot minimum width, conforming to Table 7 of AASHTO M 288.
- B. Wood Post – 1½ inches by 1½ inches by 4 feet minimum dimensions.
- C. Fasteners – Staples, wire, cable ties, or nails sufficient to maintain fabric attachment to post.

2.3 CHECK DAM

- A. Fiber Roll – 12 inch diameter, or
- B. Stone – Angular, well-graded 2 to 6 inch diameter.

2.4 DROP-INLET BARRIER

- A. Fiber Roll – 18 inch diameter, or

B. Silt Fence

1. Wooden Support Frame – 2 by 4 inch (nominal) wood studs.

2.5 GUTTER-INLET BARRIER

- A. Apparent Opening Size (ASTM D 4751) – between 20 and 40 sieve.
- B. UV Resistance (ASTM D 4355) – 65percent minimum.
- C. Flow Rate (ASTM D 4491) – 100 gpm/ft² minimum.
- D. Filter Material – Monofilament, woven or nonwoven geotextile.
- E. Provide protection to entire inlet opening.
- F. Types:
 1. Above Inlet Grate
 - a. Mount securely to the top side of the inlet grate at each corner with cable ties, wire or similar.
 2. Inlet Cover Grate
 - a. Sewn geotextile fabric that envelopes entire inlet grate.
 - b. Must have built-in lifting straps or other device to allow removal of inlet grate and barrier.
 3. Below Inlet Grate
 - a. Mount device securely to the inlet grate or have independent frame that allows geotextile bag to hang below grate to capture runoff.
 - b. Must be designed with a bypass feature that allows stormwater to be conveyed into the conveyance system when geotextile is filled to capacity.
 - c. Must be able to remove from storm drain inlet and maintain device without dumping captured sediment into the storm drain system.

2.6 PIPE-INLET BARRIER

- A. Fiber Roll – 18 inch diameter, or
- B. Stone – Angular, well-graded 2 to 6 inch diameter.

2.7 TEMPORARY BERM

- A. Compacted existing soil.

- B. Free of debris, such as trees, brush, obstructions and other objectionable material that will not allow for compaction of berm material.

2.8 TEMPORARY ENVIRONMENTAL FENCE

- A. Fence Fabric
 - 1. Polyethylene, high-density (HDPE) and UV stabilized
 - 2. Height – 4 ft minimum
 - 3. Color – Orange
- B. Posts
 - 1. Wood Post – 1½ inches by 1½ inches by 4 feet minimum dimensions.
 - 2. Fasteners – Staples, wire, cable ties or nails sufficient to maintain fabric attachment to post.

2.9 SEDIMENT TRAP

- A. Stone – Angular, well-graded 6 to 12 inch diameter

2.10 SLOPE DRAIN

- A. 12 inch diameter single wall polyethylene pipe
- B. Polyethylene pipe end section
- C. Stone – Angular, well-graded 6 to 12 inch diameter
- D. Wood Stakes – 1½ inches by 1½ inches by 3 feet minimum dimensions.

2.11 STABILIZED CONSTRUCTION ENTRANCE

- A. Stone – Crushed aggregate, well-graded 2 to 3 inch diameter.
- B. Geotextile Fabric (Separation) – Refer to Section 02075.

2.12 STRAW-BALE BARRIER

- A. Straw Bales – Certified weed free straw bales by the Utah Department of Agriculture.
- B. Wood Stakes – 1½ inches by 1½ inches by 4 feet minimum dimensions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install appropriate controls as shown before beginning earth disturbing activities.
- B. Refer to installation procedures outlined in EN Series Standard Drawings and the AASHTO Construction Stormwater Field Guide.
- C. Install temporary environmental fence in the required locations before construction activities begin.
 - 1. Install posts at a 12 ft maximum spacing so the fence does not sag more than 2 inches between posts.
 - 2. Weave the fence over the support posts alternating every two loops and secure it to the posts with fasteners.
- D. Install Gutter-Inlet Barrier according to manufacturer's recommendations.

3.2 INSPECTION

- A. Check installed controls before and after each rain event to verify proper working function and compliance with the UCGP.
- B. Replace controls that are not properly working to prevent erosion and sedimentation.

3.3 MAINTENANCE

- A. Maintain controls to function properly until surrounding disturbed areas have met final stabilization measures.
- B. Remove accumulated sediments from controls when depth reaches 50 percent of the control height or when it interferes with the performance of the control.
- C. Properly dispose of accumulated sediment.

3.4 REMOVAL

- A. Remove temporary environmental controls when surrounding disturbed areas have met final stabilization measures, except as follows:
 - 1. Do not remove perimeter controls, such as silt fence, fiber rolls or straw bales, when they protect a wetland or waterway unless the surrounding area meets final stabilization requirements identified within the UCGP.
 - 2. When the Engineer determines that controls should remain in place.

- B. Remove temporary environmental fence and posts upon completion of construction.

END OF SECTION

SECTION 01 57 20 – DUST CONTROL AND WATERING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Provide and apply water for dust control and pre-wetting, mixing, or compacting materials.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES Not Used

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS Not Used

- A. List all contractor submittals

1.6 PAYMENT

- A. All costs associated with Dust Control and Watering are incidental to other items of work and no separate measurement or payment will be made unless otherwise specified.

PART 2 - PRODUCTS

2.1 WATER

- A. Free of dirt, silt, and other detrimental matter in adequate quantities for dust control and watering requirements.

2.2 EQUIPMENT

- A. Water distribution system – Self-propelled, pressure distributor with a spray system, equipped with a positive shut-off control.
 - 1. Pressure pump must have the capacity to apply the whole load uniformly.
- B. Water truck – 1,000 U.S. gallons minimum capacity, with the capacity clearly and permanently marked on the tank.
 - 1. Engineer may require Contractor to verify capacity.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Apply water for dust control in quantities and locations as directed by the Engineer and to maintain environmental compliance.
 - 1. Dust control may be required at any time.
 - 2. Do not waste water.

END OF SECTION

SECTION 01 70 00 – CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Repair of the Work.

1.2 ACTION SUBMITTALS

- A. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

1.3 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 7 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, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number where applicable.

- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 7 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Instruct Owner's personnel in maintenance of products.
 2. Complete final cleaning requirements, including touchup sealant installation.
 3. 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 7 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. 2. Results of completed inspection will form the basis of requirements for final completion.

1.4 FINAL COMPLETION PROCEDURES

- A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
1. Submit a final Application for Payment.
 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. Submit Commissioning Checklists
 4. Instruct Owner's personnel in maintenance of products and systems
- B. Inspection: Submit a written request for final inspection to determine acceptance. 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.

1.5 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. Submit list of incomplete items in the following format:
 - a. PDF electronic file. Engineer will return annotated copy electronically.

1.6 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 into an orderly sequence based on the table of contents of the Project Manual.
 - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper. Fines issued by regulatory agencies against the Department are added to the disincentives assessed to the Contractor.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION

3.1 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.

PART 4 - PRODUCTS Not Used

PART 5 - EXECUTION Not Used

END OF SECTION

SECTION 01 71 23 – SURVEY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Construction surveying, staking, measurement, and calculations essential to complete the project and properly control the entire work.
- B. Directed surveying.
- C. Processes and procedures for implementing Machine Control Guidance (MCG) technology. MCG uses Global Positioning System (GPS) and Robotic Total Station (RTS) in conjunction with three-dimensional computer models to determine the precise location and elevation of the materials being moved.

1.2 RELATED SECTIONS

- A. Section 32 17 23: Pavement Markings

1.3 REFERENCES

- A. UDOT CADD Standards
- B. UDOT Plan Sheet Development Standards
- C. UDOT Survey & Geomatics Standards Manual
- D. Utah Administrative Code
- E. Utah Code

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS

- A. Submittals must be signed and sealed by a Professional Land Surveyor licensed in the State of Utah.
- B. Statement before work begins indicating the horizontal and vertical survey control provided in the plans has been field checked and the control has been determined to be accurate within the tolerances specified in the UDOT Survey and Geomatics Standards Manual. Refer to <http://www.udot.utah.gov/go/standardsreferences>.
 - 1. Attach field survey information used to verify control.
 - 2. Contact the Engineer verbally and in writing if discrepancies are found.
 - 3. Include additional survey points required to implement the MCG/RTS technology.

- C. Written description of the equipment before beginning work including calibration certifications, manpower, methods, and data storage format proposed for use to complete survey activities.
- D. Surveying and design data:
 - 1. As-built survey and design data to the Engineer after project completion with compliance to the UDOT Survey and Geomatics Standards, Plan Sheet Development Standards, and UDOT CADD Standards. Refer to <http://www.udot.utah.gov/go/standardsreferences>.
 - 2. Complete the following if design plans were included with the advertising package for the project:
 - a. Provide a red-lined hard copy plan set showing "As-built" features denoting changes from the original design.
 - b. Provide an electronic copy of the red-lined 11 x 17 "As-built" plan, containing the "As-Built" stamp dated and signed by the Engineer (Utah Code 58-22-602), in a colored PDF format as follows:
 - 1) Resolution of not less than 400 dpi.
 - 2) Individual file sizes not greater than 100 megabytes.
 - 3) Group similar sheet types together into individual PDF files such as Summary Sheets grouped together in a single PDF file or Summary Sheets and Plan and Profile Sheets grouped together in a single PDF file.
 - c. Salt Lake City As-Built Plan requirements (hard-copy):
 - 1) Provide the following data on the as-built plans at all manholes, valves, lids, hydrants, vents, and other above-ground utility appurtenances:
 - a) Roadway station and offset
 - b) Top Elevation
 - c) Flowline Elevation (if applicable)
- E. Survey Monuments certified supplement
 - 1. Refer to this Section, Article 3.12, paragraph C3 for submittal of drawings and notes.
- F. Provide the following for MCG technology implementation:
 - 1. Notification that MCG will be used on the project at preconstruction meeting.
 - 2. Electronic or hand written stakeout/cut-fill reports or both for cross section stakes, according to this Section, Article 3.5.

- G. Reports are not required when measurement of work is by "Plan Quantity" or Weight.

1.6 MEASUREMENT

- A. Directed Survey – Use a survey crew measured by the hour and approved if extra survey work is directed. No additional payment is made for travel time to and from the project.

1.7 PAYMENT

- A. Directed survey work is paid for in the accepted quantities if needed and approved at a standard negotiated rate.

1.8 QUALITY ASSURANCE

- A. Assume responsibility for survey and control of the work and for correcting errors whether the errors are discovered during the actual survey work or in subsequent phases of the project and bears cost overruns resulting from errors.
- B. Any 3D model used in conjunction with MCG must be verified and approved before use by the Contractor.
- C. Assume responsibility for construction errors that result from the 3-D model once the design 3D model has been accepted.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Tools, supplies, and stakes suitable for use in highway survey work.
- B. Stakes and hubs of sufficient length to provide a solid set in the ground with sufficient surface area above ground for necessary legible markings.
- C. Survey instruments and supporting equipment capable of achieving the specified tolerances.
 - 1. Calibrate survey equipment annually and check for accuracy before beginning survey work and as required throughout the duration of the project. Make the calibration certificate available upon the Engineers request.

2.2 EQUIPMENT FOR OWNER USE

- A. Provide and maintain the following equipment when MCG is used on the project:
 - 1. GPS Capable Rover compatible with the other GPS equipment being used on the project.

2. Other hardware and software associated with the equipment so that Engineer's personnel can operate the equipment for quality assurance purposes.
3. Provide adequate training so that Engineer's personnel can operate the survey equipment.
4. Make GPS rover available immediately upon request from the Engineer.
5. Develop a process with to check-in and check-out equipment from the Contractor.

PART 3 - EXECUTION**3.1 PREPARATION**

- A. Discuss and coordinate the following with the Engineer before survey work begins:
 1. Submittals
 2. Survey and staking methods
 3. Stake markings
 4. Grade control
 5. Referencing
 6. Structure control
 7. Other procedures and control necessary for the work
 8. Documentation procedures
- B. Establish construction survey points, elevations, and grades as necessary to control layout and complete the work.
 1. Verify control surveying and staking meet specified tolerances before beginning work.
- C. Calculate grades, elevations, offsets, and alignment data necessary for staking or setting items of work.
- D. The Owner will provide, if available:
 1. Horizontal and vertical control points and elevation benchmarks.
 - a. Do not disturb control points and elevation benchmarks.
 2. Electronic project data
 3. Digital Terrain Model used for design
- E. Record keeping – Keep field notes, diaries, and books according to standard surveying practice.

1. Make available survey records including field notebooks and forms used for the work to the Engineer upon request.
 2. Electronic records and reports are acceptable
- F. Contract Provision Disclaimer
1. Provide a written request to the Engineer to obtain electronic data.
 - a. Electronic data is available in AutoCAD Civil3D format only.
 - b. Waive claims that may result from the use of or reliance on the electronic data.
 2. Electronic Data is prepared by the Owner for its own purposes and not for the benefit of private individuals or businesses.
 3. Indemnify and hold the Owner harmless for damages, costs, attorney fees, or other liabilities that might be incurred as a result of the Owner's use and reliance on the Contractor's modified data.

3.2 DIRECTED SURVEY

- A. Conduct directed surveying if directed by the Engineer.
1. Includes work needed for changes and extra work.
 2. Provide labor, materials, and equipment including total stations, global positioning system (GPS), LiDAR scanning or other equipment.

3.3 COMPUTATIONS AND PLOTS

- A. Use cross-sections to calculate volume measurements.
1. Superimpose final cross sections with original cross sections and calculate final quantities using the average end area method.
 2. Develop cross-sections from field measurements.
 - a. Take cross section measurements both before and after excavation and before backfill.
 - b. Take cross sections at a maximum centerline spacing of 15ft when the centerline curve radius is less than or equal to 500 ft.
 - c. Take cross sections at a maximum spacing of 30 ft when the centerline curve radius is greater than 500 ft.
 - d. Take additional cross sections at breaks in terrain and at changes in typical sections.
 - e. Measure and record points at breaks in terrain for each cross section but at least every 15 ft.
 - f. Measure and record points to at least the anticipated slopes and reference locations.

- g. Reduce cross section distances to horizontal distances from centerline.
 - h. Take cross sections at right angles to tangents and normal to curves.
 - i. Include in cross sections: grades, locations, and existing ground line profiles.
- 3. May develop volumes from digital terrain models if:
 - a. Ground survey locations do not exceed 50 ft in any direction.
 - b. Major horizontal and vertical breaks in terrain are also included.
 - c. Horizontal and vertical control for the project is used.
 - d. DTM is verified accurate to required tolerances as indicated in the UDOT Survey & Geomatics Standards manual by spot checking throughout the length of the project. Refer to <http://www.udot.utah.gov/go/standardsreferences> to view this manual.

3.4 STAKE MAINTENANCE AND MARKINGS

- A. Provide and maintain reference/location stakes that identify stationing at least every 100 ft until the work has reached physical completion and accepted by the Engineer for each alignment and approved for removal.
 - 1. Provide reference/location stakes at whole station intervals such as 1032+00.
- B. Maintain staking necessary for the work until the construction has reached physical completion, accepted by the Engineer, and approved for removal.
 - 1. Legibly mark survey stakes with station and offset referenced to their respective control line.
 - 2. Mark slope, reference, and guard stakes with station.
 - 3. Renew illegible or damaged stakes.

3.5 SURVEY TOLERANCES

- A. Follow the guidelines set in the UDOT Survey & Geomatics Standards manual.
 - 1. Refer to <http://www.udot.utah.gov/go/standardsreferences> to view this manual.
- B. Amend the survey control diagram as requested for the project.
 - 1. Have the amended diagram sealed, signed, and dated by a Professional Land Surveyor in accordance with UC 58-22-601, 602, 603, and Utah Administrative Code R156-22-601.

-
2. Refer to <http://www.udot.utah.gov/go/standardsreferences> for Utah Code and Utah Administrative Code.
- C. Relocate initial horizontal and vertical survey control points in conflict with construction to areas that will not be disturbed by construction operations.
1. Furnish to the Region Surveyor in coordination with the Engineer the coordinates and elevations for the relocated points before the initial points are disturbed.
- D. Protect benchmarks from construction activities.
1. Position benchmarks to allow a level rod to stand vertically and squarely on the mark.
- E. Reference benchmarks to centerline and horizontal measurements.
1. Compensate or correct for systematic errors, including those associated with instrument calibration
 2. Select the appropriate equipment and methods, and use trained personnel.
 3. Use appropriate error propagation and other measurement design theory to select the proper instruments, field procedures, geometric layouts and computational procedures to control random errors.
- F. Apply appropriate procedures to verify that the allowable positional tolerance of such points is not exceeded if radial survey methods, GPS, or other acceptable technologies or procedures are used to locate or establish points on the survey.
- G. The positional tolerance may be tested by:
1. Comparing the relative location of points in a survey as measured by an independent survey of equal or higher accuracy or,
 2. The results of a minimally constrained, correctly weighted least squares adjustment of the points on the survey.
- H. Employ field procedures, instrumentation and adequate survey personnel in order to achieve a precision of 0.02 feet (or 6 mm) + 20 ppm.
1. See Table 1 for construction staking tolerances.

Table 1 – CONSTRUCTION STAKING TOLERANCES		
Description	Horizontal	Vertical
	Decimals of a foot	
Box Culverts	± 0.02	± 0.02
Bridge Superstructures	± 0.02	± 0.02
Bridge Substructures	± 0.02	± 0.02
Clearing and Grubbing Stakes	± 1.00	-----
Construction Centerline Control Points	± 0.05	-----
Construction Centerline Station Points	± 0.10	-----
Curbs, Walks, and Bike Paths	± 0.03	± 0.02
Grade Stakes – Roadway Subgrade	± 0.20	± 0.05
Grade Stakes – Top of Rock	± 0.20	± 0.03
Grade Stakes – Roadway Finish	± 0.10	± 0.02
Luminaire and Signal Poles (incl. footings)	± 0.20	± 0.20
Manholes, Inlets, and Culverts	± 0.10	± 0.03
PCC Pavement	± 0.10	± 0.02
Slope Stakes and References	± 0.30	± 0.10
Traffic Markings	± 0.20	-----
Walls – Retaining, MSE, Sound, etc.	± 0.05	± 0.05
Wetland Mitigation Control Stakes	± 0.20	± 0.20
Notes: 1. Stakes for miscellaneous items not listed above will have a horizontal and vertical tolerance of 0.20 ft, unless otherwise directed. 2. Features that are to be constructed flush to another surface should take on the same tolerance as that surface. 3. Staking tolerances for special circumstances will be discussed at the pre-survey meeting. 4. Meet the appropriate construction tolerances for the material as specified in the special provisions or standard specifications, regardless of the construction staking tolerances, specific to the work item. 5. Use bridge control once established, independent of other project controls for the duration of the bridge construction. Refer to Survey & Geomatics Standards manual for bridge control methodology. Refer to http://www.udot.utah.gov/go/standardsreferences. 6. Tolerances stated for each type of construction stake in this table indicates the acceptable deviation of the position of each reference point from its computed position relative to the given alignment and grade. Staked positions are generally checked using electronic stakeout reports and, if within tolerances, the stated position is accepted. Reference points may also have an accuracy relative to each other for precise measurements such as structures.		

2. Survey Staking Methods:
 - a. Furnish reference stakes for slope stakes and stakes used for setting items for work.
 - b. Furnish the following for projects using Conventional Survey Methods:
 - 1) Establish and set slope stakes and references on both sides of centerline at cross section locations.
 - a) Place slope stakes at a maximum centerline spacing of 25 ft when the centerline curve radius is less than or equal to 500 ft.
 - b) Place slope stakes at a maximum spacing of 50 ft when the centerline curve radius is greater than 500 ft.
 - c) Place reference stakes at a maximum centerline spacing of 100 ft on tangents.
 - 2) Establish slope stakes in the field as the actual point of intersections of the design slope with the natural ground line.
 - 3) Set slope stake references outside the clearing limits.
 - 4) Include reference point and slope stake information on the reference stakes.
3. Furnish the following for projects using Machine Control Guidance Methods:
 - a. Establish and set location stakes and references on one side of centerline at cross section locations.
 - 1) Place cross section stakes at a maximum spacing of 300 ft. (Cross-section stakes reference physical points in the proposed cross-section, such as edge of pavement or top back of curb)
 - b. Place slope stakes at a maximum spacing of 300 ft.
 - c. Establish slope stakes in the field at the actual point of intersections of the design slope with the natural ground line.
 - d. Set slope stake references outside the clearing limits.
 - e. Include reference point information on the reference stakes.
 - f. Provide adequate bench marks throughout the project for construction equipment equipped with MCG to check setup and tolerances.
 - 1) Perform equipment checks at least once per day.

-
- 2) Record equipment checks in a log for verification by the Engineer.
 4. Staking limits – Reference/Location stakes can serve the purpose of the following staking requirements as long as required information for both purposes can be written on the stake.
 - a. Stake clearing limits on both sides of centerline at each established station.
 - 1) Locate the clearing limit on the ground as shown by the cut and fill limits on the plans.
 - b. Stake right of way limits, or temporary construction easement (TCE) if one exists, every 500 ft maximum on tangents, every 250 ft maximum on curves where ROW is not delineated by existing fence lines or other obvious boundaries.
 - 1) Stake Right of Way limits at right of way break/angle points along the right of way lines.
 - 2) Reduce the distance if staking distance is affected by line of sight.
 - c. Stake environmental control limits on both sides of centerline at each established station.
 - 1) Locate the environmental control limits on the ground as shown by the slope rounding contours and environmental and silt fence locations as shown on the Plans.
 - 2) Stake environmental control limits every 25 ft in environmentally sensitive areas.
 - 3) Provide staking as needed to guarantee the silt fence is located inside of right of way in standard silt fence installations where stations/locations are not called out on the environmental control plan sheets,.
 - I. Setting grade finishing stakes (Conventional Survey or RTK):
 1. Grade elevations and horizontal alignment:
 - a. On centerline.
 - b. On each shoulder at roadway cross section locations and between centerline and shoulder with a maximum spacing of 25 ft.
 - c. At the top of subgrade and the top of each aggregate course.
 2. Locations:
 - a. Set stakes on centerline, on each normal shoulder, and on the shoulder of the turnout where turnouts are constructed.
 - b. Set hubs at the center and along the edges of parking areas.
 - c. Set stakes in ditches to be paved.

3. Maximum spacing between stakes along the alignment is 50 ft.
 4. Use brushes or guard stakes at each grade finishing stake.
 5. Reset grade finishing stakes as many times as necessary to construct the subgrade and each aggregate course.
- J. Grade Verification (Machine Control Guidance)
1. The following procedure will only be applicable for verification of roadway layers for grade elevations and horizontal alignment.
 - a. The Engineer will use the Contractor provided survey equipment that is capable of verifying grade to tolerances required.
 - b. The Engineer may verify elevations at the following locations:
 - 1) On centerline.
 - 2) On each shoulder at roadway cross section locations and between centerline and shoulder with a maximum spacing of 25 ft.
 - 3) At the top of subgrade and the top of each aggregate course.
 2. Locations:
 - a. On centerline, on each normal shoulder, and on the shoulder of the turnout where turnouts are constructed.
 - b. At the center and along the edges of parking areas.
 - c. At the top of subgrade and the top of each aggregate course.
 - d. In ditches to be paved.
 3. The Engineer may verify and document elevations at a 300 ft maximum spacing between locations along the alignment.
 - a. The Engineer reserves the right to increase the spacing between grade verification locations up to, but not to exceed, 1000 ft if a level of confidence can be attained by the Engineer.

3.6 CONCRETE PAVING

- A. Develop a method of horizontal and vertical survey control for the placement of concrete pavement.
1. Use laser, wire, or string line to maintain horizontal and vertical control.
 2. Maximum spacing, 50 ft
 3. Set control on both sides of roadway.
- B. 3D Paving, Machine Control Guidance, Wireless Paver

1. Stagger survey control on either side of the highway to provide a good strength of figure.
 - a. Place control points for MCG according to equipment manufacturer recommendations.
 - b. The instrument setup must obtain vertical accuracies within ± 0.02 ft of the existing control.
- C. Stake concrete joint and station stamp locations as determined by the Engineer.

3.7 DRAINAGE STRUCTURES

- A. Stake drainage structures in coordination with the Engineer.
 1. Survey and record the ground profile along the centerline of the structure.
 2. Determine the slope catch points at inlets and outlets.
 3. Set reference points and record information necessary to determine structure length and end treatments.
 4. Stake ditches or grade to make the structure functional.
 5. Plot the profile along centerline of the structure to show the natural ground, the flow line, the roadway section, and the structure.
 6. Mark guard stakes with the following, when applicable:
 - a. Diameter, length, and type of culvert such as 18 inch x 35 ft corrugated metal pipe (cmp)
 - b. The vertical and horizontal distance from the hub to the invert at the end of the culvert or intermediate point as needed or directed
 - c. Flow line grade of the pipe
 - d. Station
 7. Provide a reference at a maximum spacing of 50 ft for storm sewers and waterlines. Reference inverts of pipe at manholes.

3.8 BRIDGES

- A. Based upon the Projects Primary Control points, set at least 4 horizontal and vertical survey control reference points to be used for surveying bridge substructure and superstructure components including but not limited to pile locations and cutoffs, line and grade for abutments, bents, beam seats, anchor bolts, and screed grades.
- B. Set intermediate slope stakes at bridge abutments to establish transitions.
 1. Place finish grade stakes on the centerline of abutment bearing and at the top of slope of bridge berms.

2. Place finish grade stakes on each side at top, mid-point, or slope and toe of fill.

3.9 BOX CULVERTS

- A. Set horizontal and vertical control and reference points.
 1. Establish and reference the centerline, back of parapet or barrier, skew, and flow line elevations at inlet, outlet, and breaks.

3.10 CURB AND GUTTER

- A. Set curb and gutter staking at 25 ft intervals on tangent and 10 ft intervals on curve radii.
- B. Set line and grade for curb and gutter within 0.02 ft of the proposed or established grade line.

3.11 GUARDRAIL

- A. Stake guardrail vertical and horizontal control at a maximum spacing of 25 ft on tangent sections and 10 ft on curves.
- B. Obtain the Engineer's approval and field verification of staking before installation.

3.12 EXISTING SURVEY MONUMENTS

- A. Locate and reference private and public land survey monuments that may be destroyed by project construction activities before disturbing those existing monuments and under the direction of a Professional Land Surveyor licensed in the State of Utah.
- B. Complete referencing and reestablishing those existing monuments before project completion.
- C. Reference and reestablish the monuments created by the county surveyor.
 1. Notify the county surveyor at least 30 days before the destruction of monument.
 2. Coordinate the reestablishment of section corner and quarter corner monuments with the county surveyor.
 3. Prepare a corner record to be filed in the office of the County Surveyor's Office per Utah State Code 17-23-17.5 unless prepared by the County Surveyor's Office.
 4. Submit a certified supplement to the Survey Control Sheet with notes to the Engineer showing references to section corners and quarter corners.

3.13 RETAINING WALLS

- A. Set horizontal and vertical control and reference points based upon the projects primary and secondary control.
 - 1. Establish and reference the centerline offsets for the walls, radius points, and the beginning and ending wall locations as shown.
- B. Stake retaining wall vertical and horizontal control at no more than 25 ft on tangent sections and 10 ft on curved sections.

3.14 PAVEMENT MARKING

- A. Layout temporary and permanent pavement markings according to Section 32 17 23 Pavement Marking.
 - 1. Place references for traffic striping no more than 150 ft apart on tangents and 50 ft on curves.

3.15 CLEANUP

- A. Remove and dispose of flagging, lath, stakes, and other staking material after the project has reached physical completion and the Engineer has approved removal.

3.16 UTILITIES

- A. Stake control lines as needed in cooperation with the utility companies so their facilities can be relocated to their proper final position.
- B. Stake crossings or potential points of conflict between facilities to give proper horizontal and vertical control for the relocation.
- C. Schedule this survey work with the utility companies to minimize delays and disruption of survey stakes.
- D. Replace disturbed stakes as necessary to facilitate the relocations.
- E. The Contractor is responsible for costs incurred to relocate utility more than once due to inaccurate or incomplete staking.
- F. Collect survey grade coordinate data for exposed, relocated, and new utilities during construction.
 - 1. Collect data in 1 ft intervals unless otherwise directed in the UDOT Survey & Geomatics Standards manual.
 - a. Refer to <http://www.udot.utah.gov/go/standardsreferences>.

3.17 EXISTING MILEPOST SIGNS

- A. Locate existing milepost sign stations within the project limits.
 - 1. Contact the Engineer to determine locations where a milepost sign was placed at a point other than the actual mile point due to prior physical limitations such as driveways, intersections, or bridge parapets, in coordination with Highway Referencing Specialist of the Asset Management Division.
- B. Reestablish locations of milepost signs before project completion if construction activities required removal of existing milepost signs.
 - 1. Reset sign location at original station of existing sign.
 - a. Exceptions
 - 1) Prior physical limitations listed in this Section, Article 3.17, paragraph A were removed during construction and no longer prevent installation of a sign at the actual mile point.
 - 2) Roadside conditions or newly constructed physical limitations would prevent reestablishment of milepost sign within 3 ft of its original station.
 - b. Contact the Engineer to determine how to proceed in either of these special cases in coordination with the Highway Referencing Specialist.
 - 2. Establish an appropriate offset for each milepost sign to meet installation and clear zone requirements.
- C. Contact the Engineer to determine the preferred action for reestablishing the milepost signs where the alignment of the roadway was modified during construction to the extent that the new measured mile point locations of milepost signs were shifted more than 10 ft from their original location.

END OF SECTION

SECTION 02 41 10 – SITE PREPARATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Clear, grub, remove, and dispose of trees, stumps, and debris within the designated limits of the roadways, channels, easements, and other designated areas.

1.2 RELATED SECTIONS

- A. Section 01 35 43: Environmental Compliance
- B. Section 01 57 13: Temporary Erosion and Sediment Control
- C. Section 02 41 12: Remove Structure and Obstruction

1.3 REFERENCES **Not Used**

1.4 DEFINITIONS **Not Used**

- A. Clear – Remove and dispose of trees, stumps, logs, limbs, sticks, vegetation, debris, and other material on the natural ground surface.
- B. Grub – Remove and dispose of roots, buried logs, debris, organic matter, and other deleterious materials under the ground surface.
- C. Strip – Removal and stockpiling of topsoil on-site for revegetation purposes.
- D. Construction Limits – Areas within which Work is to be performed. Unless otherwise noted on the drawings, these limits are the “Right-of-Way”.

1.5 SUBMITTALS

- A. Copies of disposal permits, agreements, or both.

PART 2 - PRODUCTS **Not Used**

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify with the Engineer the vegetation or objects to be removed.
- B. Review work procedures with the Engineer.
- C. Schedule work carefully with consideration for property owners and general public.

- D. Refer to Section 01 57 13 for Temporary Erosion and Sediment Control.

3.2 PRECONSTRUCTION SURVEY

- A. Provide a preconstruction survey of all buildings and structures within 150 feet of the project Right-of-Way.
- B. Include photographic and High-Definition video evidence of the current condition of all buildings and structures.
- C. Notify the Engineer if access to property cannot be achieved and provide adequate documentation showing any attempts made to access adjacent property.

3.3 VEGETATION REMOVAL

- A. Grub the areas 2 ft below natural ground, within the limits of clearing, of all stumps, roots, buried logs, and all other underground obstructions.
- B. Stumps, roots, and non-perishable solid objects may remain in cleared areas where the embankment is:
 - 1. 2 ft or more above the natural ground.
 - 2. At least 2 ft away outside the slope stake lines.
- C. Completely grub stumps and roots where a structure is to be constructed, piles are to be driven, or unsuitable material is to be removed.

3.4 STRIP AND STOCKPILE TOPSOIL

- A. Strip the topsoil:
 - 1. Only from areas shown or determined by Engineer.
 - 2. To a depth determined by the Engineer.
- B. Remove and dispose of any roots larger than 2 inches in diameter or 12 inches in length.
- C. Stockpile stripped topsoil:
 - 1. At locations acceptable to the Engineer.
 - 2. So that placement or activity around the stockpile does not damage or impact any existing trees, shrubs, or environmentally sensitive areas. Obtain appropriate clearances if such impacts are unavoidable.
- D. Grade to minimize erosion on and around the stockpiles.

3.5 BACKFILLING

- A. Backfill all stump holes, cuts, depressions, and other holes resulting from clearing and grubbing within areas to receive embankment.
 - 1. Compact backfilled areas to the density of the surrounding ground.
- B. Measure and pay separately for materials used for backfilling under Roadway Excavation or Borrow.
- C. Consider Roadway Excavation and Borrow as incidental to the work when these items are not included in the bid proposal.
 - 1. No separate measurement or payment made in this case.

3.6 DISPOSAL

- A. Dispose of material. Refer to Section 01 35 43 Environmental Compliance.
- B. Do not dispose of material within the designated roadbed.
- C. Outside of the Right-of-Way
 - 1. Acceptable when done according to prevailing laws including environmental laws, ordinances, regulations, and rules.
- D. Inside the Right-of-Way
 - 1. Bury material at locations specified by or acceptable to the Engineer.
 - 2. Use material to widen embankments and flatten embankment side slopes as approved by the Engineer.
 - 3. Cover disposed material with at least 2 ft of earth and grade to drain properly.
 - 4. Reduce wood to chips a maximum of ½ inch thick for mulching cut and fill slopes.
 - a. Chips may be buried or distributed uniformly on the ground surface and mixed with the underlying earth so the mixtures will not sustain burning.

3.7 TREE REMOVAL

- A. Refer to Section 02 41 12 Remove Structure and Obstructions.

3.8 PROTECTION

- A. Land monuments, property markers, or official datum points

1. Protect until their removal is approved.
 2. Reference for re-establishment before removing.
- B. Protect trees from damage to roots and branches if they are designated to remain.
- C. Protect other vegetation and objects designated to remain.

END OF SECTION

SECTION 02 41 12 – REMOVE STRUCTURE AND OBSTRUCTIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Removal and disposal of structures and obstructions that interfere with construction.
- B. Salvage of equipment or materials when specified.

1.2 RELATED SECTIONS

- A. Section 01 35 43: Environmental Compliance
- B. Section 01 71 23: Survey
- C. Section 31 23 30: Embankment, Borrow, and Backfill
- D. Section 03 30 40: Portland Cement Concrete
- E. Section 31 20 00: Earthwork and Dewatering

1.3 REFERENCES Not Used

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS

- A. Copies of disposal permits, agreements, or both.

1.6 PROJECT SITE CONDITIONS

- A. Protect adjacent structures and utilities and their contents that are designated to remain.

PART 2 - PRODUCTS

2.1 CONCRETE

- A. Use Class A (AE) Concrete. Refer to Section 03 30 40 Portland Cement Concrete.

2.2 GRANULAR BORROW AND GRANULAR BACKFILL BORROW

- A. Refer to Section 31 23 30 Embankment Borrow and Backfill.

2.3 FLOWABLE FILL

- A. Refer to Section 31 20 00 Earthwork and Dewatering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Review all work procedures with the Engineer.
- B. Coordinate utility location according to all applicable Laws and Regulations.
 - 1. Locate and protect all active utilities.
 - 2. Before beginning work:
 - a. Notify Engineer
 - b. Notify owners of affected utilities
 - c. Have the utilities in the area located by Blue Stakes
- C. Restore utility services disturbed by construction operations.
- D. Disconnect water service by excavating to the corporation stop and turning it off. Disconnect the service line from the corporation stop.
- E. Remove items such as existing cesspools and leach lines.
- F. Excavate all material necessary to permit removal.

3.2 BACKFILL AND COMPACTION

- A. Fill all holes or pits resulting from removal operations with suitable material.
- B. Compact the backfilled areas to the density of the surrounding ground or as specified.
- C. Department will pay separately for Roadway Excavation or Borrow material used for backfill.
 - 1. Material items not included in the Bidding Schedule are considered incidental to the work.

3.3 REMOVAL AND DISPOSAL

- A. Remove and dispose of material promptly using methods acceptable to the Engineer and according to applicable rules and regulations.
 - 1. Include excavation, removal, transportation, and disposal costs in the item of work.
- B. Remove concrete to at least 2 ft below the subgrade surface or finished ground lines.

- C. Dispose of removed obstructions at a site secured by the Contractor.
 - 1. Obtain required permits and provide an environmentally safe area for disposal of removed items. Refer to Section 01 35 43 Environmental Compliance.
- D. Removed materials not designated for use or salvage become the property of the Contractor unless owned and requested by a utility company.

3.4 SALVAGE

- A. Salvage designated equipment and materials.
- B. All other materials become the property of the Contractor unless otherwise noted.

3.5 REMOVE BUILDING, BASEMENT, AND FOUNDATION

- A. Move or demolish designated buildings including basements, foundations, sidewalks, pavement slabs, porches, fences, and outbuildings on each parcel.
- B. The Department is not responsible for vandalism or theft that occurs to the building or its contents that reduces the value of the salvage or increases the cost of removal after the award of the Contract.
- C. Break the floor into pieces not larger than 1 ft² in areas to remain in place. Remove and dispose of pieces over 1 ft².

3.6 REMOVE SEPTIC TANK AND UNDERGROUND TANK

- A. Empty and dispose of tank contents according to all applicable Laws and Regulations.
- B. Break down and remove tank and appurtenances to at least 2 ft below the subgrade surface or finished ground lines.
- C. Break the floor into pieces not larger than 1 ft² in area.

3.7 REMOVE BURIED FUEL TANK

- A. Remove buried fuel storage tanks and dispose of tank contents according to all applicable Laws and Regulations.
- B. Do not spill fuel on subgrade.
- C. Comply with the State and local authorities having jurisdiction over fuel tank removals.

3.8 REMOVE BRIDGE AND BOX CULVERT

- A. Remove structure so that no remaining portion is closer than 3 ft to a watercourse or closer than 2 ft to the subgrade and embankment surface or within 2 ft of the finished ground lines.
- B. Remove structures that will interfere with proposed construction.
- C. Complete blasting or other removal operations of existing structure that may damage new construction before beginning the new work.

3.9 REMOVE CONCRETE HEADWALL

- A. Remove headwall where designated.

3.10 REMOVE CONCRETE SLOPE PROTECTION

- A. Remove portions of the existing slope protection and cutoff wall as shown.
- B. Mark the concrete slope protection removal limits in the presence of the Engineer.
- C. Saw cut the existing slope protection to full depth.
- D. Do not damage the portions of concrete slope protection that will remain.

3.11 REMOVE MANHOLE, CLEANOUT, DIVERSION BOX, AND CATCH BASIN

- A. Maintain satisfactory by-pass service during construction operations.
- B. Plug unused sewers with a 2 ft long concrete plug.

3.12 REMOVE PIPE AND PIPE END SECTION

- A. Remove pipe, end sections and attached appurtenances.
- B. Cut pipe to 2 ft inside the Department's right-of-way when the pipe extends into private property.
 - 1. Seal the remaining pipe with a 2 ft long concrete plug.
- C. Seal openings in remaining manhole or catch basin walls with a concrete plug.

3.13 ABANDON PIPE

- A. Completely fill the pipe with flowable fill.
 - 1. Obtain approval from the Engineer for alternate materials.

- B. Cut pipe to 2 ft inside the Department's right-of-way if the pipe extends into private property.
 - 1. Seal the pipe extending into private property with a 2 ft long concrete plug.
- C. Survey the location of exposed abandoned pipes ends. Refer to Section 01 71 23 Survey.

3.14 REMOVE CONCRETE AND ASPHALT PAVEMENT

- A. Cut existing pavement on the designated lines with straight vertical edges free from irregularities when joining new construction to existing pavement.
- B. Completely remove pavement down to the underlying base course or subgrade.

3.15 REMOVE RAILROAD TRACK

- A. Coordinate all work in the Railroad Right of Way with the Railroad Company

3.16 OBLITERATE CONCRETE ROAD

- A. Break up pavement into pieces not larger than 1 ft² in area.
 - 1. Scarify and cover broken concrete with at least 1 ft of suitable backfill material.
- B. Fill depressions and form rounded slopes to blend with the natural or surrounding contours.
- C. Grade materials either along the toe of an embankment or into a depression or borrow pit.
 - 1. Cover with at least 1 ft of suitable backfill material.

3.17 REMOVE CONCRETE SIDEWALK AND CONCRETE DRIVEWAY

- A. Remove concrete to the nearest expansion joint or saw cut to provide proper grades and connections.
- B. Make concrete cuts straight, vertical to the surface, full depth, and free from irregularities.

3.18 REMOVE CONCRETE CURB, CONCRETE GUTTER, CONCRETE CURB AND GUTTER, RAISED ISLAND, AND BITUMINOUS CURB

- A. Remove concrete curb, concrete gutter, concrete curb and gutter, raised island, bituminous curb, and parts of such improvements to an existing joint or joint sawed with a vertical face.

- B. Remove material to provide proper grades and connections.

3.19 REMOVE CONCRETE BARRIER

- A. Precast
 - 1. Remove connection pins and concrete barrier including any stabilization pins.
 - 2. Dispose or salvage as required.
 - a. Contact the Engineer for delivery location and coordination for salvaged barrier.
- B. Cast-In-Place
 - 1. Saw cut the pavement at the front face of the cast-in-place barrier.
 - 2. Remove barrier and underlying pavement.

3.20 REMOVE GUARDRAIL

- A. Remove and dispose of guardrail, posts, hardware, anchor assemblies, terminal assemblies, and attached posts, signs, and delineators.
- B. Remove steel posts to at least 8 inches below the subgrade surface or finished ground lines.

3.21 REMOVE CATTLE GUARD

- A. Remove the cattle guard to at least 2 ft below the subgrade surface or finished ground lines.
- B. Prevent livestock from entering work site from adjacent properties during removal and installation.

3.22 REMOVE FENCE

- A. Prevent people or livestock from entering work site from adjacent properties during removal and installation.
- B. Remove fence, posts, and foundations to at least 2 ft below subgrade or finished ground lines.
- C. Do not damage vegetation and ground cover during removal operations.

3.23 REMOVE TREE

- A. Remove all trees with a circumference larger than 20 inches measured at a point 2 ft above existing ground.

1. A tree consists of stump, root, trunk, branches, and foliage.
 2. Multiple leaders rising from a common root will not be counted separately.
 3. Remove the root system to at least 2 ft below the finished ground level and within a 2 ft radius of the stump.
- B. Trees removed with a circumference 20 inches or less measured at 2 ft above existing ground are considered incidental construction.

3.24 REMOVE UTILITY POLE

- A. Remove pole and all appurtenances.
- B. Remove foundation to at least 2 ft below subgrade or finished ground lines.

END OF SECTION

SECTION 02 41 20 – NOXIOUS WEED CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Controlling the introduction and spread of noxious weeds on construction projects.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. Utah Noxious Weed Control Act

1.4 DEFINITIONS

- A. Noxious weeds subject to control are listed on the Utah State Noxious Weed List and the county's weed list that applies based on the project location.
- B. Refer to the Section, article 3.3 for a list of the Utah State Noxious Weeds (Table 1) and the county lists (Table 2) for additional noxious weeds.

1.5 SUBMITTALS Not Used

1.6 PAYMENT PROCEDURES

- A. Include payment for cleaning earth-moving construction equipment under mobilization.
- B. Pay for the control of invasive weeds using pre-emergent, selective, and non-selective herbicides by the unit area.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Follow all regulatory, application, and safety precautions listed by the herbicide manufacturer. Refer to Utah Noxious Weed Control Act: Utah Code - Title 04 - Chapter 17.
 - 2. Apply herbicides using only state licensed pesticide applicators.

1.8 SEQUENCING

- A. Clean all earth-moving equipment before bringing them on the project.
- B. Treat existing noxious weeds 10 days before starting earthwork operations.

PART 2 - PRODUCTS

2.1 HERBICIDE

- A. Refer to this Section for a list of noxious weeds subject to control and the recommended herbicide for each species.
- B. Use commercially available herbicides specified to control the weed species identified.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Use high-pressure water blasting or steam cleaning methods to clean all earth-moving construction equipment (scrapers, bulldozers, excavators, backhoes, trenchers) of dirt, mud, and seed residue before initially entering the project.

3.2 EXAMINATION

- A. Verify and locate all noxious weeds on the project. Contact the county weed control supervisor or the Department's region landscape architect if assistance is needed for identification.

3.3 CONTROLLING INVASIVE WEEDS

- A. Spray invasive weeds located within the project limits before starting earth disturbing activities and if they appear during construction. Use pre-emergent, selective, and non-selective herbicides as appropriate (See Noxious Weed Tables 1 and 2 below). Apply herbicide as directed on the manufacturer's label.
- B. Noxious Weed Tables:

Table 1 - Utah State Noxious Weeds		
Common Name	Scientific Name	Herbicide
Bermudagrass*	<i>Cynodon dactylon</i>	Glyphosate
Black henbane	<i>Hyoscyamus niger</i>	Tordon (picloram) & Escort
Canada thistle	<i>Cirsium arvense</i>	2,4-D, Dicamba, Picloram
Dalmation toadflax	<i>Linaria genistifolia</i>	Tordon (picloram)
Diffuse knapweed	<i>Centaurea diffusa</i>	2,4-D+Dicamba or Picloram or Clopyralid
Dyer's woad	<i>Isatis tinctoria</i>	2,4-D+Dicamba or Chlorsulfuron
Field bindweed	<i>Convolvulus arvensis</i>	Dicamba+2,4-d or Picloram
Hoary cress, (whitetop)	<i>Cardaria draba</i>	2,4-D+Dicamba or Chlorsulfuron

Houndstounge	<i>Cynoglossum officinale</i>	Tordon (picloram)
Johnsongrass	<i>Sorghum halepense</i>	Glyphosate
Leafy Spurge	<i>Euphorbia esula</i>	Dicamba or Picloram
Medusahead	<i>Taeniatherum caput-medusae</i>	Glyphosate
Musk thistle	<i>Carduus nutans</i>	2,4-D amine, Metsulfuron or Picloram
Ox-eye daisy	<i>Chrysanthemum leucanthemum</i>	Tordon (picloram) & clopyralid
Perennial pepperweed	<i>Lepidium latifolium</i>	Metsulfuron or Chlorsulfuron
Perennial sorghum	<i>Sorghum halepense</i>	Glyphosate
Poison hemlock	<i>Conium maculatum</i>	Tordon (picloram)
Purple loosestrife	<i>Lythrum salicaria</i>	Glyphosate (Rodeo aquatic label)
Quackgrass	<i>Elytrigia repens</i>	Glyphosate
Russian knapweed	<i>Centaurea repens</i>	Picloram, Clopyralid or Chlorsulfuron
Saltcedar	<i>Tamarix ramosissima</i>	Habitat or Arsenal
Scotch thistle	<i>Onopordum acanthium</i>	2,4-D amine, Metsulfuron or Picloram
Spotted knapweed	<i>Centaurea maculosa</i>	2,4-D+Dicamba, Picloram or Clopyralid
Squarrose knapweed	<i>Centaurea virgata</i>	Picloram
St. Johnswort	<i>Hypericum perforatum</i>	Tordon (picloram) & Escort
Sulfur cinquefoil	<i>Potentilla recta</i>	Tordon (picloram)
Yellow star-thistle	<i>Centaurea solstitialis</i>	Picloram or Clopyralid
Yellow toadflax	<i>Linaria vulgaris</i>	Tordon (picloram)
*Do not consider Bermudagrass a noxious weed in Washington County		

Table 2 - County Noxious Weeds		
Common Name	Scientific Name	Herbicide
Salt Lake County		
Garlic mustard	<i>Alliaria petiolata</i>	Glyphosate
Myrtle spurge	<i>Euphorbia myrsinites</i>	Glyphosate or Dicamba
Use rates: Use rates for herbicides vary, follow the use rate on the LABEL for each herbicide		

END OF SECTION

SECTION 03 11 00 - CONCRETE FORMWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.2 RELATED SECTIONS

- A. Section 03 20 00 - Concrete Reinforcement.
- B. Section 03 30 40 - Portland Cement Concrete.
- C. Section 03 30 00- Concrete Work

1.3 REFERENCES

- A. ACI 301 - Structural Concrete for Buildings.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ACI 347 - Recommended Practice for Concrete Formwork.
- D. PS 1 - Construction and Industrial Plywood.

1.4 DESIGN REQUIREMENTS

- A. Design, engineer and construct formwork, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301 standards.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable code for design, fabrication, erection and removal of formwork.

PART 2 - PRODUCTS

2.1 WOOD FORM MATERIALS

- A. Form Materials: At the discretion of the Contractor.

2.2 PREFABRICATED FORMS

- A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
- B. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.
- C. Void Forms: Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete mix until initial set; 2 inches thick.

2.3 FORMWORK ACCESSORIES

- A. Form Ties: Snap-off type, galvanized metal adjustable length, with waterproofing washer, free of defects that could leave holes larger than 1 inch in concrete surface.
- B. Form Release Agent: Colorless mineral oil which will not stain concrete, or absorb moisture.
- C. Corners: Chamfered, 2 inch size; maximum possible lengths. Chamfer all exposed corners
- D. Nails, Spikes, Lag Bolts, Through Bolts, and Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- E. Waterstops: Polyvinyl chloride, minimum 2,000 psi tensile strength, minimum 50 degrees F (46 degrees C) to plus 175 degrees F working temperature range, 1 inch wide, maximum possible lengths, ribbed profile, preformed corner sections, heat welded jointing.

2.4 WATERSTOP

- A. Manufacturer: Greenstreak Plastic Products

- B. Model: Ribbed with Centerbulb.
- C. Waterstop shall be installed in concrete joints where indicated on the Plans and on the Typical Details.
- D. Waterstop shall be installed in concrete joints where indicated on the Plans and on the Typical Details.
- E. Waterstop shall be made of polyvinyl chloride (PVC).
- F. All vertical joints in waterbearing structures shall have waterstops, whether indicated on the Plans or not.
- G. All waterstops shall be continuous.
- H. Waterstops in the walls shall be carried into lower slabs and shall join the waterstops in the slabs with appropriate types of fittings.
- I. Waterstops shall meet or exceed the requirements in the following table:

Waterstop Requirements

PROPERTY	TEST METHOD	RECOMMENDED LIMITS
Water Absorption	ASTM D 570	5% max
Tear Resistance	ASTM D 624	285 lf/in
Ultimate Elongation	ASTM D 638	360%
Tensile Strength	ASTM D 638	2,000 psi min
Low Temperature Brittleness	ASTM D 746	No Failure @-35EF/-37EC
Stiffness in Flexure	ASTM D 747	600 psi min
Specific Gravity	ASTM D 792	1.4 max
Ozone Resistance	ASTM D 1149	No failure
Volatile Loss	ASTM D 1203	0.50% max
Hardness, Shore A/15	ASTM D 2240	65 to 80
Tensile Strength After Accelerated Elongation	CRD-C 572	1,600 psi min
Elongation After Accelerated Extraction	CRD-C 572	300% min
Effect on Alkali After 7 Days	CRD-C 572	-0.1% to 0.25%

2.5 NEOPRENE BEARING PAD

- A. Neoprene pads shall be of dimensions and hardness shown on the drawings and shall be made by approved manufacturer.
- B. The material for 40 durometer neoprene pads shall conform to ASTM D-200 M2BC414A14C12F17 and the material for the 30 durometer neoprene pads shall conform to ASTM D-200 M2BC10A14C12F17.
- C. Unless otherwise specified on the drawings, neoprene pads shall be 40 durometer.

2.6 CLOSED CELL NEOPRENE PAD

- A. Closed cell neoprene pads, shall be used as a filler material in the flexible joints between the wall and wall-footing and between the wall and roof connection in the areas not taken up by the solid neoprene bearing pads and waterstops.
- B. The material shall be medium grade closed cell neoprene conforming to 2A3 of ASTM D 1056-85.
- C. Rubatex R431N or R423N, or Cypress Sponge 431N or 423N, or approved equal.

2.7 SOFT MASTIC

- A. Soft mastic shall be installed in all voids and cavities around the bearing pads, waterstop and seismic cable sleeves. Such material shall be installed with a consistency that will not adversely affect the quality of PVC and neoprene materials.
- B. Sikaflex 1A, or Select Seal U-230, or approved equal.

2.8 INSTALLATION OF BEARING AND FILLER PADS

- A. Bearing and filler pads shall be installed as indicated on the drawings.
- B. Bearing and filler pads shall be glued to the concrete with an approved rubber cement material to prevent uplift of the pads during concrete pouring.
- C. All pads shall be held down with approved plastic shim plates placed under reinforcing steel.
- C. Nailing down pads will not be permitted.
- D. All voids and cavities between bearing and filler pads, waterstop and seismic cable sleeves shall be filled with soft mastic.
- E. Contractor's workmanship shall be such that no cement grout or concrete seepage will occur through the bearing and filler pad area resulting in a restraint of radial wall movements.
- F. A continuous neoprene pad and one or more filler pads are required between the top of the wall and the underside of the roof. Any void area between such pads shall be caulked and sealed to prevent any cement from the roof pour to come in contact with the wall top.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.2 EARTH FORMS

- A. Earth forms are not permitted.

3.3 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- D. Align joints and make watertight. Keep form joints to a minimum.
- E. Obtain approval before framing openings in structural members which are not indicated on Drawings.
- F. Provide chamfer strips on external corners.
- G. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.
- H. Coordinate this section with other sections of work which require attachment of components to formwork.
- I. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Engineer.

3.4 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are effected by agent. Soak inside surfaces

of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.5 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items which will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.
- D. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Install waterstops in accordance with manufacturer's instructions, continuous without displacing reinforcement.
- F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- G. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.6 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
- D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.7 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI 301.

3.8 FIELD QUALITY CONTROL

- A. Section 01 45 13 Materials Quality Requirements: Field inspection and testing.
- B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.
- C. Do not reuse wood formwork more than 2 times for concrete surfaces to be exposed to view. Do not patch formwork.

3.9 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads (**minimum of seven days**).
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

END OF SECTION

SECTION 03 20 00 - CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Reinforcing steel bars, wire fabric and accessories for cast-in-place concrete.

1.2 RELATED SECTIONS

- A. Section 03 11 00 - Concrete Formwork.
- B. Section 03 30 40 - Portland Cement Concrete.
- C. Section 03 30 00 - Concrete Work

1.3 REFERENCES

- A. ACI 301 - Structural Concrete for Buildings.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ACI SP-66 - American Concrete Institute - Detailing Manual.
- D. CRSI - Concrete Reinforcing Steel Institute - Manual of Practice.
- E. CRSI 63 - Recommended Practice For Placing Reinforcing Bars.
- F. CRSI 65 - Recommended Practice For Placing Bar Supports, Specifications and Nomenclature.
- G. AASHTO M 55: Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

1.4 SUBMITTALS FOR REVIEW

- A. Section 01 33 00 - Submittals Procedures.
- B. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel bending and cutting schedules, and supporting and spacing devices.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.
- C. Headed-Steel Reinforcing Bars: ASTM A970/A970M.
 - 1. Epoxy-Coated Reinforcing Bars:
 - a. Steel Bars: ASTM A615/A615M, Grade 60 [ASTM A706/A706M], deformed bars.
 - b. Epoxy Coating: [ASTM A775/A775M] [or] [ASTM A934/A934M] with less than 2 percent damaged coating in each 12-inch (305-mm) bar length.
 - 2. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
 - 3. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
 - 4. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.
 - 5. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A coated, Type 1, [plain] [deformed] steel.

2.2 ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.
- B. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60 (Grade 420), plain-steel bars, ASTM A775/A775M epoxy coated.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
 - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel

wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

- b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
- D. Mechanical Splice Couplers: ACI 318 (ACI 318M) [Type 1] [Type 2], same material of reinforcing bar being spliced; [tension-compression typedowel-bar type, mechanical-lap type.
- E. Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch (1.2908 mm) in diameter.
 - 1. Finish: ASTM A884/A884M, Class A, Type 1, epoxy coated, with less than 2 percent damaged coating in each 12-inch (305-mm) wire length.
- F. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.

2.3 FABRICATION

- A. Fabricate concrete reinforcing in accordance with ACI 318.
- B. Locate reinforcing splice not indicated on drawing at points of minimum stress. Indicate locations of splices on shop drawings.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
 - 2. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
 - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - 2. Do not tack weld crossing reinforcing bars.

- C. Preserve clearance between bars of not less than 1 inch (25 mm), not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318 (ACI 318M).
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
 - 1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches (610 mm), whichever is greater.
 - 2. Stagger splices in accordance with ACI 318 (ACI 318M).
 - 3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
 - 4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.
- G. Install insulated connection system in accordance with manufacturer's instructions.
- H. Install welded-wire reinforcement in longest practicable lengths.
 - 1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice".
 - a. For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches (305 mm).
 - 2. Lap edges and ends of adjoining sheets at least one mesh spacing plus 2 inches (50 mm) for plain wire and 8 inches (200 mm) for deformed wire.
 - 3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
 - 4. Lace overlaps with wire.
- I. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.

3.3 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
 - 1. Place joints perpendicular to main reinforcement.
 - 2. Continue reinforcement across construction joints unless otherwise indicated.
 - 3. Do not continue reinforcement through sides of strip placements of floors and slabs.
- B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.
- B. Inspections:
 - 1. Steel-reinforcement placement.
 - 2. Steel-reinforcement mechanical splice couplers.
 - 3. Steel-reinforcement welding.

END OF SECTION

SECTION 03 30 00 - CONCRETE WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cast-in-place concrete placement operations for slabs on grade, slabs on fill, structural building frame, and other concrete components.

1.2 REFERENCES

- A. AASHTO M-182: Standard Specification for Burlap Cloth Made from Jute or Kenaf.
- B. ACI 301: Specifications for Structural Concrete for Buildings.
- C. ACI 305: Hot Weather Concreting.
- D. ACI 306: Cold Weather Concreting.
- E. ACI 309: Standard Practice for Consolidation of Concrete.
- F. ACI 315: Details and Detailing of Concrete Reinforcement.
- G. AASHTO M-148: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- H. ASTM C-642: Standard Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete.
- I. ACI 318: Building Code Requirements for Reinforced Concrete

1.3 RELATED WORK

- A. Manufacture of Portland cement concrete and its delivery to site, in accordance with Section 03 30 40.

1.4 SUBMITTALS

- A. Record of Placed Concrete: Record date, location of pour, quantity, air temperature, and test samples taken.
- B. Product name, type, and chemical analysis of the following as applicable:
 - 1. Curing compound.

2. Sealing compound.
3. Chemical hardener.

1.5 QUALITY ASSURANCE

- A. Rejection: Concrete work which fails to meet one or more of the following requirements, and which cannot be brought into compliance shall be rejected. Engineer shall determine appropriate modifications or payment adjustments to be made.
1. Appearance: Concrete exposed to view with defects which adversely affect appearance of specified finish.
 2. Strength: Strength of concrete fails to comply with any of the following requirements.
 - a. Low compressive or flexural strength.
 - b. Reinforcing steel size, quantity, strength, position, damage, or arrangement at variance with requirements.
 - c. Concrete which differs from required dimensions or location in such a manner as to reduce its strength or load carrying capacity.
 - d. Inadequate protection of concrete from extremes of temperature during the early stages of hardening and strength development.
 - e. Mechanical injury, construction fires, accidents, or premature removal of formwork likely to result in deficient strength development.
 - f. Workmanship likely to result in deficient strength.
 3. Slab Tolerance: Field quality control as specified herein.

1.6 WARRANTY

- A. Repair or replace defective or damaged work at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 ACCESSORIES

- A. Bonding Compound: Polyvinyl acetate or acrylic base, rewettable type.

- B. Vapor Retarder: 10 mil thick clear polyethylene sheet. Type recommended for below grade application.
- C. Forms: In accordance with Section 03 11 00 and ACI 315.
- D. Reinforcement: In accordance with section 03 20 00.
- E. Covering: Waterproof paper, polyethylene sheet or burlap cloth complying with AASHTO M 182, Class two.
- F. Waterstop: In accordance with section 03 11 00.

2.2 CONCRETE SURFACE CURING COMPOUND

- A. Liquid membrane, in accordance with AASHTO M-148.
- B. Type of Compound:
 - 1. Type 1, clear or translucent without dye.
 - 2. Type 1-D, clear or translucent with red fugitive dye.
 - 3. Type 2, white pigmented.
- C. Class of Vehicle: Class A, no restrictions.
- D. Performance Criteria of Compound: Compatible with sealing compound, if sealing compound is to be applied over concrete curing compound.

2.3 EPOXY INJECTION SYSTEM

- A. Liquid membrane, in accordance with AASHTO M-148
- B. Type of Compound:
 - 1. Type 1, clear or translucent without dye.
 - 2. Type 1-D, clear or translucent with red fugitive dye.
 - 3. Type 2, white pigmented

PART 3 – EXECUTION

3.1 CONCRETE PLACEMENT

- A. Deposit concrete as close as possible to its final position, without allowing it to flow laterally in the form any considerable distance. Do not use vibrators to flow concrete laterally.
- B. Limit placement duration to 45 minutes.
- C. When placing concrete with a concrete pump, use a pump that produces a continuous stream of concrete without air pockets. Do not add water to the concrete in the pump hopper.
- D. Use high frequency internal vibrators to compact all concrete. Supply enough vibrators (two minimum) to compact concrete within 15 minutes after it is deposited in forms. Do not allow vibrators to penetrate layers of concrete that have taken an initial set.
- E. Do not allow the free fall of concrete to exceed 5-feet without the use of a tremmie or metal spout.

3.2 WATERTIGHTNESS OF CONCRETE WORK

- A. Provide concrete work and grout of homogeneous structure, which when hardened will have the required strength, watertightness, and resistance to weathering.
- B. Construction, contraction, and expansion joints have been positioned in structures, and curing methods specified, for the purpose of reducing the number and size of these expected cracks, due to the normal expansion and contraction expected from the specified concrete mixes. Class A concrete shall be watertight. Cracks which develop in walls or slabs shall be repaired. Cracks which show any signs of leakage shall be repaired until all leakage is stopped.
- C. Visible cracks, other than hairline cracks and crazing, in the following areas shall be pressure grouted with low viscosity epoxy as specified herein as Epoxy Injection System for floors and walls of water bearing structures.
- D. Walls or slabs, as above, that leak or sweat because of porosity or cracks too small for successful pressure grouting, shall be sealed on the water or weather side by coatings of a surface sealant system, as specified elsewhere herein.
- E. Grouting or sealing as specified above shall be continued until the structure is watertight and shall remain watertight.

3.3 PREPARATION

- A. All exposed corners shall be chamfered (3/4" x 3/4").

- B. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, held securely, and will not impede placing concrete.
- C. Do not allow construction loads to exceed member capacity.
- D. Prepare previously placed concrete by cleaning with steel brush and applying bonding compound. Apply bonding compound in accordance with manufacturer=s instructions.
- E. Do not disturb reinforcement, inserts, embedded parts, and formed joints.
- F. Do not break or interrupt successive pours such that cold joints occur.
- G. Honeycomb or embedded debris in concrete is not acceptable.

3.4 JOINTS

- A. As far as practicable the concrete work shall be constructed as a monolith. The locations of contraction, construction, and other joints are indicated on the Plans or specified herein. Where not specified or indicated otherwise, all slabs and walls shall have construction joints at intervals not greater than 30 feet. In order to preserve the strength and water tightness of the structures, no other joints shall be made except as the Engineer may authorize.
- B. At construction joints, the concrete in place shall be thoroughly cleaned of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of a brush, hammer or heavy sandblasting, after which the surfaces shall be washed just prior to the succeeding concrete placement.
- C. Immediately prior to resuming concrete placing operations, a bed of grout not less than two (2) inches in thickness nor more than one (1) inch in thickness shall be thoroughly spread over the horizontal joint surfaces.
- D. Keyways in joints shall be provided as indicated on the Plans. Material for keyways shall be steel, plastic or lumber treated with form release coating, applied in accordance with the manufacturer's published instructions.
- E. Construction joints shall be washed free of sawdust, chips, and other debris after forms are built and immediately before the concrete placement. Should formwork confine sawdust, chips, or other loose matter in such a manner that it is impossible to remove them by flushing with water, a vacuum cleaner shall be used for their removal, after which the cleaned surfaces shall be flushed with water. A cleanout hole shall be provided at the base of each wall and column for inspection and cleaning.

- F. In any case where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, the surface of the set concrete shall first be coated with epoxy bonding agent Concessive No. 1001 LPL as manufactured by Adhesive Engineering; Sikadur HiMod as manufactured by Sika Chemical Corporation; or equal. This material shall be applied in accordance with the manufacturers published instructions.
- G. Expansion, contraction, and construction joints shall be constructed where and as indicated on the Plans. Waterstops, expansion joint material, synthetic rubber sealing compound, and other similar materials, shall be as specified elsewhere herein.
- H. The Contractor shall schedule the placing of concrete in such a manner as to complete any single placing operation to a construction, contraction, or expansion joint. Special care shall be taken to insure that concrete is well consolidated against waterstops and that waterstops are secured in the proper position.

3.5 CAULKING

- A. All caulking where indicated on the Plans or as specified, except for masonry construction and where specified otherwise, shall be done with synthetic rubber sealing compound.
- B. Concrete must be thoroughly cured prior to caulking. All surfaces to be caulked shall be dry, clean, and free dirt, grease, curing compounds, and other residue which might interfere with adhesion of the caulking compound. Concrete surfaces shall be cleaned and primed in strict accordance with the manufacturers recommendations prior to caulking. Sponge rubber filler materials may be used as backing for caulking, if acceptable to the Engineer. Filler material, when used, shall be compressible and untreated.
- C. Caulking shall be applied with a pneumatic caulking gun. Nozzles of the proper shape and size shall be used for the application intended. A continuous bond shall be maintained between the caulking and the sides of the joint to eliminate gaps, bubbles, or voids and to fill the joint in a continuous operation without layering of the compound. All joints and seams shall be caulked by experienced applicators in a neat workmanlike manner.
- D. No caulking shall be applied when the temperature exceeds 120 degrees F to avoid sponging or bubbling of compound. To hasten curing of the compound when used on wide joints subject to movement, the Contractor shall apply heat with infrared lamps or other convenient means.
- E. Excess caulking shall be removed by soaking and scrubbing before caulking has cured with Chem Seal CS9900; equivalent product of Products Research and Chemical Corporation; or equal. Excess cured material shall be removed by sanding with No. 80 grit paper.

3.6 CONSOLIDATION

- A. In accordance with ACI 309.
- B. Keep spare vibrator available during concrete placement operations.

3.7 FINISHING

- A. Do not add water or retemper concrete unless Engineer's approval is secured.
- B. Slab Finishing Tolerance:
 - 1. Class A finish: 1 in 1000.
 - 2. Class B finish: 1 in 500.
 - 3. Class C finish: 1 in 150.
- C. Finishes: In accordance with Section 03 35 00. When type of finish is not indicated, use following finishes as applicable:
 - 1. Sidewalks, garage floors, and ramps: Broom or belt finish.
 - 2. Exterior concrete pavement: Broom or belt finish.
 - 3. Exterior platforms, steps, and landings, exterior and interior pedestrian ramps, not covered by other finish materials: Nonslip finish.
 - 4. Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
 - 5. Surfaces intended to receive roofing, except future floors, waterproofing membranes, and roof surfaces which are future floors or sand bed terrazzo: Floated finish.
 - 6. Floors and roof surfaces which are floors intended as walking surfaces or to receive floor coverings: Troweled finish.
 - 7. Unpainted concrete surfaces not exposed to public view: Smooth as-cast form finish.
 - 8. Unpainted concrete surfaces exposed to public view: Rubbed finish.
 - 9. Concrete surfaces to receive paint or plaster: Grout cleaned finish.
- D. Chemical Hardener: After completion of curing, apply chemical hardener in

accordance with manufacturer's instructions to all interior floor slabs which are exposed in finished work and elsewhere as indicated. After final coat of chemical hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water. Do not place liquid floor hardener on floor areas scheduled to receive synthetic matrice terrazzo, or setting beds for tile, terrazzo, vinyl flooring, or like items.

3.8 CURING

- A. Curing: In accordance with Section 03 39 00.
- B. General: Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete. Cure concrete by applying curing and sealing compound, by moisture curing, by moisture-retaining cover curing, or by combinations thereof.
- C. Curing Compounds:
 - 1. Apply curing compound to concrete slabs within 2 hours of completing final finishing operations. Apply uniformly in continuous operation. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period. Should side forms be removed before expiration of 7 days from start of curing, coat exposed surfaces with curing compound.
 - 2. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glue-down carpet), painting, and other coatings and finish materials, unless otherwise acceptable to Engineer.
- D. Moisture Curing: Provide either of the following methods.
 - 1. Keep concrete surface continuously wet by covering with water or continuous water-fog spray.
 - 2. Cover concrete surface with absorptive cover, thoroughly saturated with water and kept continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.

3.9 SEALING

- A. Surface Preparation: If necessary to remove curing compound, sandblast concrete surface. Clean surface free of dirt, oil, grease and other contaminants. If necessary use proprietary cleaning compounds (not raw acids) followed by thorough water rinsing. Use high pressure water equipment providing 1,200-

2,000 psi to remove detergent residues. Do not attempt application when condensation is present.

- B. Application: Spray with low pressure (20 psi) airless spray equipment. Saturate the surface to the point of rejection. On vertical surfaces apply 2 coats.
- C. Coverage Rates: In accordance with manufacturer's recommendation.
- D. Paint Adhesion: Always test to verify compatibility between sealant and other proposed surface treatments.
- E. Warning: Remove inadvertent splashes before the solution has dried on the surface. If sealant is a hazardous material, allow use only by professional applicator.

3.10 METHOD OF INJECTION OF EPOXY

- A. Adequate surface seal shall be applied to the crack or joint to prevent escape of the epoxy. Entry points shall be established at a distance along the seal not less than the thickness of the cracked member.
- B. A 100 percent solid epoxy adhesive as specified shall be forced into the crack at the first port with sufficient pressure to advance the epoxy to the adjacent port. The original port shall be sealed and entry shifted to the port at which the epoxy appears. This manner of port-to-port injection shall be continued until each joint has been injected for its entire length.
- C. Before processing, the space in the vicinity of a crack location receiving epoxy shall have been swept and left in generally clean condition. All joints receiving epoxy under this section shall be cleaned free from dirt, laitance, and other loose matter.
- D. Pump unit used for injection shall be a positive displacement type with interlock to provide an in-line mixing and metering system for the two-component epoxy. The pressure hoses and injection nozzle shall be of such a design as to allow proper mixing of the two components of epoxy. The presence of a standby injection unit may be required.
- E. For small amounts, or where excessive grout pressure developed by a pump unit might further damage the structure, premixed material and a hand caulking gun may be used if acceptable to the Engineer.
- F. Seal all ports, including adjacent locations where epoxy seepage occurs, as necessary to prevent drips or run out. Any condition other than normal shall be reported to the Engineer. Solvents may not be used to thin the epoxy system

introduced into the cracks or joints. All work under this Specification shall be performed and conducted in a neat orderly manner.

3.11 DAMPPROOFING

- A. Surfaces to be dampproofed shall be cured, dry and free of all frost, loose material and dirt.
- B. The surface which is to be protected by dampproofing shall be thoroughly cleaned before the primer is applied. The surface shall then be brush or spray painted with two coats of asphalt for primer treatment at a rate of 1/8 gallon per square yard for each coat. After the primed surface has dried one application of asphalt dampproofing material shall be applied by brush, at a rate of 1/10 gallon per square yard.
- C. Care shall be taken to prevent discoloration of other parts of the structure not to be dampproofed, by the dripping or spreading of asphalt.

3.12 TESTS

- A. Arrange for and perform all testing required for qualification of proposed materials and the establishment of mix designs, in determining strengths for early form removal, for cylinder tests after the addition of water, and other needs of Contractor.
- B. Two slump tests, one before and one after the addition of super-plasticizer.
- C. Five (5) standard 4-inch cylinder samples of concrete from trucks receiving water after addition of water.

3.13 DEFECTIVE CONCRETE

- A. Modify or replace concrete not conforming to required levels, lines, details, and elevations.
- B. Structural analysis and additional testing may be required at no additional cost to Owner when the strength of a structure is considered potentially deficient.
- C. Patch imperfection. Refer to Section 03 35 00 requirements.

3.14 PROTECTION AND REPAIRS

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

- C. Random Cracks in Pavement Slabs on Grade: When cracks occur within 2 feet of expansion of construction joints, remove and repair, otherwise grout with approved epoxy grout. Use saw cuts and dowels in all cut planes.

3.15 PLACING CONCRETE IN COLD WEATHER

- A. No concrete shall be placed where the air temperature is lower than 40 degrees Fahrenheit, at a location where the concrete cannot be covered or protected from the surrounding air.
- B. When concrete is placed below a temperature of 35 degrees Fahrenheit the ingredients of the concrete shall be heated so that the temperature of the mixture shall not be less than 50 degrees or more than 100 degrees Fahrenheit.
- C. Before mixing, the heated aggregates shall not exceed 175 degrees Fahrenheit.
- D. Cement shall not be added while the temperature of the mixed aggregates and water is greater than 100 degrees Fahrenheit.
- E. When there is likelihood of freezing during the curing period, the concrete shall be protected by means of an insulated covering to prevent freezing of the concrete for a period of not less than 7 days after placing.
- F. Equipment for protecting concrete from freezing shall be available at the job site prior to placing concrete. Particular care shall be exercised to protect edges and exposed corners from freezing.
- G. In the event heating is employed, care shall be taken to insure that no part of the concrete becomes dried out or is heated to temperatures above 100 degrees Fahrenheit.
- H. The housing, covering, or other protection used shall remain in place and intact at least 24 hours after the artificial heating is discontinued.
- I. For a period of five days the concrete shall be kept above 40 degrees F and below 100 degrees F.

3.16 CLEANING AND WATERPROOFING

- A. After construction is completed, the interior of the structure shall be completely hosed out and cleaned of all dirt and loose material.

- B. Floor, wall, footing, column, and roof cracks, which may have developed from drying shrinkage, shall not be taped or chipped out and caulked. All cracks shall be pumped and sealed with a two-part water insensitive grout.

3.17 TESTING AND REPAIR LEAKS

A. TESTING

- 1. After filling the structure, the water level shall be held at the overflow for a period of 72 hours.
- 2. All visible leaks and damp spots repaired to the satisfaction of the Engineer at the expense of the Contractor
- 3. Damp spots are defined as spots where moisture can be picked up on dry land.

B. LEAK DETECTION METHODS

- 1. Leaks in floor construction joints may be detected with the aid of a diver.
- 2. Mud or cement deposits on the floor, when stirred up, would flow to the leak and may so indicate where the leaks are.
- 3. Honeycomb and cracks around waterstops may be detected through tapping with a hammer along the joint.
- 4. Any of these procedures may be insisted upon by the Engineer when cement seeding has not stopped the leaks.
- 5. Leakage through joints, which may have resulted from bent over waterstops or honeycomb under or around waterstops may require the removal of concrete around the waterstops in suspected areas.
- 6. Chipped out concrete areas shall be properly drypacked with a mix of 1 cement to 2 coarse sand, after coating the existing concrete surface with an approved grout.

C. ACCEPTANCE

- 1. The acceptable drop in water level of covered water bearing structures shall not exceed 1/10 inch per 24 hours after the structure has been filled. There shall be no visible running leaks or water puddles. Small damp spots may be accepted, at the discretion of the Engineer, during the first few months of operation; however, if they have not healed, the Engineer may order the immediate repair of such areas. Any cracks, voids, honeycomb, or cold joints showing or causing running leaks of water shall

be group pumped by qualified operators until such cracks and voids have been completely sealed. If requested by the Contractor to stop floor leakage and if allowed by the Owner, the floor may be covered with a minimum of two inches of water and pure cement shall then be spread evenly over the entire floor area at the rate of one sack of cement to every 1000 square feet of floor area. The floor shall not be allowed to dry after the application of cement. If the tank has been cement seeded and if the structure is drained during the warranty period, Contractor shall be given fourteen (14) days advance notice and Contractor shall promptly remove all cement residue from the tank floor and clean the tank to the Owners satisfaction. The Owner shall pay for the subsequent tank disinfection and chlorination.

2. The water bearing structure shall not be backfilled until and unless the Engineer has accepted the leakage tests.
3. This section shall be applicable during the entire specified warranty period of the structure.

END OF SECTION

SECTION 03 30 40 - PORTLAND CEMENT CONCRETE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Portland cement concrete material requirements.
- B. Mix design requirements.

1.2 REFERENCES

- A. AASHTO T 26: Standard Method of Test for Quality of Water to be Used in Concrete.
- B. ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- C. ACI 211.2: Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
- D. ACI 211.3: Standard Practice for Selecting Proportions for No-Slump Concrete.
- E. ACI 214: Recommended Practice for Evaluation of Strength Test Results of Concrete.
- F. ACI 306: Cold Weather Concreting.
- G. ASTM C 33: Standard Specification for Concrete Aggregates.
- H. ASTM C 88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- I. ASTM C 94: Standard Specification for Ready-Mixed Concrete.
- J. ASTM C 150: Standard Specification for Portland Cement.
- K. ASTM C 260: Standard Specification for Air-Entraining Admixtures for Concrete.
- L. ASTM C 289: Standard Test Method for Potential Reactivity of Aggregates (Chemical Method).
- M. ASTM C 494: Standard Specification for Chemical Admixtures for Concrete.
- N. ASTM C 618: Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

1.3 DEFINITIONS

- A. Average Strength (f_{cr}): The required average strength for 30 consecutive strength tests which statistically assures no more than the permissible proportions of tests will fall below specified strength.
- B. Specified Strength (f'_c): The indicated strength.

A.4 SUBMITTALS

- A. Mix Design: Submit each proposed mix design 14 days prior to use in the Work. Indicate whether mixes have been designed for pumping. Include in the report of the following information.
 - 1. Water-cement ratio.
 - 2. Proportion of materials in the mix.
 - 3. Source and type of cement.
 - 4. Analysis of water to be used.
 - 5. Type name of admixtures applied. Indicate when accelerating or retarding admixtures are to be used.
 - 6. Slump, air content and temperature of samples.
 - 7. Unit weight of fresh and dry light weight concrete.
- B. Pre-Approved Mix Design Data: If supplier has on record, an Owner approved mix design, submit name and address of supplier for each mix design 1 day prior to using concrete mix.

1.5 QUALITY ASSURANCE

- A. Use the same source and type of cement, air-entraining agent, water reducing agent, other admixtures, and aggregate.
- B. In proportioning material for mixing, use scales certified by the State of Utah. Do not use volume measurement except for water and liquid admixtures.
- C. Do not change the quantity of cement per cubic yard.
- D. Use of admixtures will not relax hot or cold weather placement requirements.

- E. Ready-mixed concrete, in accordance with Alternate No. 3 of ASTM C 94 and requirements in this Section.
- F. Testing Concrete: In accordance with ASTM C39.

1.6 PRODUCT STORAGE AND HANDLING

- A. Store bagged and bulk cement in weatherproof enclosures to exclude moisture and contaminants.
- B. Stockpile aggregate to avoid segregation and prevent contamination.
- C. Avoid contamination, evaporation, or damage to admixtures. Protect liquid admixtures from freezing and temperature changes.

PART 2 - PRODUCTS

2.1 CEMENT

- A. Type V, in accordance with ASTM C 150.
- B. Do not use air entraining cement.

2.2 WATER

- A. Clean, non-staining and not detrimental. Comply with AASHTO T 26.

2.3 AGGREGATES - GENERAL

- A. Gravel, crushed slag, crushed stone, or other inert materials, composed of hard, strong, durable particles free of injurious coatings.
- B. The materials passing the No. 200 sieve shall not exceed 1.75 percent by weight in the combined coarse and fine aggregate.

2.4 COARSE AGGREGATE

- A. Sieve Analysis: Graded in accordance with ASTM C 33.

These limitations may be changed if, in the judgment of the Engineer, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids and the maximum aggregate size does not exceed the following requirements.

1. 1/5 of narrowest dimension between forms.
2. 1/3 of depth of slabs.

3. 3/4 of minimum clear spacing between reinforcing bars.

B. Deleterious Substances: Maximum percentage by weight.

1. Soft Fragments: 2.0 percent.
2. Coal and Lignite: 0.3 percent.
3. Clay Lumps: 0.3 percent.
4. Other Deleterious Substances: 2.0 percent.

2.5 FINE AGGREGATE

A. Sieve Analysis: Graded in accordance with ASTM C 33, as follows.

FINE AGGREGATE		
Sieve Size	Percent Passing (by weight)	
	Min	Max
3/8"	100	
No. 4	95	100
No. 16	45	80
No. 50	10	30
No. 100	2	10

B. Deleterious Substances: Maximum percentage by weight.

1. Coal and Lignite: 0.3 percent.
2. Clay Lumps: 0.5 percent.
3. Other Deleterious Substances: 2.0 percent.

2.6 SOUNDNESS AND REACTIVITY OF AGGREGATE

A. Determine suitability of fine and coarse aggregate sources for soundness in accordance with ASTM C 88. Weight loss; not exceeding 16 percent by weight when subject to 5 cycles of sodium sulphate.

- B. Determine alkali-silica reactivity in accordance with ASTM C 289. Do not use aggregates determined either potentially or actually deleterious.

2.7 ADMIXTURES

- A. Air Entrainment: pH 2.0 maximum type in accordance with ASTM C 260.
 - B. Water Reducing and Water Retarding Agents: In accordance with ASTM C 494.
 - 1. Type A: Water reducing.
 - 2. Type B: Retarding.
 - 3. Type C: Accelerating.
 - 4. Type D: Water reducing and water retarding.
 - 5. Type E: Water reducing and accelerating.
 - 6. Type F: High range water reducing (super plasticizer). *
 - 7. Type G: High range water reducing and retarding. *
- *The relative durability factor of water reducing admixtures shall not be less than 90 and the chlorides content (as C1-) shall not exceed 1 percent by weight of the admixtures.
- C. Calcium Chloride: None allowed.
 - D. Pozzolan: None allowed.
 - E. Fly Ash: None allowed.
 - F. Fiber Mesh: A.G. 0.90, Tensile Strength 70-11 ksi, Lengths of 0.5", 0.75, 1.5", & 2.0".

2.8 ENTRAINING AGENT

- A. An entraining agent shall be used in all concrete exposed to weather. The agent shall conform to AASHTO designation M-154

2.9 ACI MIX DESIGN

- A. The amount by which the average strength of a concrete mix exceeds the specified strength shall be based upon no more than 1 in 100 random individual strength tests falling below the specific strength.
- B. Proportion the materials in accordance with ACI 211.1, 211.2 or 211.3 as applicable to produce concrete having the following properties or limitations:

CONCRETE MIX PROPERTIES			
Class	A	B	C
Properties	4500	3000	2500
Specified Compressive Strength f'_c at 28 days, psi	4500	3000	2500
Compressive Strength at 7 days, psi (a)	3000	2000	1675
Cement content (94 lb. Sacks of cement per cubic yard of concrete)	6.5	5.5	5
Fiber Mesh	0	0	0
Superplasticizer	0	0	0
Water	As Reqr	As Reqr	As Reqr
Crushed Rock	As Reqr	As Reqr	As Reqr
Sand	As Reqr	As Reqr	As Reqr
Entrained air content, (% by volume)	4 to 6	4 to 6	4 to 6
Slump Range, in. (b)	2 to 4	2 to 4	2 to 6

- Used for monitoring purposes only.
- Not more than 8" after adding high range water reducer admixture (superplasticizer) to verified 2" to 3" slump concrete.

- C. The use for each class of concrete is as follows:
 - 1. Class A (4500 psi): All other reinforced structural concrete
 - 2. Class B (3000 psi): Sidewalks, curb and gutter, cross gutters, pavements and unreinforced footings and foundations.
 - 3. Class C (2500 psi): Thrust blocks, anchors and mass concrete.
 - 4. All other concrete, unless specified or otherwise indicated on the Drawing use Class A concrete.
- D. Water
 - 1. Sufficient water shall be added to produce concrete with the minimum practicable slump.

2.10 HAND MIXING

- A. Do not hand mix batches exceeding 0.5 cubic yards.
- B. Hand mix only on watertight platform. Mix cement and aggregate prior to adding water.
- C. Ensure all stones are thoroughly covered with mortar and mixture is of uniform color and consistency.

2.11 HEATING, WATER, AND AGGREGATE

- A. Do not allow products of fuel combustion to contact the aggregate.
- B. Heat aggregate and mixing water to 150 degrees F. maximum. Heat aggregates uniformly.
- C. Maintain mixed concrete temperature at time of placement between 60 and 90 degrees F.
- D. Do not mix cement with water or with mixtures of water and aggregate greater than 90 degrees F.

PART 3 - EXECUTION**3.1 DELIVERY**

- A. Slump: Do not transport concrete to the work location if concrete is greater than permissible slump.

- B. Discharge: After the introduction of mixing water to the cement and aggregates at the batch plant, discharge concrete from truck mixer within the following air temperatures and time periods.

1. Less than 80 degrees F.: 1-1/2 hours.
2. 80-90 degrees F.: 75 minutes.
3. 90+ degrees F.: 1 hour maximum.

3.2 RE-TEMPERING

- A. Adding Water: When concrete arrives at site with slump below specified, water may be added if neither the maximum approved water/cement ratio nor the maximum slump is exceeded provided that:
1. The approved mix design has allowed for on-site addition of water.
 2. The amount of water added at the site is accurately measured to ± 1 gallon of the desired added amount.
 3. That water additions is followed by 3 minutes of mixing at mixing speed prior to discharge.
 4. That additional standard cylinder samples are taken from all trucks receiving water after addition of water at no additional cost to Owner.
 5. That the person authorized to add water is mutually approved of in writing by Engineer, Contractor, and ready-mix vendor.
- B. Super-plasticizers: Premeasure and add high range water reducers (super-plasticizers) in accordance with manufacturer's instructions. Add super-plasticizers at site using truck-mounted power injection equipment capable of rapidly and uniformly distribution the admixture to the concrete. Mix for a minimum of 3 minutes prior to discharge.
- C. Re-tempering after delivery time with super-plasticizer is prohibited.

END OF SECTION

SECTION 03 35 00 - CONCRETE FINISHING

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Application procedure for concrete surface finishes.

1.2 PROJECT CONDITIONS

- A. Allow concrete to cure not more than 72 hours before commencing surface finish operations, unless otherwise acceptable to Engineer.
- B. Protect adjacent materials and finishes from dust, dirt and other surface or physical damage during finishing operations. Provide protections as required and remove from site at completion of Work.
- C. For surfaces to be blast finished, perform abrasive blasting within 24 to 72 hours after casting. Coordinate with form work construction, concrete placement schedule, and form work removal to ensure that surfaces are blasted at same age for uniform results.

PART 2 - EXECUTION

2.1 PATCH FINISHING

- A. Repair surface defects immediately after form removal.
- B. Make any patches in concrete to closely match color and texture of surrounding surfaces. Determine mix formula for patching mortar by trial and obtain a good color match with concrete when both patch and concrete are cured and dry.
 - 1. Mix white and gray Portland cement as required to match surrounding concrete to produce grout having consistency of thick paint.
 - 2. Use a minimum amount of mixing water.
 - 3. Mix patching mortar in advance and allow to stand without frequent manipulation, without addition of water, until it has reached stiffest placeable consistency.
 - 4. After initial set, dress surfaces of patches manually to obtain same texture as surrounding surfaces.
- C. Repair defective areas.

1. Remove honeycomb and defective concrete down to sound concrete.
 2. Make edges perpendicular to surface or slightly undercut.
 3. Feathered edges are not permitted
 4. Dampen area to be patched and at least 6" surrounding it to prevent absorption of patching mortar water.
 5. Prepare bonding grout.
 6. Mix to consistency of thick cream.
 7. Brush into surface.
- D. After surface water has evaporated from patch area, brush bond coat into surface.
1. When bond coat begins to lose water sheen, apply patching mortar.
 2. Thoroughly consolidate mortar into place and strike-off to leave patch slightly higher than surrounding surface.
 3. Leave undisturbed for at least 1 hour before final finish.
 4. Keep patched area damp for 72 hours or apply curing compound.
 5. Do not use metal tools in finishing an exposed patch.
- E. Tie Holes: Unless indicated otherwise, after being cleaned and thoroughly dampened, fill the hole solid with patching mortar.
- F. Whereas-cast finishes are indicated, total patched area may not exceed 1 in 500 of as-cast surface. This is in addition to form tie patches, if ties are permitted to fall within as-cast areas.
- G. In any finishing process which is intended to expose aggregate on surface, patched areas must show aggregate.
1. Outer 1" of patch shall contain same aggregates as surrounding concrete.
 2. For aggregate transfer finish, patching mixture shall contain same selected colored aggregates.
 3. After curing, expose aggregates together with aggregates of adjoining surfaces by same process.

2.2 SLAB FINISHING

- A. Broom or Belt Finish: After concrete has been placed, consolidated, struck-off, and leveled to the required tolerance, roughen surface transversely with stiff brushes, rakes, or burlap belt before final set.
- B. Float Finish: After concrete has been placed, consolidated, struck-off, and leveled, do not work further until ready for floating.
 - 1. Begin floating when water sheen has disappeared and surface has stiffness sufficient to permit operation.
 - 2. During or after first floating, check planeness of entire surface with a 10 feet long straightedge applied at 2 or more different angles.
 - 3. Cut down high spots and fill low spots to the required tolerance.
 - 4. Refloat slab immediately to a uniform sandy texture.
- C. Trowel Finish:
 - 1. Float finish surface.
 - 2. Power trowel.
 - 3. Hand trowel as required to provide surface. Do not apply water to retemper concrete in finishing operations.
 - 4. First troweling after power floating shall produce smooth surface relatively free of defects but which may still show some trowel marks.
 - 5. Second trowel by hand after surfaces has hardened.
 - 6. Leave finished surface essentially free of trowel marks, uniform in texture and appearance.
 - 7. On surfaces intended to support floor coverings, grind off defects which would show through floor covering.

2.3 AS-CAST FORMED FINISHING

- A. Rough: Patch defects, chip or rub off fins exceeding 1/4" height.
- B. Smooth: Patch tie holes and defects and remove fins completely.

1. When surface texture is impaired and form joints misaligned, grind, bushhammer, or correct affected concrete as directed by Engineer.
2. Slurry grout areas evidencing minor mortar leakage to match adjacent concrete.
3. Repair major mortar leakage as a defective area.
4. When in opinion of Engineer, workmanship is less than acceptable standard, provide one of rubbed finishes at no additional cost to Owner.

2.4 RUBBED FINISHING

- A. Produce following finishes on concrete with a smooth form finish.
 1. Smooth Rubbed: Remove forms and perform necessary patching as soon after placement as possible.
 2. Finish newly hardened concrete no later than 24 hours following form removal.
 3. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced.
- B. Grout Cleaned: Undertake no cleaning operations until all contiguous surfaces are completed and accessible.
 1. Wet surface of concrete sufficiently to prevent absorption of water from grout.
 2. Apply grout uniformly.
 3. Immediately after grouting, scrub surface with cork float or stone to coat surface and fill voids.
 4. While grout is still plastic, remove excess grout by working surface with rubber float or sack.
 5. After-surface whitens from drying, rub vigorously with clean burlap.
 6. Keep damp for at least 36 hours after final rubbing.
 7. Cork Floated: Remove forms within 2 to 3 days of placement where possible.
 8. Remove ties.

9. Remove all burrs and fins.
10. Dampen wall surface.
11. Apply mortar with firm rubber float or with trowel, filling all surface voids.
12. Compress mortar into voids.
13. If mortar surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with fog sprayer.
14. Produce final texture with cork float using a swirling motion.

2.5 UNFORMED FINISHING

- A. After concrete is placed, strike smooth, tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces.
- B. Float to texture which is reasonably consistent with formed surfaces.
- C. Continue final treatment on formed surfaces uniformly across unformed surfaces.

END OF SECTION

SECTION 03 39 00 - CONCRETE CURING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Initial and final curing of horizontal and vertical concrete surfaces.

1.2 RELATED SECTIONS

- A. Section 03 30 40 – Portland Cement Concrete.

1.3 REFERENCES

- A. ACI 301 - Structural Concrete for Buildings.
- B. ACI 302 - Recommended Practice for Concrete Floor and Slab Construction.
- C. ACI 308 - Standard Practice for Curing Concrete.
- D. ASTM C171 - Sheet Materials for Curing Concrete.
- E. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
- F. ASTM D2103 - Polyethylene Film and Sheeting.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Membrane Curing Compound Type 1: ASTM C309 Type 1 acrylic type, clear without fugitive dye.
- B. Water: Potable, not detrimental to concrete.
- C. Mat Coverings: Clean roll goods of cotton or burlap fabric

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify substrate conditions under provisions of Section 31 23 27 Soil Compaction.
- B. Verify that substrate surfaces are ready to be cured.

3.2 EXECUTION - HORIZONTAL SURFACES

- A. Cure floor surfaces in accordance with ACI 308.
- B. Ponding: Maintain 100 percent coverage of water over floor slab areas, continuously for 4 days.

* * * OR * * *

- C. Membrane Curing Compound: Apply compound in accordance with manufacturer's instructions in one coat.
- D. Absorptive Mat: For roof slab of storage tank, place absorptive mat to provide coverage of concrete surfaces and edges. Lap over adjacent absorptive covers. Thoroughly saturate with water and keep continuously wet.

3.3 EXECUTION - VERTICAL SURFACES

- A. Cure surfaces in accordance with ACI 308.
 - B. Spraying: Spray water over surfaces and maintain wet for 7 days.
- * * * OR * * *
- C. Membrane Curing Compound: Apply compound in accordance with manufacturer's instructions in one coat.

3.4 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 03 35 00 Concrete Finishing.
- B. Do not permit traffic over unprotected floor surface.

END OF SECTION

SECTION 03 41 00 – PRECAST BOX CULVERT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Material and procedures for fabricating and installing single-cell precast concrete box culverts, multi-cell precast concrete box culverts, and secondary elements such as cutoff walls, aprons, footings, floor slabs, headwalls, and wingwalls.
- B. Waterproofing membrane for concrete structures.

1.2 RELATED SECTIONS

- A. Section 31 23 30: Embankment, Borrow, and Backfill
- B. Section 03 30 40: Portland Cement Concrete
- C. Section 03 20 00: Concrete Reinforcement
- D. Section 03 30 00: Concrete Work
- E. Section 03 39 00: Concrete Curing

1.3 REFERENCES

- A. AASHTO M 111: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- B. AASHTO T 106: Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens)
- C. AASHTO T 160: Length Change of Hardened Hydraulic Cement Mortar and Concrete
- D. AASHTO T 161: Resistance of Concrete to Rapid Freezing and Thawing
- E. AASHTO LRFD Bridge Design Specifications
- F. AASHTO Manual for Bridge Evaluation
- G. ASTM C 877: External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
- H. ASTM C 882: Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
- I. ASTM C 928: Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs

- J. ASTM C 990: Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- K. ASTM C 1504: Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts and Storm Drains
- L. ASTM C 1577: Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD
- M. Precast/Prestressed Concrete Institute (PCI) Design Handbook
- N. UDOT Quality Control/Quality Assurance (QC/QA) Procedures
- O. UDOT Quality Management Plan
- P. UDOT Structures Design Memoranda
- Q. Waterproofing Membrane:
 - 1. ASTM D 5: Penetration of Bituminous Materials
 - 2. ASTM D 36: Softening Point of Bitumen (Ring and Ball Apparatus)
 - 3. ASTM D 146: Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
 - 4. ASTM D 882: Tensile Properties of Thin Plastic Sheet
 - 5. ASTM D 3236: Apparent Viscosity of Hot Melt Adhesives and Coating Materials
 - 6. ASTM E 96: Water Vapor Transmission of Materials
 - 7. ASTM E 154: Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

1.4 DEFINITIONS

- A. Working Drawings – Drawings produced by the Contractor that supplement the contract drawings to provide information not included in the contract documents but required to fabricate, erect, transport, or temporarily support the structure or structural elements in the completion of the work.
 - 1. Working drawings do not supersede the contract drawings.
- B. Approval of Working Drawings – Acceptance by the Department for use on the project. The Department will review working drawings for general conformance with the design concept and compliance with the contract documents. Review and approval do not relieve the Contractor from responsibility for errors, correctness of details, conformance to the contract, and the successful completion of the work.
- C. Manufacturer's product data sheets and recommended installation instructions.

1.5 SUBMITTALS**A. Working Drawings**

1. Detailed fabrication and installation drawings for approval of all fabricated materials and cast-in-place elements that are included in this item of work and are not detailed in the contract plans.
 - a. Include all details not provided in the contract documents for the construction and erection of the members included in this item of work.
 - b. Detail all phases of construction including layout, joint details, lifting devices, casting methods, construction placement, connections between elements, and details of any cast-in-place elements included in this item of work.
 - c. Note proposed transportation methods.
 - d. Provide the seal of a Professional Engineer (PE) or Professional Structural Engineer (SE) licensed in the State of Utah and include supporting engineering calculations for the following:
 - 1) Special designs of precast concrete box culverts for sizes and loads other than those shown in Table 1 of ASTM C 1577.
 - 2) Provide 2 inches concrete cover to all reinforcing steel and Welded Wire.
 - 3) Lifting devices.
 - 4) Structural members and ancillary appurtenances designed by the fabricator.
 - 5) Connections between precast and cast-in-place members and appurtenances.
 - 6) Connections between culvert, wingwall, and footing sections
 - 7) Any other means and methods that require an engineer's design.
 - e. Do not begin work before receiving approval of the shop detail drawings. The Department rejects units fabricated before shop drawing approval.
2. Prepare drawings according to the following:
 - a. Submit drawings electronically in PDF format. Use 11 x 17 inch sheets with a 1½ inch blank margin on the left edge. Place the following information in the title block in the lower right corner of each sheet:
 - 1) Project Designation

- 2) Project Name
 - 3) Project Structure Number
 - 4) Contractor, Fabricator, or Erector Name
 - 5) Contractor, Fabricator, or Erector Drawing Number
 - 6) Contractor, Fabricator, or Erector Sheet Number
 - b. Revise and resubmit drawings when directed by the Engineer.
 - c. Provide the seal of a PE or SE licensed in the State of Utah when required in the contract. Place the seal in the lower left corner of each sheet.
3. Prepare engineering calculations according to the following:
- a. Submit calculations electronically in PDF format. Use 8½ x 11 inch sheets with a 1 inch blank margin on the left edge or 11 x 17 inch sheets with a 1½ inch blank margin on the left edge. Title block location is at the top of 8½ x 11 inch sheets or the lower right corner of 11 x 17 inch sheets. Place the following information in the title block:
 - 1) Project Designation
 - 2) Project Name
 - 3) Project Structure Number
 - 4) Contractor, Fabricator, or Erector Name
 - 5) Contractor, Fabricator, or Erector Drawing Number
 - 6) Contractor, Fabricator, or Erector Sheet Number
 - b. Provide the seal of a PE or SE licensed in the State of Utah on all engineering calculations. Place the seal on the calculation cover sheet.
 - c. Certify that engineering calculations have been checked according to the Department QC/QA Procedures.
4. Allow the Engineer 14 calendar days to review and approve working drawings and supporting calculations.
- a. The Engineer may grant an increase in the number of working days for the project when that time is exceeded.
 - b. This review period applies each time the drawings are submitted.
5. Do not deviate from the approved drawings unless authorized in writing. Assume the responsibility for costs incurred due to faulty detailing or fabrication.

- B. Mix Design
 - 1. Submit to the Engineer for approval. Refer to this Section, article 2.1 paragraph B.
- C. Structural Non-Shrink Grout
 - 1. Certificate of Compliance.
 - 2. The proposed method for forming grout voids and installing the non-shrink grout including the sequence and equipment for the grouting operation for review at least 14 days before work begins. Obtain approval before beginning placement of structural non-shrink grout.

1.6 ACCEPTANCE

- A. Precast concrete box culverts will not be accepted when the concrete strength is below that specified on the plans.
- B. The Department rejects any elements fabricated before receiving written approval or any elements that deviate from the approved drawings. The Contractor is responsible for costs incurred due to faulty detailing or fabrication.

1.7 WEATHER LIMITATIONS

- A. Do not work during wet conditions or when the deck or ambient air temperatures are below 50 degrees F.
- B. Do not apply the membrane until it has been a minimum of 12 hours since the deck surface was wet and is dry per the manufacturer's requirements.

PART 2 - PRODUCTS

2.1 CONCRETE

- A. Wet Cast Concrete – Class AA(AE). Refer to Section 03 30 00 Concrete Work.
- B. Dry Cast Concrete
 - 1. Minimum cement content 470 lb/yd³ of concrete
 - 2. Maximum water/cement ratio 0.40
- C. Flowable Bedding Concrete – Use flowable fill; refer to Section 31 20 00 Earthwork and Dewatering.

2.2 REINFORCING STEEL AND WELDED WIRE

- A. Coated – Refer to Section 03 20 00.

2.3 JOINT SEALANT

- A. Refer to ASTM C 990.
- B. Use a flexible butyl rubber material with a minimum cross-section of $\frac{3}{4}$ x $1\frac{1}{2}$ inches as a joint sealant for box culverts.

2.4 JOINT WRAP

- A. Refer to ASTM C 877.

2.5 WATERPROOFING MEMBRANE

- A. Refer to Section 07 16 16.

2.6 STRUCTURAL NON-SHRINK GROUT

- A. Use gray, non-shrink grout containing no calcium chloride or admixture containing calcium chloride or other ingredient in sufficient quantity to cause corrosion to steel reinforcement.
- B. Use quick-setting, rapid strength gain, non-shrink, and high-bond strength grout.
- C. Meet all the requirements of AASHTO T 160 with the exception that the Contractor-supplied cube molds will remain intact with a top firmly attached throughout the curing period.
- D. Mix structural non-shrink grout just before use according to the manufacturer's instructions.
- E. Refer to Table 1 for additional structural non-shrink grout requirements.

Table 1 - Structural Non-Shrink Grout			
*Properties	Requirements	ASTM	AASHTO
Accelerated Weathering: Tested Medium Accepted Weight Loss	<3% White Utah Road Salt <15% @ 300 Cycles		T 161
Compressive Strength	>3,000 psi @ 24 hours >5,000 psi @ 7 days		T 106
Accepted Bond Strength	>1,000 psi @ 24 Hours	C 882 as modified by C 928 8.5	
Length Change	No expansion after 7 days		T 160

- * Certified test results from a private AASHTO accredited testing laboratory are acceptable.

2.7 LIFTING DEVICES

- A. Use lifting devices that can support the required vertical and horizontal forces with the applicable safety factors as specified in the Component Handling and Erection Bracing requirements of the PCI Design Handbook.
- B. Galvanize according to AASHTO M 111.

2.8 GROUTED SPLICE COUPLERS

- A. Refer to Section 03 20 00.

2.9 MANUFACTURE

- A. Use a Department Certified Concrete Precaster or a pre-qualified project site caster for precast concrete box according to the Department Quality Management Plan: Precast-Prestressed Concrete Structures.
- B. Precast Concrete Box Culverts
 - 1. Refer to ASTM C 1577.
 - 2. Special designs for sizes and loads other than those shown in Table 1 of ASTM C 1577 require approval by the Engineer.
 - 3. Prepare special designs according to AASHTO LRFD Bridge Design Specifications, Section 12.
 - 4. Provide 2 inch minimum concrete cover to reinforcing steel bars.
 - 5. Provide minimum concrete cover to reinforcement where welded wire fabric is used, equal to the greater of three times the diameter of the wire or 2 inches.
 - 6. Provide 2 inch minimum concrete cover to the reinforcing steel in the top of the top slab of box sections covered with less than 2 feet of fill for all types of reinforcement.
 - 7. Provide tongue and groove ends or equivalent to transfer shear between sections at all joints.
 - 8. Design and form section ends so that the sections can be laid together to make a continuous line of box sections compatible with the permissible variations in Section 11 of ASTM C 1577.
- C. Do not locate horizontal and vertical changes in alignment greater than 10 degrees at a joint between precast segments of a precast concrete box culvert unless otherwise approved by the Engineer.
- D. Permanently mark each precast unit with date of casting and supplier identification.

- E. Cast the project structure number into the top and exposed faces of the headwall at each end of the structure.
- F. Provide the number and type of lifting devices required to support the vertical and horizontal forces with the applicable safety factors as specified in the Component Handling and Erection Bracing requirements of the PCI Design Handbook.
 - 1. Use a maximum diameter of 3 inches when lifting holes are used. Locate holes to avoid interference with the reinforcing steel.
- G. Concrete Curing – Refer to Section 03 39 00.

2.10 QUALITY ASSURANCE

- A. Precast Elements
 - 1. Prevent cracking or damage of precast elements during shipping, handling, and storage.
 - 2. Replace defects and breakage of precast elements.
 - a. Members that sustain damage or surface defects during fabrication, handling, storage, hauling, or erection are subject to review or rejection.
 - b. Obtain approval before performing repairs.
 - c. Repair work must reestablish the elements' structural integrity, durability, and aesthetics to the satisfaction of the Engineer.
 - d. Determine the cause when damage occurs and take corrective action.
 - e. Failure to take corrective action, leading to similar repetitive damage, can be cause for rejection of the damaged element.
 - f. Cracks that extend to the nearest reinforcement plane and fine surface cracks that do not extend to the nearest reinforcement plane but are numerous or extensive are subject to review and rejection.
 - g. Full depth cracking and breakage greater than 1 ft are cause for rejection.
 - 3. Document all test results. The quality control file will contain at least the following information:
 - a. Element identification
 - b. Date and time of cast
 - c. Concrete cylinder test results
 - d. Quantity of used concrete and the batch printout
 - e. Form-stripping date and repairs if applicable

- f. Location/number of blockouts and lifting inserts
- g. Temperature and moisture of curing period
- h. Lifting device details, requirements, and inserts

2.11 RUBBERIZED ASPHALT MEMBRANE

A. Characteristics

- 1. Laminate form
- 2. Heat resistant
- 3. Self-adhesive surface protected by special release paper

B. Mechanical Properties – Refer to Table 1:

Table 1 - Mechanical Properties		
Property	Value	Method
Thickness, inch, minimum	0.065	
Permeance-Perms, grains/sq ft-hr-inhg	0.10	ASTM E 96, Method B
Tensile Strength, psi	50	ASTM D 882, modified for 1 inch opening
Elongation, percent	75	ASTM D 882, modified for 1 inch opening
Puncture Resistance (Mesh), lb	200	ASTM E 154
Pliability, at -15 degrees F	No cracks in mesh or rubberized asphalt when bent 180 degrees over a ¼ inch mandrel	ASTM D 146

2.12 FIBERGLASS MATTING

- ### A.
- Weight = 1.5 lb/yd²

2.13 BINDER

- ### A.
- Compatible with the matting material and conforming to the following requirements:

Table 2 - Binder Requirements		
Property	Value	Method
Penetration, 0.1 mm	40-82	ASTM D 5
Softening point, min.	155 degrees F	ASTM D 36
380 degrees F. viscosity, cps	1,000 – 1,800	ASTM D 3236

PART 3 - EXECUTION

3.1 PREPARATION

- A. Excavating, Trenching, Bedding, and Backfill – Refer to Specification Sections in Division 31.
- B. Scarify moisture condition and compact the top 8 inches of the excavated ground surface to at least 90 percent of the maximum laboratory density.

3.2 BEDDING AND BACKFILL

- A. Over excavate the material under the box location according to Section 31 23 33 to a minimum depth of 12 inches.
 - 1. Replace over excavated material with granular backfill borrow or free draining granular backfill as specified in Section 31 23 33.
 - 2. Provide a minimum bedding of 12 inches of granular backfill borrow or free draining granular backfill.
 - 3. Limit the soil gradation for granular backfill borrow used as bedding under precast members to 100 percent passing the $\frac{3}{4}$ inch sieve.
 - 4. Modify the soil gradation for free draining granular backfill used as bedding under precast members to 100 percent passing the $\frac{3}{4}$ inch sieve and no more than 10 percent passing the No. 4 sieve.
- B. Level and compact bedding material to provide uniform support of the structure along its entire supported width and length.
- C. Backfill structure with granular backfill borrow as specified in Section 31 23 33 and as shown in the plans.

3.3 INSTALLATION

- A. Inspect precast elements for defects before lowering into trench.
- B. Repair or replace any defective, damaged, or unsound precast elements.
- C. Use a trench width adequate to place and compact bedding material. Minimum outside width of trench is the outside width of structure plus 2 feet each side.
- D. Lay precast elements starting at the downstream end.
- E. Carefully lower precast elements into the trench with suitable equipment to prevent damage.
- F. Remove all dirt and foreign material from joints. Prevent dirt and material from re-entering joints.

-
- G. Apply joint sealant furnished by culvert manufacturer to box culvert.
1. Place the joint material on the bottom half of the groove (bell) of the box last placed.
 2. Place the balance of the joint material on the top half of the tongue (spigot) of the box to be set.
 3. Place the material about 1 inch from the leading edge of the groove and tongue.
 4. Maintain the joint material at 70 degrees F or greater during placement.
- H. Disassemble joint, check position of joint sealant, repair alignment, and re-install when adjoining elements cannot be pulled together to meet minimum joint requirements.
- I. Pull box culvert sections together to ½ inch joint gap spacing measured face to face of adjoining concrete surfaces with the joint gap being uniform on all sides of the box culvert.
1. Use appropriate pulling devices to avoid misalignment and damage to box sections.
 2. The Engineer may approve up to a ¾ inch joint gap spacing in cases where it is necessary to adjust the total length of a box culvert run.
 3. Reject box sections when the installation tolerance cannot be met due to casting variations.
 4. Prevent soil from being forced into the joint as the box sections are placed.
- J. Do not disturb previously completed joints during laying operation.
- K. Do not lay precast elements when water is in the trench.
- L. Apply joint wrap to the top slab and side walls at all joints.
1. Clean top and sides of concrete surface at joints before placing joint wrap.
 2. Use a minimum width of 2 ft centered on the joint.
- M. Install precast cutoff walls, aprons, wingwalls, and headwalls, as follows:
1. Establish working points, working lines, and benchmark elevations before placing elements.
 2. Clean bonding surfaces between elements of debris, dust, and rust before connecting elements to achieve the required bonding between protruding bars and elements.
 3. Place cut-off wall and apron elements as shown in the plans.

- a. Adjust the final location of the cut-off wall or apron elements if actual joint gaps cause the final location to vary.
 - b. Adjust the height of each apron element by means of leveling devices or shims.
4. Lift apron segments using lifting devices as shown on the approved fabrication and installation working drawings.
5. Set elements in the proper horizontal location. Check for proper alignment and grade within specified tolerances.
6. Adjust vertical leveling devices before full release of the apron from the crane to reduce the amount of torque required to turn the bolts in the leveling devices. Check for proper grade within specified tolerances.
7. Place or pump bedding concrete or grout into voids and pockets as shown in the plans.

3.4 STEEL REINFORCEMENT

- A. Refer to Section 03 20 00.

3.5 JOINTS

- A. Mechanically connect the exterior sections of three-sided precast concrete structures at all top joints within a minimum length of 12 ft from each end of the structure.
 1. Use at least four mechanical connections per joint with a maximum spacing of 10 ft.
 2. Galvanize all plates, shapes, and hardware.
- B. Connect three-sided precast concrete structures to the footing, pedestal, or slab 2 ft from the outermost exterior edge of the structure at all four corners of the structure with a galvanized rigid mechanical connection.
 1. Locate the connection on the interior face of the segment to allow for future inspection.

3.6 LIFTING HOLES AND DEVICES

- A. Plug lifting holes and lifting device recesses with structural non-shrink grout. Finish flush with all concrete surfaces.

3.7 CAST-IN-PLACE CONCRETE

- A. Refer to Section 03 30 00.

- B. Project the reinforcing steel at least 12 inches out of the precast box section and square off the concrete face where precast box sections join cast-in-place concrete.

3.8 REPAIRS

- A. Box sections may be repaired as allowed in the referenced specification only when approved in advance by the Engineer.
- B. Repairs made before approval will be cause for rejection.

3.9 MINIMUM LENGTH

- A. Do not use precast segments less than 5 ft in lay length.

3.10 WATERPROOFING PREPARATION

- A. Apply a waterproofing membrane to the top slab and side walls of all concrete box culverts for the full length of the structures.
- B. Expansion Joint Modification and Joint Closure
 - 1. Remove the curing cover materials and dry according to manufacturer's recommendations or 48 hours, whichever is greater after concrete placed at expansion joint modifications and joint closures has cured.
- C. Concrete Deck
 - 1. Sandblast to remove asphalt and all other foreign material from the entire deck, approach slabs, and sides of the parapet for a height of 4 inches above the concrete deck.
 - 2. Vacuum or use compressed air to remove all dust and loose material from the deck.
 - 3. Remove all sharp ridges and projections that can puncture the membrane.
 - 4. Patch holes or spalled areas in the concrete deck with patching concrete to provide a flat deck surface. Refer to Section 07 16 16.
- D. Joints and Cracks
 - 1. Bond a 12 inch wide strip of woven fiberglass reinforcing to the deck over cracks and cold joints greater than 3/16 inch wide using a compatible binder.

3.11 APPLY WATERPROOFING MEMBRANE

- A. Rubberized asphalt membrane – Follow membrane manufacturer's recommendations for application temperatures, equipment, and procedures.

1. Primer
 - a. Use primer furnished by the manufacturer of membrane material.
 - b. Apply primer to all surfaces to be covered by the membrane according to the manufacturer's recommended procedure and application rate.
2. Placement
 - a. Overlap prefabricated membrane strips at least 4 inches or as required by the Manufacturer.
 - b. Place joints in a shingling effect so water will drain effectively.
3. Bonding
 - a. Use hand rollers or other satisfactory pressure apparatus on the membrane to assure firm and uniform contact with the primed surfaces.
 - b. Use a wide tipped torch to cause tackiness if an adhesive is required to create a good seal at joints.
4. Placement
 - a. Place the membrane on the vertical face of the concrete curb to the height of the finished overlay surfacing plus 1 inch.
5. Defects
 - a. Protect the entire membrane from developing wrinkles, air bubbles, or other placement defects.
 - b. Patch any torn or cut areas and narrow overlaps using a satisfactory adhesive and a piece of membrane.
 - c. Extend the patch at least 4 inches beyond any defect.
 - d. Bond the patch firmly to the surface.
6. Traffic
 - a. Allow only necessary rubber tire vehicles on the membrane.
 - b. Do not allow public traffic.
 - c. Maintain the membrane in good condition until covered with pavement.
7. Preparation for Overlaying
 - a. Apply a bond coat of an acceptable adhesive to the surface of the membrane if required by the membrane manufacturer.

END OF SECTION

SECTION 03 61 00 - GROUT

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This section specifies grout for uses other than masonry.

1.2 QUALITY ASSURANCE

A. QUALITY CONTROL BY CONTRACTOR

1. To demonstrate conformance with the specified requirements for grout, the Owner shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329. The testing laboratory shall sample and test grout materials as required in this section. Costs of testing laboratory services shall be borne by the Contractor.

B. REFERENCES

1. This section references the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail. The references shall be the latest edition.
- a. ASTM C33 - Standard Specification for Concrete Aggregate.
 - b. ASTM C40 - Standard Test Method for Organic Impurities in Sand for Concrete.
 - c. ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 - d. ASTM C117 - Standard Test Method for Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing.
 - e. ASTM C136 - Standard Test Method for Sieve or Screen Analysis of Fine and Course Aggregates.
 - f. ASTM C150 - Standard Specification for Portland Cement.
 - g. ASTM C289 - Standard Test Method for Potential Reactivity of Aggregates (Chemical Method).

- h. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
- i. ASTM E329 - Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.
- j. CRD - G588 - Corps of Engineers Specification for Nonshrink Grout.

1.3 INFORMATION TO BE PROVIDED

A. The following information shall be provided in accordance with the General Conditions and Division 1 General Requirements.

- 1. **PRODUCT DATA-** Three copies of manufacturer's data shall be provided for the following:
 - a. Bonding Compounds.
 - b. Nonshrink Grout.
 - c. Pressure Grout.
 - d. Retardants.
- 2. **LABORATORY TEST REPORTS**
 - a. Before delivery of materials, three copies of the reports of the tests specified herein shall be provided. Test reports on previously tested materials shall be accompanied by the manufacturer's statement that the previously tested material is the same type, quality, manufacture, and make as that proposed for use in the project. Test reports are required for the following:
 - 1) Cement.
 - 2) Aggregates.
 - 3) Retardants.
 - 4) Bonding Compounds.
- 3. **EVIDENCE OF TESTING LABORATORY COMPETENCE**

- a. The Contractor shall require that the laboratory provide directly to the Construction Manager evidence of the most recent inspection of its facilities by the Cement and Concrete Reference Laboratory of the National Bureau of Standards. The laboratory shall also show evidence of current ACI certification. The evidences shall show that deficiencies mentioned in the report of that inspection

have been corrected. The evidence of the inspection shall be provided prior to delivery of materials to the job site.

PART 2 – PRODUCTS

2.1 MATERIALS

A. CEMENT

1. Portland cement shall be ASTM C150, Type II or Type V, Low Alkali, containing less than 0.60 percent alkalis.

B. AGGREGATE

1. GENERAL: Aggregate shall be nonreactive and shall be washed before use.
 - a. When sources of aggregate are changed, test reports shall be provided for the new material. The tests specified shall be performed prior to commencing grout work.
2. FINE AGGREGATE: Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine and shall conform to ASTM C33 as modified herein. When tested in accordance with ASTM C136, gradation shall be such that 100 percent by weight will pass a standard No. 8 mesh sieve and no less than 45 percent by weight will pass a standard No. 40 mesh sieve.
 - a. Variation from the specified gradations in individual tests will be acceptable if the average of three consecutive tests is within the specified limits and the variation is within the permissible variation listed below.

U.S. Standard Permissible variation in

<u>Sieve Size</u>	<u>Individual tests, percent</u>
30 or coarser	2
50 or finer	0.5

- b. Other tests shall be in accordance with the following specifications:

Organic Impurities	ASTM C40	Color lighter than standard
Amount of Material Passing No. 2 Sieve	ASTM C117	3% maximum by Weight
Soundness	ASTM C88	10% maximum loss with sodium sulfate
Reactivity	ASTM C289	Innocuous aggregate
Sand Equivalent	CALTEST 217	Minimum 80

C. ADMIXTURES

1. **GENERAL:** Admixtures shall be compatible with the grout. Calcium chloride or admixtures containing calcium chloride are not acceptable. Admixtures shall be used in accordance with the manufacturer's recommendations and shall be added separately to the grout mix.
2. **WATER REDUCING RETARDER:** Water reducing retarder shall be ASTM C494, Type D and shall be Master Builders Pozzology 300-R; Sika Chemical Corp. Plastiment; or equal.
3. **LUBRICANT FOR CEMENT PRESSURE GROUTING:** Lubricant additive for cement pressure grouting shall be Intrusion Prepakt Intrusion Aid, Sika Chemical Corporation Intraplast, or equal.

D. WATER

1. Water for washing aggregate, for mixing and for curing shall be free from oil and deleterious amounts of acids, alkalis, and organic materials; shall not contain more than 1000 mg/l of chlorides as Cl, nor more than 1300 mg/l of sulfates as SO₄; and shall not contain an amount of impurities that may cause a change of more than 25% in the setting time of the cement nor a reduction of more than 5% in the compressive strength of the grout at 14 days when compared with the result obtained with distilled water. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the grout.

2.2 GROUT**A. DRYPACK GROUT**

1. Drypack grout shall be a mixture of approximately one part cement; 12 to 2 parts sand, water reducing retarder, and sufficient water to make a stiff workable mix.

B. CEMENT GROUT

1. Cement grout shall be a mixture of one part cement, two parts sand, proportioned by volume, admixtures for pressure grouting, and sufficient water to form a workable mix.

C. NONSHRINK GROUT

1. Nonshrink grout shall be nonrusting metallic aggregate grout and shall be Master Builders Embeco 636; U.S. Grout Corp. Five Star Grout; or equal.

D. EPOXY GROUT

1. Epoxy grout shall be Adhesive Engineering Concrecive 1380 as applicable; Sika Chemical Corporation Sikastix 350; or equal.

2.3 PRESSURE GROUTING EQUIPMENT

- A. Pressure grouting equipment shall include a mixer and holdover agitator tanks and shall be designed to place grout at pressures up to 50 psi. Gages shall be provided to indicate pressure used. The mixer shall be provided with a meter capable of indicating to one-tenth of a cubic foot the volume of grout used.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Holes required for grouting shall be blown clean. Horizontal holes for grouting shall be drilled at a slight downward angle to facilitate holding the grout until setting is complete. Bolts or reinforcing steel installed in horizontal grout holes shall be bent slightly accordingly.
- B. Bonding compound for use with grout is specified in Section 03 30 00.

3.2 DRYPACK GROUT

- A. Drypack grout shall be used for built-up surfaces, setting miscellaneous metal items and minor repairs.

- B. Surfaces required to be built up with drypack grout shall be roughened by brushing, cleaned, and coated with the bonding compound specified in Section 03 30 00 before the application of the grout. The drypack grout shall be applied immediately following the application of the bonding compound in bands or strips to form a covering of the required thickness. The covering strips shall be smooth. Construction joints in the grout shall be sloped and shall be cleaned and wetted before application is resumed.
- C. Drypack grout shall be cured in accordance with Section 03 30 00.
- D. Grout shall not be placed during freezing weather unless adequate protection is provided.

3.3 CEMENT GROUT

- A. Cement grout shall be used for filling nonbearing portions of equipment pads and pressure grouting.
- B. Except for the specialized equipment for pressure grouting, mixing and placing apparatus shall be similar to that normally used for cast-in-place concrete. Grout shall be mixed for a period of at least one minute. Diluted grout shall be agitated to keep ingredients mixed.

3.4 NONSHRINK GROUT

- A. Nonshrink grout shall be used for the bearing surfaces of machinery and equipment bases, column baseplates and bearing plates. It also shall be used for setting bolts and reinforcing steel in holes for grouting. Embeco 636 shall be used for grouting any rotating equipment, pumps, motors, etc., weighing over 500 pounds.
- B. Where specified, grout shall meet CRD-G588. Grout shall be placed in accordance with manufacturer's instructions.

3.5 EPOXY GROUT

- A. Epoxy grout shall be used for repairing cracks by pressure grouting, repairing structural concrete, and setting reinforcing dowels into holes for grouting. Concrete shall be primed in accordance with the grout manufacturer's instructions.

3.6 PRESSURE GROUTING

- A. Prior to grouting, systems and holes to be grouted shall be washed clean. Washing is not required for grouting soil voids outside pipe cylinders or casing pipes. Grouting, once commenced, shall be completed without stoppage. In case of breakdown of equipment, the Contractor shall wash out the grouting system sufficiently to ensure

fresh grout and adequate bond and penetration will occur upon restarting the grouting operation. Grout pressure shall be maintained until grout has set.

END OF SECTION

SECTION 04 05 10 - MORTAR AND MASONRY GROUT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Mortar and grout for masonry.

1.2 RELATED SECTIONS

- A. Section 04 22 10 - Reinforced Unit Masonry System

1.3 REFERENCES

- A. ACI 530 - Building Code Requirements for Masonry Structures.
- B. ACI 530.1 - Specifications For Masonry Structures.
- C. ASTM C5 - Quicklime for Structural Purposes.
- D. ASTM C91 - Masonry Cement.
- E. ASTM C94 - Ready-Mixed Concrete.
- F. ASTM C144 - Aggregate for Masonry Mortar.
- G. ASTM C150 - Portland Cement.
- H. ASTM C199 - Test Method for Pier Test for Refractory Mortar.
- I. ASTM C207 - Hydrated Lime for Masonry Purposes.
- J. ASTM C270 - Mortar for Unit Masonry.
- K. ASTM C387 - Packaged, Dry, Combined Materials, for Mortar and Concrete.
- L. ASTM C404 - Aggregates for Masonry Grout.
- M. ASTM C476 - Grout for Masonry.
- N. ASTM C595 - Blended Hydraulic Cement.
- O. ASTM C780 - Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- P. ASTM C1019 - Method of Sampling and Testing Grout.

- Q. ASTM C1072 - Method for Measurement of Masonry Flexural Bond Strength.
- R. ASTM C1142 - Ready-Mixed Mortar for Unit Masonry.
- S. ASTM E447 - Test Methods for Compressive Strength of Masonry Prisms.
- T. ASTM E518 - Test Method for Flexural Bond Strength of Masonry.
- U. IMIAC (International Masonry Industry All-Weather Council) - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

1.4 SUBMITTALS

- A. Include design mix, indicate whether the Proportion or Property specification of ASTM C270 is to be used, required environmental conditions, and admixture limitations.
- B. Reports: Submit reports on mortar indicating conformance of test and evaluation reports to ASTM C780.
- C. Reports: Submit reports on grout indicating conformance of test and evaluation reports to ASTM C1019.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 530 and ACI 530.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Cold Weather Requirements: IMIAC - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
- B. Maintain materials and surrounding air temperature to maximum 90 degrees F (32 degrees C) prior to, during, and 48 hours after completion of masonry work.
- C. Protect grout from freezing a minimum of 48 hours after work is completed.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Portland Cement: ASTM C150, Type I.

- B. Mortar Aggregate: ASTM C144, standard masonry type.
- C. Hydrated Lime: ASTM C207.
- D. Grout Course Aggregate: ASTM C404.
- E. Water: Clean and potable.
- F. Bonding Agent: Latex type.

2.2 MORTAR COLOR

- A. Mortar Color: Color to match block.

2.3 MORTAR MIXES

- A. Mortar For Load Bearing Walls and Partitions: ASTM C270, Type S with sand equal to 2-1/4 to three times the sum of the volume of the cementitious materials.
- B. Mortar shall consist of 1 part Portland Cement, 1/4 part to 1/2 part lime putty, or hydrated lime, and water repellant admixture.
- C. Coloring shall be added to the mortar when used with colored masonry units. The type and amount shall be as recommended by manufacture to match colored masonry units.
- D. Mortar 28-day compressive strength shall be not less than 1,800 psi.

2.4 MORTAR MIXING

- A. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use.
- B. Maintain sand uniformly damp immediately before the mixing process.
- C. Add mortar color and admixtures in accordance with manufacturer's instructions. Provide uniformity of mix and coloration.
- D. Do not use anti-freeze compounds to lower the freezing point of mortar.
- E. If water is lost by evaporation, re-temper only within one hour of mixing.
- F. Use mortar within one hour after mixing at temperatures of 90 degrees F (32 degrees C).

2.5 GROUT MIXES

- A. 2,000 psi strength at 28 days; slump; Mixed in accordance with ASTM C476 Fine grout.
- B. Mix shall be 1 part Portland cement, not more than 1/10 part lime putty or hydrated lime and fine aggregate equal to 2 1/4 to 3 times the sum of the volumes of the cementitious materials.
- C. Sufficient water shall be added to produce consistency for pouring without segregation of the constituents of the grout.
- D. Grout used in spaces larger than 4" may contain pea gravel equal to 1 to 2 times the amount of the cementitious material.

2.6 GROUT MIXING

- A. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 Fine grout.
- B. Add admixtures in accordance with manufacturer's instructions; mix uniformly.
- C. Do not use anti-freeze compounds to lower the freezing point of grout.

2.7 MIX TESTS

- A. Testing of Mortar Mix: In accordance with ASTM C780 for compressive strength.
- B. Testing of Grout Mix: In accordance with ASTM C1019 for compressive strength.
- C. Cost of testing shall be born by contractor.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Request inspection of spaces to be grouted.

3.2 PREPARATION

- A. Apply bonding agent to existing concrete and block surfaces.
- B. Plug clean-out holes with masonry units. Brace masonry for wet grout pressure.

3.3 INSTALLATION

- A. Install mortar in accordance with ASTM C270. Install grout in accordance with ASTM 476.

- B. Work grout into masonry cores and cavities to eliminate voids.
- C. Do not install grout in lifts greater than 16 inches without consolidating grout by rodding.
- D. Do not displace reinforcement while placing grout.
- E. Remove excess mortar from grout spaces.

3.4 FIELD QUALITY CONTROL

- A. Test and evaluate mortar in accordance with ASTM C780.
- B. Test and evaluate grout in accordance with ASTM C1019.

END OF SECTION

SECTION 05 05 00 - BOLTS, WASHERS, DRILLED ANCHORS, AND EYEBOLTS

PART - 1 GENERAL

1.1 DESCRIPTION

- A. This section describes materials and installation of anchor bolts, connecting bolts, washers, drilled anchors, eyebolts, and stainless-steel fasteners.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. General Concrete Construction: 03 30 00.
- B. Miscellaneous Structural Steel and Aluminum: 05 12 10.
- C. Pipe Hangers and Supports: 22 05 29.

1.3 DESIGN CRITERIA

- A. Structural Connections: AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings (ninth edition), except delete the second paragraph of Section A7.1, the last sentence of the first paragraph of Section M5, the last sentence of Section M5.2, and Chapter N in its entirety.

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00: Submittal Procedures.
- B. Submit manufacturer's catalog data for bolts, washers, and concrete anchors. Show dimensions and reference materials of construction by ASTM designation and grade.

PART - 2 MATERIALS

2.1 ANCHOR BOLTS

- A. Steel anchor bolts shall conform to ASTM A 307, Grade A.

2.2 CONNECTION BOLTS

- A. Steel connection bolts shall conform to ASTM A 325, Type 3. Connection type shall be N per the AISC handbook.
- B. Provide galvanized bolts where shown in drawings. Galvanizing shall be by the hot-dipped process.

2.3 STAINLESS-STEEL BOLTS

- A. Stainless-steel bolts shall be ASTM A 193, Grade B8M, or ASTM F 593, Type 316. Nuts shall be ASTM A 194, Grade 8M, or ASTM F 594, Type 316. Use ASTM A 194 nuts with ASTM A 193 bolts; use ASTM F 594 nuts with ASTM F 593 bolts. Provide washer for each nut and bolthead. Washers shall be of the same material as the nuts.

2.4 BEVELED WASHERS

- A. Washers for American Standard beams and channels shall be square or rectangular, tapered in thickness, smooth, hot-dipped galvanized, and conforming to ASTM F 436.

2.5 DRILLED ANCHORS

- A. Unless otherwise indicated in the drawings, drilled anchors shall be Type 316 stainless-steel zinc-plated steel hot-dipped galvanized steel wedge anchors as manufactured by ITW Ramset/Redhead, Hilti, or equal.

2.6 EMBEDDED EYEBOLTS

- A. Eyebolts shall be of the welded-eye type, Type 316 stainless steel.

PART - 3 EXECUTION

3.1 STORAGE OF MATERIALS

- A. Store material, either plain or fabricated, above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

3.2 GALVANIZING

- A. Zinc coating for bolts, anchor bolts, and threaded parts shall be in accordance with ASTM A 153.

3.3 INSTALLING CONNECTION BOLTS

- A. Use steel bolts to connect structural steel members. Use stainless-steel bolts to connect structural aluminum members.
- B. Install ASTM A 325 bolts per the AISC "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

- C. Bolt holes in structural members shall be 1/16 inch (1.6 mm) in diameter larger than bolt size. Measure cast-in-place bolt locations in the field before drilling companion holes in structural steel beam or assembly.
- D. Drive bolts accurately into the holes without damaging the thread. Protect boltheads from damage during driving. Boltheads and nuts shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, provide beveled washers to give full bearing to the head or nut. Where self-locking nuts are not furnished, bolt threads shall be upset to prevent the nuts from backing off.
- E. Bolts shall be of the length that will extend entirely through but not more than 1/4 inch (6.4 mm) beyond the nuts. Draw boltheads and nuts tight against the work. Tap boltheads with a hammer while the nut is being tightened. After final tightening, lock the nuts.

3.4 INSTALLING ANCHOR BOLTS

- A. Preset bolts and anchors by the use of templates.
- B. After anchor bolts have been embedded, protect their threads by applying grease and by having the nuts screwed on until the time of installation of the equipment or metalwork.

END OF SECTION

SECTION 05 12 00 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section describes structural steel including structural steel shapes and plates, fasteners, welding, and associated accessories.

1.2 SUBMITTALS

- A. Submit design data of members to be fabricated before starting their fabrication.
- B. Submit certified copies of mill tests and analyses made in accordance with applicable ASTM standards, or reports from a recognized commercial laboratory, including chemical and tensile properties of each shipment of structural steel or part thereof having common properties.
- C. Submit current International Conference of Building Officials Evaluation Report for chemical anchors.
- D. Shop Drawings: Submit shop drawings showing member sizes, lengths, locations and fabrication requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver structural steel free from mill scale, rust, and pitting.
- B. Storage and Protection: Until erection and painting, protect from weather items not galvanized or protected by a shop coat of paint.

PART 2 - MATERIALS

2.1 STRUCTURAL STEEL MATERIALS

- A. Unless Otherwise Specified or Indicated on the Drawings, Materials Shall Conform to the Following:

<u>Item</u>	<u>ASTM Standard Item</u>	<u>Class, Grade, Type or Alloy Number</u>
Steel		
Plate, bars, rolled shapes, and miscellaneous items	A 36	--
Tubing, cold-formed	A 500	--
Tubing, hot-formed	A 501	--
Steel pipe	A 53	Grade B
Stainless Steel		
Plate, sheet, and strip	A 167	Type 304* or 316
Bars and shapes	A 276	Type 304* or 316

* Use Type 304L or Type 316L if material will be welded.

- B. Stainless steels are designated by type or series defined by ASTM. Where stainless steel is welded, use low-carbon stainless steel. Where anchors, connections or other details of structural steel are not specifically indicated on the Drawings or specified, their material, size, and form shall be equivalent in quality and workmanship to items specified.

2.2 FASTENERS

- A. Furnish threaded fasteners, except high strength bolts, with flat washers, and self-locking nuts, or lock washers and nuts. Bolt heads and nuts shall be Hex-type. Bolts, nuts and washers shall be manufactured domestically. Galvanized fasteners shall be galvanized in accordance with ASTM A 153.
- B. Thread Rods for use in wet and moist locations including all water-containing structures shall be Type 316 stainless steel. This includes thread rods used below and at water level, above water level and below the top of walls, under the roof, slab, beam, or walkway of enclosed water-containing structures, and the dryside of walls of water containing structures. Type 316 stainless steel shall also be used in pump bases. Thread Rods of Type 304 or Type 316 stainless steel shall be used for aluminum assemblies. Thread Rods shall be ASTM A 36 meeting the mechanical requirements of ASTM A 307. Hot-dip galvanize for galvanized assemblies and for applications other than those specified.
- C. Anchor Bolts, Nuts, and Washers for Use in Wet and Moist Locations including all water-containing structures shall be Type 316 Stainless Steel. This includes anchor bolts used below and at water level, above water level and below the top of walls, under the roof, slab, beam, or walkway of the enclosed water-containing structures, and the dryside of walls of water containing structures. Anchor Bolts, Nuts, and Washers shall be Type 304 or Type 316 stainless steel for fastening aluminum to concrete or steel. Anchor bolts, nuts and washers shall be hot-dip

galvanized ASTM A 307 steel or hot-dip galvanized ASTM A 36 steel, for applications other than those specified.

- D. Assembly bolts, nuts, and washers for wood baffles, collectors, and other field-assembled construction shall be Type 316 stainless steel for use in wet and moist locations which includes water-containing structures below and at water level, above water level and below top of walls, under the roof, slab, beam, or walkway of enclosed water-containing structures and the dry side of the walls of water-containing structures. Type 316 stainless steel shall also be used in pump bases. Use hot-dip galvanized ASTM A 307 steel for galvanized assemblies and for applications other than those specified.
- E. Chemical Anchors shall have vinyl ester resin in the composition of the adhesive, where installed in concrete. All-thread rods shall be ASTM A 36 steel hot-dip galvanized or zinc plated or stainless steel. Stainless steel all-thread rod shall conform with ASTM F 593 and shall be used for corrosive conditions where indicated on the Drawings. Where indicated, use reinforcing bars in lieu of all-thread rods. All-thread rods and reinforcing bars used with the adhesive capsule shall have chisel points and shall be free of oil or coatings that may reduce bond. Chemical anchors to resist tension in overhead positions should not be used.
- F. Concrete Anchor's Integral Threaded Stud, Wedge, Washer, and Nut shall be Type 304 or Type 316 Stainless Steel for Use in Wet and Moist Locations, Including water-containing structures below and at water level, above Water Level, below top of walls of water-containing structures, under the roof, slab, beam, or walkway of enclosed water-containing structures and the dry side of walls of water-containing structures. Concrete anchors in pump basins shall also be Type 304 or Type 316 stainless steel. Type 304 or 316 stainless steel for fastening aluminum to concrete or steel. Use hot-dip galvanized ASTM A 307 steel, or hot-dip galvanized ASTM A 36 steel, for applications other than those specified.
- G. Deformed Bar Anchors shall be in accordance with ASTM A 496.
- H. Eyebolts shall be welded or forged, when manufactured of materials other than carbon steel. Eyebolts having geometric and strength characteristics of eyebolts specified in ASTM A 489, Type 1. The strength characteristics include proof load requirements, breaking strength requirements, tensile strength requirements, bend test, and impact strength.
- I. Flush Shells shall be Type 303 stainless steel.
- J. High strength bolts, nuts, and hardened flat washers shall be in accordance with ASTM A 325 or ASTM A 490.
- K. Powder actuated fasteners for installation in concrete or steel shall be zinc coated, heat-treated, alloy steel. Fasteners not sufficiently protected against corrosion under conditions to which they will be exposed shall be coated as necessary to make suitable for such conditions. Pins shall be furnished with head or threaded

stud capable of transmitting loads to shanks. Pins connected to steel shall be furnished with longitudinal serrations around circumference of shank.

- L. Studs shall meet ASTM A 108 with 50,000 pounds per square inch minimum yield strength, and 60,000 pounds per square inch minimum tensile strength.

2.3 SUPPLEMENTARY PARTS

- A. Furnish as required for complete structural steel erection, whether or not such parts and work are specified or indicated on the Drawings.

2.4 FABRICATION

- A. Shop Assembly:
 - 1. Fabricate structural steel in conformance with AISC "Specification for the Structural Steel Buildings - Allowable Stress Design and Plastic Design," unless otherwise specified or modified by applicable regulatory requirements.
 - 2. Where anchors, connections or other details of structural steel are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.
 - 3. Structural Members Such as W Shapes, S Shapes, Channels, Angles, and Similar Members not Available in Quantity, Size, and Type of Stainless Steel Specified or indicated on the Drawings.
 - a. Fabricate by welding together pieces of low carbon stainless steel plate, such as 316L.
 - b. Make full penetration welds between pieces of plate to attain same or higher section modulus and moment of inertia as members indicated on the Drawings.
 - 4. Where galvanizing is required, hot-dip galvanize structural steel after fabrication in accordance with ASTM A 123.
 - a. Do not electro-galvanize unless specified or accepted by Construction Manager.
 - b. Restraighten galvanized items that bend or twist during galvanizing.
 - 5. Round off sharp and hazardous projections and grind smooth.
 - 6. Take measurements necessary to properly fit work in the field. Take responsibility for and be governed by the measurements and proper working out of all the details.

7. Take responsibility for correct fitting of all metal work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.2 ERECTION

- A. General:
 1. Fabricate structural and foundry items to true dimensions without warp or twist.
 2. Form welded closures neatly, and grind off smooth where weld material interferes with fit or is unsightly.
 3. Install structural items accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.
 4. Do not cock out of alignment, redrill, reshape, or force fit fabricated items.
 5. Place anchor bolts or other anchoring devices accurately and make surfaces which bear against structural items smooth and level.
 6. Rigidly support and brace structural items needing special alignment to preserve straight, level, even, and smooth lines. Keep structural items braced until concrete, grout, or dry pack mortar has hardened for 48 hours minimum.
 7. Erect structural steel in conformance with AISC "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design," unless otherwise specified or modified by applicable regulatory requirements.
 8. Where anchors, connections, and other details of structural steel erection are not specifically indicated on the Drawings or specified, form, locate, and attach with equivalent in quality and workmanship to items specified.
 9. Round off sharp or hazardous projections and grind smooth.
 10. Paint or coat steel items in accordance with Section 09 90 00.
 11. Coat aluminum items embedded in concrete in accordance with Section 09 90 00.

- B. Make welds full penetration type, unless otherwise indicated on the Drawings.
- C. When welding Stainless Steel comply with AWS D1.1 and perform with electrodes and techniques in accordance with AWS D10.4.
- D. When welding Carbon Steel comply with AWS D1.1. Weld ASTM A 36 structural steel, ASTM A 500 and A 501 structural tubing, and ASTM A 53 pipe with electrodes conforming to AWS A5.1, using E70XX electrodes; AWS A5.17, using F7X-EXXX electrodes; or AWS A5.20, using E7XT-X electrodes.
- E. Where steel fasteners come in contact with aluminum or other dissimilar metals, bolt with stainless steel bolts and separate or isolate from dissimilar metals with sleeves and washers. Sleeves shall be Mylar, 1/32 inch thick, of proper size to fit bolts. One sleeve required for each bolt. Manufactured by Central Plastics Company, Shawnee, Oklahoma, or equal. Washers shall be 63 glass phenolic, 1/8 inch thick, of proper size to fit bolts. Two washers are required for each bolt. Prior to installing nuts, coat threads of stainless steel fasteners with following to prevent galling of threads. Manufactured by Never Seez Compound Corporation, Never-Seez, or Oil Research, Inc., WLR No. 111 or equal.
- F. Threaded Fasteners: Install anchor bolts and concrete anchors, to project 2 threads minimum, but 1/2 inch maximum beyond nut. Unless otherwise specified, tighten bolts, including anchor bolts and concrete anchors, to the "snug-tight" condition, defined as tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.
- G. Use cast-in-place anchor bolts when concrete is placed, wherever feasible. Accurately locate anchor bolts embedded in concrete with bolts perpendicular to surface from which they project. Do not allow anchor bolts to touch reinforcing steel. Where anchor bolts are within 1/4 inch of reinforcing steel, isolate with a minimum of 4 wraps of 10 mil polyvinyl chloride tape in area adjacent to reinforcing steel. In anchoring machinery bases subject to heavy vibration, use 2 nuts, with 1 serving as a locknut. Where bolts are indicated on the Drawings for future use, first coat thoroughly with nonoxidizing wax, then turn nuts down full depth of thread and neatly wrap exposed thread with waterproof polyvinyl tape. Furnish anchor bolts with standard hex bolt head unless otherwise indicated on the Drawings. Where anchor bolts with 90 degree hooks are indicated on the Drawings, provide anchors with minimum 4 diameter hook length. Embed anchor bolts 10 diameters minimum. Where indicated on the Drawings, set anchor bolts in metal sleeves having inside diameter approximately 2 inches greater than bolt diameter and minimum 10 bolt diameters long. Seal top of sleeve to prevent grout from filling sleeve and fill sleeves with grout when a machine or other equipment is grouted in place. Anchor bolts may be cast in concrete in lieu of using concrete anchors. Consider connections with high strength bolts to be slip critical structural connections, unless otherwise indicated on the Drawings. Connections with high

strength bolts shall conform to AISC Specification for Structural Joints Using

ASTM A 325 or A 490 Bolts. Furnish hardened flat washer shall be under element, nut or bolt head, turned in tightening and on outer plies for short slotted holes. Notify Construction Manager in advance of method selected for tightening and verification pursuant to the referenced AISC Specification.

- H. When drilling holes do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by Construction Manager. Determine location of reinforcing bars, or other obstructions with a non-destructive indicator device. Use electric or pneumatic rotary type hole drilling equipment with medium or light impact. Drill bits shall be carbide-tipped in accordance with ANSI B212-15. Hollow drills with flushing air systems are preferred. Air shall be free of oil, water, or other contaminants which will reduce bond. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.
- I. Consider connections with high strength bolts to be slip critical structural connections, unless otherwise indicated on the Drawings. Connections with high strength bolts shall conform to AISC Specification for Structural Joints Using ASTM A 325 or A 490 Bolts. Furnish Hardened Flat Washer under element, nut or bolt head, turned in tightening and on outer plies for short slotted holes. Notify Construction Manager in advance of method selected for tightening and verification pursuant to the referenced AISC Specification.
- J. Deformed bar anchors shall be butt welded with automatic stud welding gun as recommended by manufacturer. Ensure butt weld develops full strength of the anchor.
- K. Flush shells shall be used only where specifically indicated on the Drawings. Accurately locate and set perpendicular to surfaces from which they project.
- L. Drilling Holes do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by Construction Manager. Determine location of reinforcing bars, or other obstructions with a non-destructive indicator device.
- M. Use electric or pneumatic rotary type hole drilling equipment with medium or light impact. Drill Bits shall be Carbide-tipped in accordance with ANSI B212-15. Hollow drills with flushing air systems are preferred. Air shall be free of oil, water, or other contaminants which will reduce bond. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process. Use powder actuated fasteners only for applications indicated on the Drawings or specified.
- N. Butt weld studs with automatic stud welding gun as recommended by the manufacturer. Ensure butt weld develops full strength of the stud.

END OF SECTION

SECTION 05 12 10 - MISCELLANEOUS STRUCTURAL STEEL AND ALUMINUM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes materials, fabrication, and installation of structural steel, structural aluminum, stainless-steel plate and members, steel tubing, aluminum tubing, and aluminum sheet.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Structural Steel 051200.

1.3 DESIGN CRITERIA

- A. Structural Connections and Framing: AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings (ninth edition), except delete the second paragraph of Section A7.1, the last sentence of the first paragraph of Section M5, the last sentence of Section M5.2, and Chapter N in its entirety.

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00: Submittal Procedures.
- B. Submit placing or erection drawings which indicate locations of fabricated items. Reproductions of contract documents will not be accepted for this purpose.

PART 2 - MATERIALS

2.1 STRUCTURAL STEEL

- A. Material for all-purpose bolted or welded construction shall conform to ASTM A 36. Steel pipe shall conform to ASTM A53.

2.2 STRUCTURAL STEEL TUBING

- A. Conform to ASTM A 500, Grade A 501.

2.3 STAINLESS-STEEL PLATE AND MEMBERS

- A. Except where otherwise specified, stainless-steel plate and members shall be Type 316, ASTM A 167.

2.4 ALUMINUM SHEET

- A. Aluminum sheet shall conform to ASTM B 209, Alloy 3003, H 14 temper, unless

otherwise shown.

2.4 STRUCTURAL ALUMINUM

- A. Aluminum structural members shall conform to ASTM B 308, Alloy 6061-T6.

2.6 ALUMINUM TUBING

- A. Aluminum tubing shall conform to ASTM B 241, Alloy 6061-T6. Wall thickness shall be Schedule 80, per ANSI H35.2, unless otherwise shown in the drawings.

2.7 WELDING ELECTRODES

- A. Welding electrodes for structural steel shall conform to AWS A5.5. Use electrodes in the E-70 series.
- B. Welding electrode for aluminum shall be 4043 filler metal.
- C. Use Type 347 electrode for stainless steel.

PART 3 - EXECUTION

3.1 STORAGE OF MATERIALS

- A. Store structural material, either plain or fabricated, above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

3.2 FABRICATION AND ERECTION

- A. Fabricate miscellaneous metal items to straight lines and true curves. Drilling and punching shall not leave burrs or deformations. Continuously weld permanent connections along the entire area of contact. Exposed work shall have a smooth finish with welds ground smooth. Joints shall have a close fit with corner joints coped or mitered and shall be in true alignment. Unless specifically indicated in the drawings, there shall be no bends, twists, or open joints in any finished member nor any projecting edges or corners at intersections. Conceal fastenings wherever possible. Built-up parts shall be free of warp. Exposed ends and edges of metal shall be slightly rounded.
- B. Clean the surfaces of metalwork to be in contact with concrete of rust, dirt, grease, and other foreign substances before placing concrete.
- C. Set embedded metalwork accurately in position when concrete is placed, and support it rigidly to prevent displacement or undue vibration during or after the placement of concrete. Unless otherwise specified, where metalwork is to be installed in recesses in formed concrete, said recesses shall be made, metalwork installed, and recesses filled with dry-pack mortar in conformance with Section 03000.

3.3 GALVANIZING

- A. Zinc coating for steel plates shall be in accordance with ASTM A 153. Structural steel, pipe, and tubing shall be zinc coated in accordance with ASTM A 123.

3.4 WELDING

- A. Perform welding on steel by the shielded metal arc welding (SMAW) process. Welding shall conform to the AWS Structural Welding Code D1.1.
- B. Perform welding on aluminum by the gas metal arc (MIG) or gas tungsten arc (TIG) process, per the AWS Welding Handbook.
- C. Provide a minimum of two passes for metal in excess of 5/16-inch (8 mm) thickness.
- D. Produce weld uniform in width and size throughout its length with each layer of weldment smooth; free of slag, cracks, pinholes, and undercuttings; and completely fused to the adjacent weld beads and base metal. Avoid irregular surface, nonuniform bead pattern, and high crown. Form fillet welds of the indicated size of uniform height and fully penetrating. Accomplish repair, chipping, and grinding of welds in manner that will not gouge, groove, or reduce the base metal thickness.

3.5 BOLTING

- A. See Section 05 05 00.

3.6 CONTROL OF FLAME CUTTING

- A. Do not use a gas-cutting torch in the field for correcting fabrication errors on any member in structural framing. Use a gas-cutting torch only on minor members when the member is not under stress.

3.7 REPAIR OF GALVANIZED SURFACES

- A. Repair or replace metal with damaged galvanized surfaces at no additional cost to the Owner. Accomplish repair of galvanized surfaces by use of DRYGALV as manufactured by the American Solder and Flux Company, Cold Galvanizing Repair Compound as manufactured by Rust-Oleum, or equal. Apply in accordance with the manufacturer's instructions.

3.8 CORROSION PROTECTION OF ALUMINUM SURFACES

- A. Coat aluminum surfaces to be embedded or which are in contact with concrete or masonry, per Section 09 90 00, System No. 51 before installation. Allow the paint to dry before the aluminum is placed in contact with the concrete.

- B. Where aluminum surfaces come in contact with dissimilar metals, keep the dissimilar metallic surfaces from direct contact by use of neoprene gaskets or washers.

3.9 PAINTING AND COATING OF STRUCTURAL STEEL

- A. Coat non-galvanized structural steel surfaces per Section 09 90 00. Apply prime coat in the shop prior to shipping to the site. Apply intermediate and finish coats after erection, except surfaces that will be inaccessible for coating after erection or assembly shall be finish coated prior to erection or assembly.

END OF SECTION

SECTION 05 21 00 – STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide pre-engineered steel joists in accordance with Contract Documents.

1.2 RELATED SECTION

- A. Section 03 61 00 – Grout
- B. Section 05 12 10 – Miscellaneous Structural Steel and Aluminum
- C. Section 09 90 00 – Painting

1.3 REFERENCES

- A. American Institute of Steel Construction (AISC) standards, most recent editions:
 - 1. Specifications for Structural Steel Buildings.
 - 2. Code of Standard Practice for Steel Buildings and Bridges.
- B. ASTM International (ASTM) standards, most recent editions:
 - 1. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - 2. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- C. American Welding Society (AWS) standards, most recent editions:
 - 1. D1.1 - Structural Welding Code-Steel.
- D. Steel Joist Institute (SJI) standards, most recent edition. Recommended code of Standard Practice for Steel Joists and Joist Girders. Standard Specifications for open Web Steel Joists, K-Series.
- E. Society for Protective Coatings (SSPC) standards, most recent edition:
 - 1. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. Shop drawings:
 - 1. Detailed shop drawings showing size and layout of joist units, bridging, connections, and accessories. Include mark, number, type, locations, and spacing of joists and bridging.
 - 2. Provide templates or location drawings for installation of any required anchor bolts.
 - 3. Indicate beveled end plates for joist roof pitch where required. Provide details of bridging, method of attachment to joists, and joist end anchorage and other details required for joist installation.
 - 4. Shop drawings shall not be reproductions of the Contract Drawings.
- C. Certifications:
 - 1. Submit evidence that joist manufacturer is a member of the Steel Joist Institute (SJI).
 - 2. Welding certifications.
 - 3. Capability of joist in accordance with Paragraph 2.2 B.

1.5 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Fabricator: Fabricator shall be a member of the Steel Joist Institute who regularly produces steel joists of the K-, KCS-, LH-, and DLH-Series, or joist girders conforming to SJI Specifications and Load Tables and whose designs have been checked and accepted by the SJI.
 - 2. Erector: Use erectors with a minimum of 5 years' experience installing steel joists equal in material, design, and scope to the trusses required for this Project.
 - 3. Welders:
 - a. Qualify welding processes, operations, and operators in accordance with AWS D1.1 and SJI Technical Digest #8, "Welding of Open Web Steel Joists."

- b. Welding operators to have been qualified during the 12 month period prior to commencement of welding.
- 4. Joist designer: The design professional, licensed to practice in the state of Nevada, having responsibility for the design of the joists. The joist designer shall be either an employee of the joist fabricator or a consultant.
- B. Shop inspection may be required by Owner at Owner's own expense and option.
 - 1. Furnish ample notice to Engineer prior to the beginning of fabrication work so that inspection may be provided.
 - 2. Furnish all facilities for the inspection of materials and workmanship in the shop and allow inspectors free access to the necessary parts of the Work.
 - 3. Inspectors shall have the authority to reject materials and Work that does not meet Specifications.
 - 4. Inspection at the shop is intended to facilitate the Work and avoid errors, but will in no way relieve Contractor from the responsibility for providing proper materials and workmanship under this Specification.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to site at such intervals to ensure uninterrupted progress of Work. Inspect the joists for damage before unloading and note any permanent bend or deformation or broken welds on the receiving documents.
- B. Store materials to permit easy access for inspection and identification. Keep joist members off ground using pallets, skids, platforms, or other supports.
- C. Protect steel members from corrosion and damage.
- D. Store packaged materials in original unbroken package or container.
- E. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures.
- F. Replace damaged shapes or members as required by Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Steel joists:
 - a. CANAM Steel Corporation.
 - b. CMC Joist and Deck.
 - c. Nucor Corporation, Vulcraft Divisions
 - d. Valley Joist, Incorporated.
 - e. Engineer approved equal.

2.2 STEEL JOIST

- A. Provide steel joists that have been designed for loadings and configurations specified on the Contract Drawings and that have been found to conform to the SJI standard specifications.
- B. Special or concentrated loads:
 - 1. Where special loadings and concentrated loads are indicated in the Contract Documents, reinforce joist and develop details as necessary for support of such loads.
 - 2. Submit written certification that the joist(s) have been designed, fabricated, and are capable of supporting the loadings indicated for the span(s) shown. Written certification to be signed and sealed by a professional engineer licensed to practice in the state of Utah.
- C. Design in accordance with SJI Specifications:
 - 1. Joist designations indicated on the Contract Drawings are minimum requirements. Increase as required to comply with design requirements specified.
 - 2. Whenever possible, increased joists shall have the same depth as joist indicated on Contract Drawings.
 - 3. When necessary to increase joist depths to meet design requirements, coordinate all Project changes required due to the increased depth at no additional cost to Owner.

- D. Bridging: Provide horizontal or diagonal type bridging as required by SJI specifications or as indicated on Contract Drawings for type of joist, chord size, spacing and span.
 - 1. Supply bridging to ensure stability of structure during construction period.
- E. Extended ends: Provide extended ends on joists as indicated on Contract Drawings complying with applicable SJI specifications and load tables.
 - 1. Top chord extension: Top chord extensions shall be capable of withstanding the full uniform load of the joist plus any concentrated loads shown on the Contract Documents. The extensions shall be attached to the perimeter bracing unless shown otherwise on the Contract Drawings.

2.3 MATERIALS

- A. Steel: Comply with requirements of SJI specifications.
- B. Primer: Red oxide, lead free and cadmium-free, corrosion inhibiting primer complying with performance requirements of SSPC Paint Specification No. 15, Type I.
- C. Unfinished threaded fasteners: ASTM A307, Grade A, regular hexagon type, low carbon steel.
- D. High-strength bolts and nuts: ASTM A325, Type I, heavy hex structural bolts, heavy hex nuts and hardened steel washers.
- E. Accessories: Provide accessories required for erection of steel joists, complying with SJI specifications and Contract Drawings.

2.4 FABRICATION

- A. Fabricate in accordance with SJI specifications and as follows:
 - 1. Do not splice principal tension members. Use only full length pieces.
 - 2. Make shop connections and splices using either arc or resistance welding. Do not shop-bolt connections.
 - 3. Design and fabricate for maximum deflection of 1/240 of clear span under design live load.
 - 4. Shop holes, field holes, and enlargement of holes will not be permitted unless approved by Engineer.
 - 5. Fabricate bearing ends to provide following minimum bearing unless a longer bearing length is shown or specified.

Support	"LH" & "DLH" Joists	"K" & "KCS" Joists	Joist Girders
On Masonry or Concrete.	6 inches min	4 inches min	6 inches min
On Steel.	2-1/2 inches min	4 inches min	4 inches min

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which steel joists are to be installed for conditions detrimental to proper and timely completion of Work.
- B. Do not proceed with Work until unsatisfactory conditions have been corrected.
- C. Do not start placement of steel joists until supporting Work is in place and secured.
- D. Joists shall be subject to rejection if:
 - 1. Joists do not comply with requirements of SJI specifications and requirements included herein and on the approved shop drawings.
 - 2. Joists are improperly welded or constructed.
 - 3. Joists are damaged so that strength is impaired.
 - 4. Joists are not installed as indicated on Contract Drawings.
 - 5. Joists are not installed straight within a tolerance as plus or minus 0.0028 times the length of the joist or the distance between points of lateral support.
- E. Review Drawings and report discrepancies to Engineer for clarification prior to starting fabrication or erection.

3.2 INSTALLATION

- A. Do not install joists that are damaged such that strength is impaired.
- B. Provide proper lifting equipment, including spreader bar, suited to sizes and types of joists required, applied at lift points recommended by joist manufacturer. Exercise care to avoid damage to joist members during erection and to keep horizontal bending of the joists to a minimum.
- C. Where not specifically indicated otherwise, place and secure steel joists in accordance with SJI specifications and as herein specified.
- D. Bearing on Masonry or Concrete Bearing Surfaces:

1. Secure joists resting on masonry or concrete bearing surfaces by welding to embedded plates anchored to masonry or concrete construction as shown on Drawings. Masonry or concrete required to support joists to have reached required 28 day compressive strength prior to placing joists thereon.
 2. Furnish steel bearing plates to be built into concrete and masonry construction. Furnish templates as may be necessary for accurate location of anchors. Steel bearing plates to conform to requirements of Section 05 12 10 – Miscellaneous Structural Steel and Aluminum.
 3. Bedding mortar (grout): Non-shrink grout in accordance with Section 03 61 00 – Grout.
- E. Place joists on supports at spacing indicated on the shop drawings. Adjust and align in accurate location and spacing before permanently fastening.
1. When joists do not bear flush on supporting member or wall, take corrective measures to ensure full bearing. Provide tapered bearings as required for uniform flush bearing.
- F. Bridging: Install bridging simultaneously with joist erection, before construction loads are applied.
1. Comply with OSHA requirements for bolted bridging to be in place before slackening lines on joist longer than 40 feet.
 2. Anchor ends of bridging lines at top and bottom chords of each joist and where terminating at walls or beams.
 3. Provide bridging connections at top and bottom chords capable of safely resisting a force specified by SJI standard specifications for open web, long span, deep long span joists, and joist girders, respectively.
 4. During construction period, CONTRACTOR shall be responsible for loads placed on joists. Joists may be unstable and cannot carry design load until steel deck and bridging are completely installed.
 5. Provide bracing that holds trusses straight and plumb and in safe condition until decking and permanent truss bracing has been fastened to form a structurally sound framing system.
- G. Removal, cutting, or other alteration of any joist chord, web, or bridging member in the field is prohibited, unless approved in advance and in writing by Engineer and joist manufacturer.
- H. Remove and replace or repair damaged joists or other Work as directed by Engineer and/or joist manufacturer at no additional expense to Owner.

END OF SECTION

SECTION 05 53 00 - GRATING, COVER PLATES, HANDRAILS, AND ROOF ACCESS HATCH

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes materials, fabrication, and installation of steel and aluminum grating, cover and floor plates, and handrails.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 30 00 - Concrete Work

1.3 DESIGN CRITERIA

- A. Grating, Floor Plates, and Miscellaneous Cover Plates: Design live load of 150 psf (732 kg per square meter), maximum deflection of 1/240 of span.
- B. Manhole frames and covers: HS20-44, maximum deflection of 1/240 of span.

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00.
- B. Submit drawings of fabricated items, such as grating, cover plates, and access hatches. Show dimensions and reference materials of construction by ASTM designation and grade. Show design criteria.
- C. Submit placing or erection drawings which indicate locations of fabricated items. Submit details showing connections of access hatches to roof deck. Reproductions of contract documents will not be accepted for this purpose.
- D. Submit manufacturer's catalog data on precast concrete manholes, frames, and covers. Show dimensions and materials of construction by ASTM reference and grade. Show lettering on manhole covers.

PART 2 - MATERIALS

2.1 MANHOLE FRAMES AND COVERS

- A. Manhole frames and covers shall be made of cast iron conforming to ASTM A 48, Class 30. Castings shall be smooth, clean, and free from blister, blowholes, and shrinkage. Frames and covers shall be of the traffic type. The cover shall seat firmly into the frame without rocking.
- B. Grind or otherwise finish each cover so that it will fit in its frame without rocking. Frames and covers shall be matchmarked in sets before shipping to the site.

- C. Before leaving the foundry, clean castings and subject them to a hammer inspection. Then dip castings twice in a preparation of asphalt or coal tar and oil applied at a temperature of not less than 290° F (143° C) nor more than 310° F (154° C).

2.2 STEEL

- A. Steel grating and walkways shall be of structural quality steel conforming to ASTM A666 Grade A, Type 316 stainless steel, unless otherwise shown on the plans.

2.3 HANDRAILS

- A. Handrails shall be made from galvanized steel.

2.4 ROOF ACCESS HATCH

- A. Furnish and install where indicated on plans metal roof hatch. The roof hatch shall be pre-assembled from the manufacturer.
- B. Performance characteristics:
 - 1. Unit designed to be pedestrian rated for 300 PSF loads. Deflection may not exceed 1/150 of the span.
 - 2. Material shall be 6061-T6 aluminum for bars, angles and extrusions.
 - 3. Operation of the cover shall not be affected by temperature.
 - 4. 1/4" diamond plate shall be 5086 aluminum.
- C. The cover shall be supplied with a heavy duty, stainless steel pneu-spring. Spring must consist of a minimum 1/2" stainless steel shaft which slides into a minimum 1" stainless steel tube. Spring must be charged with an inert gas (nitrogen). Mechanical, torsion, or coil type springs shall not be accepted as equal. Spring design must ensure ease of maintenance.
- D. Each door shall be equipped with a stainless steel automatic hold open arm. To highlight this safety device, the hold open arm must be supplied with a red powder coat finish. Doors shall lock open in the 90-degree position. Hold open arms shall be fastened to the frame with a 1/2" grade 316 stainless steel bolts.
- E. Angle frame shall be of extruded aluminum, 4" tall with a continuous 3" anchor/mounting flange. Unit is designed to lag to the top of the structure.
- F. Exterior of hatch frame shall utilize (as an isolation coating, to deter reaction of dissimilar materials) "Tufcoat 3.5PR" Industrial Coatings by Dupont at a thickness of 3 mils. Application procedure shall be as recommended by Dupont.

- G. Hinges shall be of heavy-duty design. Material shall be stainless steel with a 3/8" grade 316 stainless steel pin. Hinges shall be bolted to the channel frame and diamond plate, with grade 316 stainless steel bolts and ny-lock nuts.
- H. Each hatch shall be supplied with a grade 316 stainless steel slam lock, with keyway protected by a threaded aluminum plug. Plug shall be flush with the top of the 1/4" diamond plate. Slam lock shall be fastened with four grade 316 stainless steel bolts and washers.
- I. Each hatch shall be supplied with a Recessed Padlock Clip (RPC). RPC shall be supplied with its own separate hinged cover for owner access to the owner supplied padlock.
- J. Each hatch shall be equipped with a cast aluminum lift handle. The lift handle shall be flush with the top of the 1/4" diamond plate.

PART 3 - EXECUTION

3.1 STORAGE OF MATERIALS

- A. Store structural material, either plain or fabricated, above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

3.2 INSTALLATION AND ERECTION

- A. Clean the surfaces of metalwork to be in contact with concrete of rust, dirt, grease, and other foreign substances before placing concrete.
- B. Set frames and supports accurately in position when concrete is placed and support it rigidly to prevent displacement or undue vibration during or after the placement of concrete. Unless otherwise specified, where metalwork is to be installed in recesses in formed concrete, said recesses shall be made, metalwork installed, and recesses filled with dry-pack mortar in conformance with Section 03 61 00.

3.3 REPAIR OF GALVANIZED SURFACES

- A. Repair or replace metal with damaged galvanized surfaces at no additional cost to the Owner. Accomplish repair of galvanized surfaces by use of DRYGALV as manufactured by the American Solder and Flux Company, Cold Galvanizing Repair Compound as manufactured by Rust-Oleum, or equal. Apply in accordance with the manufacturer's instructions.

3.4 CORROSION PROTECTION OF ALUMINUM SURFACES

- A. Coat aluminum surfaces to be embedded or which are in contact with concrete or masonry per Section 09 90 00, System No. 51 before installation. Allow the paint to dry before the aluminum is placed in contact with the concrete.
- B. Where aluminum surfaces come in contact with dissimilar metals, keep the dissimilar metallic surfaces from direct contact by use of neoprene gaskets or washers.

3.5 INSTALLING MANHOLE FRAME AND COVER

- A. Set each precast concrete manhole unit plumb on a bed of sealant or mortar to make a watertight joint at least 1/2 inch (13 mm) thick with the concrete base or with the preceding unit. Point the inside joint and wipe off the excess sealant or mortar. Secure the manhole frame to the grade ring with grout and cement mortar fillet. Backfill, compact, and replace pavement.
- B. In paved areas: Top of cover shall be flush with the paving surface.

END OF SECTION

SECTION 09 90 00 - PAINTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Surface preparation and field application of paints and coatings.

1.2 REFERENCES

- A. ASTM D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.
- B. AWWA (American Water Works Association) - C204 - Chlorinated Rubber-Alkyd Paint Systems for the Exterior of Above Ground Steel Water Piping.
- C. NACE (National Association of Corrosion Engineers) - Industrial Maintenance Painting.
- D. NPCA (National Paint and Coatings Association) - Guide to U.S. Government Paint Specifications.
- E. SSPC-SP1 - Solvent Cleaning.
- F. SSPC-SP6 - Commercial Grade Blast Cleaning.
- G. FIELD SAMPLES
 - 1. Colors to be selected by Engineer prior to commencement of work.
- H. SUBMITTALS
 - 1. Product Data: Provide data on all finishing products.
- I. DELIVERY, STORAGE, AND HANDLING
 - 1. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
 - 2. Container label to include 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.

3. Store paint materials at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

J. ENVIRONMENTAL REQUIREMENTS

1. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
2. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
3. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
4. Provide adequate ventilation.

PART 2 - PRODUCTS

2.1 SEMI GLOSS FINISH

- A. Semi-gloss finish for interior and exterior walls, ceiling and architectural metal shall consist of two or more exterior acrylic latex finish coats over one or more coats of primer to a dry film thickness of not less than 5.0 mils. Acrylic latex finish coats shall contain not less than 32 percent solids by volume and not less than 23 percent pigment by weight. Finish systems shall be the following or equal.
1. GLIDDEN: Finish coats shall be Glidden Spred Latex Enamel 3900 applied to a dry film thickness of not less than 3.0 mils.
 2. MOBIL: Finish coats shall be Mobil Series 44 Water Acrylic Enamel.
 3. SHERWIN-WILLIAMS: Finish coats shall be two or more coats of Sherwin-Williams Series B-42 Metalatex Semi-gloss Enamel to a dry film thickness of not less than 3 mils.

2.2 EPOXY COATINGS

- A. Epoxy coatings for submerged metal shall be applied where specified or noted on the Painting Schedule. Epoxy shall be a colored polyamide cured epoxy consisting of not less than 49 percent solids by volume. Coatings and pigments used on potable water service shall have FDA approval and shall be approved for use with potable water. Painting systems shall be as follows or equal applied to dry film thickness of not less than 10 mils. The finish coat color shall be white. The system shall be a two or three coat system consisting of a prime coat and two

topcoats.

The paint systems shall be as indicated in this section. All surfaces receiving this paint system shall have a near white blast surface preparation of SSPC - SP10.

This product shall meet or exceed the following test requirements established:

1. Abrasion: Method: ASTM D 4060, CS-17 Wheel, 1,000 grams load.
Requirement: No more than 120 mg. loss after 1,000 cycles.
2. Adhesion: Method: ASTM D 4541.
Requirement: Not less than 950 psi pull, average of three tests.

Method: ASTM D 3359 Method B, Crosshatch adhesion.
Requirement: Not less than a rating of 5, (no removal), average of three tests.
3. Fresh Water: Method: Coating system applied to SSPC-SP10 cleaned hot-rolled steel, cured 7 days prior to testing and immersed in aerated tap water at 77 F.
Requirement: No blistering, delamination or other loss of film integrity after 4 years exposure.
4. Salt Spray: Method: ASTM B 1176 applied to SSPC-SP10 cleaned hot rolled steel.
(FOG) Requirement: No blistering, cracking or delamination of film. No more than 1/16 in. rust creepage at scribe, and no more than two percent rusting at edges after 1,000 hours exposure.
5. Dielectric Strength Method: ANSI/ASTM D 149 (short-term test).
Requirement: No less than 1,050 volts/mil, average of five tests.
6. TNEMEC: Three or more coats of Series 20 - Pota-Pox to attain the required thickness.

2.3 UNDERGROUND METALS

- A. All exposed underground metals shall be coated.
- B. Underground valves and valve boxes shall be coated with not less than two coats of asphalt varnish in accordance with AWWA C 500.
- C. Underground pipe flanges (excluding pipe), corrugated metal pipe couplings, flexible pipe couplings and miscellaneous underground metals not

specified

otherwise to receive a protective coating, shall be coated in accordance with Section 09 90 00.

2.5 FLOOR AND WALKWAY COATING

A. Where indicated on the Painting Schedule or specified, floor and walk surfaces shall be painted with a two component epoxy/polyamide primer/sealer or a 100% acrylic water-based floor coating. Acid room floors shall be Vinyl Ester. Prior to coating, concrete floors shall be cured a minimum of 28 days and thoroughly etched with muriatic acid as recommended by the paint manufacturer. After etching, the muriatic acid shall be thoroughly removed with clean water. The concrete shall be allowed to dry not less than 48 hours following cleaning before application of the coating. The system shall be a minimum of 3 coats manufacturer's recommended thickness per coat with the final coat being a skid resistant surface. Coatings shall be the following or equal systems:

1. TNEMEC: Series 567 Tnemec-Tread.
2. FEDERAL INTERNATIONAL CHEMICALS: Series PR-14 Quick Primer/Sealer with a top coat of UR-6 aliphatic urethane.
3. SHERWIN-WILLIAMS: Armorseal Tread - Plex B90 Series.

B. The finish color shall be gray and the product system shall meet or exceed the following test requirements.

1. ABRASION: Method - ASTM D 4060, CS-17 Wheel, 1,000 grams load. Requirement: No more than 105 mg. loss after 1,000 cycles.
2. ADHESION: Method: ASTM D 4541. Coating system applied to sandblasted concrete and cured 14 days at 77 F. Requirement: Not less than 375 psi pull, average of three tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. Test shop applied primer for compatibility with subsequent cover materials.

3.2 PREPARATION

- A. Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- B. Correct defects and clean surfaces which affect work of this section. Remove existing coatings that exhibit loose surface defects.
- C. Seal with shellac and seal marks which may bleed through surface finishes.
- D. Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- E. Aluminum Surfaces Scheduled for Paint Finish: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.
- F. Concrete Floors: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
- G. Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.
- H. Plaster Surfaces: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- I. Uncoated Steel and Iron Surfaces: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.
- J. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- K. Wood and Metal Doors Scheduled for Painting: Seal top and bottom edges with primer.

3.3 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Do not apply finishes to surfaces that are not dry.

- C. Apply each coat to uniform finish.
- D. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- E. Sand metal lightly between coats to achieve required finish.
- F. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
- G. Allow applied coat to dry before next coat is applied.

3.4 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Paint shop primed equipment.
- B. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- C. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars, and supports except where items are prefinished.

3.5 CLEANING

- A. Collect waste material which may constitute a fire hazard, place in closed metal containers and remove daily from site.

3.6 PAINTING SCHEDULE

- A. Schedule of masonry, plaster, concrete, and stucco surfaces to receive paint.
 - 1. Floor and Walkways 275 ft² gallon (2.6 Nonskid Surface).
 - 2. Interior Block Walls.
 - 3. Walls - Exterior - Two coats masonry sealer.
- B. Schedule of metal surfaces to receive paint.
 - 1. Acrylic latex semi-gloss (2.1).
 - a. Miscellaneous architectural metals and flashings not color anodized.

- b. All exposed structural steel.

- c. Interior walls and ceiling.
- 2. Epoxy (2.2).
 - a. Exposed steel in contact with water.
 - b. Interior of fabricated steel pipe and fittings.
 - c. Well column pipe interior.
 - d. Door and door frames in chlorine room
 - e. Louvers and exhaust fans
- 3. Coal tar mastic (2.3).
 - a. Underground flexible couplings.
 - b. Buried valves and valve boxes.
- 4. Alkyd gloss enamel (2.4).
 - a. Piping, supports, and piping insulation.
 - b. Valves, valve operators, stands, and all piping appurtenances.
 - c. Pump and piping.
- 5. PVC paint
 - a. Chlorine piping supports
 - b. Other exposed metal in acid room.
- 6. Vinyl Ester
 - a. Chlorine room floor

3.8 SCHEDULE - COLORS

- A. Use paint colors noted in plans.
- A. If color is not specifically noted in plans, use the following schedule of paint colors:
 - 1. White – interior walls and ceiling
 - 2. Gray – Doors and frames

3. Red – emergency equipment background
4. Yellow – raised step faces
5. Gray – Floors and walkways

END OF SECTION

SECTION 09 97 10 - COLD-APPLIED WAX TAPE COATING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Apply wax tape coating over all flanges, valves, actuators, and dismantling joints which are buried.
- B. Wax tape is required over all metallic components which will be buried (nuts, bolts, pipe, etc).
- C. This section includes materials and application of a three-part, cold-applied wax tape coating system for field coating of buried valves, flanges and fittings assembly of bolting and piping.

1.2 SUBMITTALS

- A. Submit manufacturer's catalog data sheets and application instructions.

PART 2 - MATERIALS

2.1 PRIMER

- A. Primer shall be a blend of petrolatums, plasticizers, and corrosion inhibitors having a paste-like consistency. The primer shall have the following properties:
 - 1. Color Brown
 - 2. Pour Point 100°F to 110°F
 - 3. Flash Point 350°F
 - 4. Coverage 1 gallon/100 square feet
- B. Primer shall be Trenton Wax Tape Primer, Denso Paste Primer, or equal.

2.2 WAX TAPE

- A. Wax tape shall consist of a synthetic-fiber felt, saturated with a blend of microcrystalline wax, petrolatums, plasticizers, and corrosion inhibitors, forming a tape coating that is easily formable over irregular surfaces. The tape shall have the following properties:

1.	Color	Brown
2.	Saturant Pour Point	115°F to 120°F
3.	Thickness	50 to 70 mils
4.	Tape Width	6 inches
5.	Dielectric Strength	100 volts/mil

- B. Wax tape shall be Trenton No. 1 Wax Tape, Denso "Densyl Tape," or equal.
- C. Wax tape coating system shall be provided by one sole manufacturer.

2.3 PLASTIC WRAPPER

- A. Wrapper shall be a polyvinylidene chloride plastic with three 50-gauge plies wound together as a single sheet. The wrapper shall have the following properties:
- | | | |
|----|------------|----------|
| 1. | Color | Clear |
| 2. | Thickness | 1.5 mils |
| 3. | Tape Width | 6 inches |
- B. Plastic wrapper shall be Trenton Poly-Ply, Denso Tape PVC Self-Adhesive, or equal.

PART 3 -EXECUTION

3.1 WAX TAPE COATING APPLICATION

- A. Surfaces shall be clean and free of all dirt, grease, water, and other foreign material prior to the application of the primer and wax tape.
- B. Apply primer by hand or brush to all surfaces of the pipefitting or valve. Work the primer into all crevices and completely cover all exposed metal surfaces.
- C. Apply the wax tape immediately after the primer application. Work the tape into the crevices around fittings. Wrap the wax tape spirally around the pipe and across the fitting. Use a minimum overlap of 55 percent of the tape width.
- D. Work the tape into the crevices and contours of irregularly shaped surfaces and smooth out so that there is a continuous

protective layer with no voids or spaces under the tape.

- E. Overwrap the completed wax tape installation with the plastic wrapping material. Wrap spirally around the pipe and across the fitting. Use a minimum overlap of 55 percent of the tape width and apply two layers or applications of overwrap. Secure plastic wrapper to pipe with adhesive tape.

END OF SECTION

SECTION 26 42 15**IMPRESSED CURRENT CATHODIC PROTECTION****PART 1 GENERAL****1.01 WORK INCLUDED:**

- A. This section covers the work necessary to furnish and install an impressed current cathodic protection system, electrical isolation, test stations, pipe joint bonds, and electrical continuity, complete.
- B. CONTRACTOR to install electrical service to each cathodic protection (CP) station as shown on the Drawings.

1.02 STANDARDS

- A. The following standards are included by reference:
 - 1. NACE SP-0169
 - 2. NACE SP-0177

1.03 QUALITY CONTROL

- A. All CONTRACTOR specified testing shall be performed by a third party Corrosion Expert whom holds a current NACE accreditation as a Cathodic Protection Specialist (CP-4) or Cathodic Protection Technologist (CP-3), and/or a registered professional engineer with verifiable expertise in corrosion control and cathodic protection.
- B. Contractor performed quality control testing shall include the following tests, which shall be performed as defined this section.
 - 1. Quality Control Testing, Joint Bond Resistance test
 - 2. Quality Control Testing, Casing Isolation testing (before and after casing fill)
 - 3. Quality Control Testing, Insulating Joint Testing
 - 4. Quality Control Testing, Concrete Reinforcement Isolation Testing
 - 5. Functional testing of cathodic protection stations
 - 6. Other Testing as specified in Section 13115, Cathodic Protection
- C. Energizing and testing of cathodic protection system, and other tests as defined under "System Tests and Inspections" shall be performed by the corrosion expert provided by contractor.

1.04 DEFINITIONS

-
- A. Active column: Active column of a Deep Well groundbed shall be that portion of the groundbed which discharges current and consist of anodes and coke breeze.
 - B. Inactive column: Inactive column of a groundbed shall be that portion of the column that does not discharge current, and consist of the backfill, casing, and/or grout or concrete seal that is above the active column.
 - C. Cathodic Protection Station: A cathodic protection station or CP Station shall consist of the rectifier, remote monitoring, electrical service, subpanel or safety disconnect switch, all conduits, and concrete slab required for a complete and functional station.
 - D. Foreign-Owned: Buried pipe or cable not specifically owned or operated by the OWNER.
 - E. Electrically Continuous Pipeline: A pipeline that has a linear electrical resistance equal to or less than the sum of the resistance of the pipe plus the maximum allowable joint bond resistance for each bonded pipe joint as specified in this section.
 - F. Electrical Isolation: The condition of being electrically isolated from other metallic structures (including, but not limited to, piping, concrete reinforcement, casings, etc.) and the environment as defined in NACE Recommended Practice SP0169.

1.05 SUBMITTALS:

- A. Shop Drawings: Catalog cuts and other information for products proposed for use.
- B. Quality Assurance Submittals:
 - 1. Field Test Reports.
 - 2. Qualifications of NACE Accredited Personnel.

PART 2 MATERIALS

2.01 GENERAL:

- A. Like items of materials provided hereunder shall be the end product of one manufacturer to achieve standardization for appearance, maintenance, and replacement.
- B. Materials and workmanship as specified in this section shall be installed concurrently with pipe installation. Coordinate all work specified herein with related sections.

2.02 SUPPLIERS:

- A. Alternate suppliers will be considered, subject to approval of the ENGINEER. Address given is that of the general office; contact these offices for information regarding the location of their representative nearest the project site.

-
1. Corpro, Inc., Chicago, IL	www.corpro.com
2. Farwest Corrosion Control, Gardena, CA	www.farwestcorrosion.com
3. Hoff Company, Inc. , Denver, CO	www.pipelinesupplies.com
4. MESA Products, Tulsa, OK	www.mesaproducts.com
5. Northtown Products, Huntington Beach, CA	www.northtownproducts.com
-

2.03 WIRE:

- A. Rectifier DC Wires:
1. No. 2 AWG wire shall be single-conductor, stranded copper wire with 600-volt, high molecular weight polyethylene (HMWPE) insulation, black.
- B. Impressed Current Anode Wire:
1. Single-conductor, No. 8 AWG stranded copper.
 2. Deep Well Anodes: 20-mil thick cross-linked Kynar or ECTFE fluoropolymer (Halar) primary insulation and high molecular weight polyethylene (HMWPE) outer insulation or equivalent.
- C. Test Wires:
1. Pipe Test Wires: No. 10 AWG wire, single-conductor, stranded copper with 600-volt, TW, THWN, or HMWPE insulation. Color coded insulation as specified.
 2. Reference Electrode Wires: No. 12 AWG wire single-conductor, stranded copper with 600-volt, TW, THWN, USE2, or HMWPE insulation. Color coded insulation as specified.
 3. Insulation Color: Color shall indicate the function of each test wire and shall be as follows:

a. Pipe:	White
b. Reference electrodes:	Yellow
c. Casings:	Orange
d. Foreign Pipe:	Blue (Water) or Red (Gas or oil)
e. Insulating Joints:	White and Green as shown on Drawings
f. Corrosion Coupons:	Green
- D. AC Power Service:
1. Subpanel to Rectifier: No. 10 AWG, minimum, stranded copper wire, Type THHN or THWN cable with quantity of conductors as required for source voltage and phasing with ground wire. Colors in conformance with NEC requirements.
 2. Underground Service: No. 8 AWG, minimum, stranded copper wire, Type UF or USE2 cable, quantity of conductors as required for source voltage and phasing with ground wire. Size wire for maximum circuit amperes in accordance with NEC requirements.
- E. Reference Electrode Wires: 12 AWG wire single-conductor, stranded copper with 600-volt, TW, THWN, USE2, or HMWPE insulation. Color code insulation as specified. Wire length of 25 feet or as required for splice free installation.
- F. Pipe Cross Bond Wire: No. 2 AWG, stranded copper, HMWPE Insulated.

- G. Pipe to Structure Grounds: No. 1/0 AWG, Stranded copper, with THHN, THWN, or HMWPE wire, green insulation.

2.04 JOINT BONDS

A. General:

1. All joint bonds provided either by pipe manufacturer or Contractor shall meet the following minimum requirements:
 - a. All connections on a joint bond shall be welded or soldered.
 - b. Mechanical or compression type connections will not be permitted.
 - c. Bonds and welds shall exhibit sufficient strength and flexibility to allow thermal movement of the pipe after pipe backfill without cracking or breakage.
 - d. Bond connections to pipe shall be with an Engineer approved welding method.
2. All joint bonds shall be insulated wire or coated copper and all exposed copper, steel, or iron surfaces field coated as specified this section.

B. Ductile or Cast Iron Pipe, External Bonds:

1. Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE insulation, 18 inches long, with formed copper sleeve on each end of the wire.
2. Quantity of joint bonds per pipe joint by pipe diameter shall be as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
#2 AWG Wire	16" or less	42" or less	Over 42"

3. Connection of wire joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for bond type used.
4. Bonds shall be as manufactured by Erico Products, Continental Industries, or approved equal. Third party manufactured bonds shall be approved by the Engineer for conformance with the requirements of this specification and proper thermite welding.

C. Coated Steel Pipe, External Bonds:

1. Rolled joint or Carnegie joint bonds shall be one of the following types at the CONTRACTOR's option:
 - a. Wire Bond: Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE or THWN insulation, 18 inches long, with a formed copper sleeve on each end of the wire.
 - b. Strap Bond:
 - (1) Solid copper strap, 1-1/4-inch wide by 1/16-inch thick, equivalent to 1/0 AWG wire, with two punched holes for thermite welding to the pipe. Strap holes shall be sized for the thermite weld mold and shall provide for physical centering of the mold over the hole.
 - (2) Strap bond shall be 12-inches long with dielectric coating applied to the center 8-inches of the strap bond. Strap bonds provided without a dielectric

coating shall be coated prior to installation with filler mastic as specified for heat shrink sleeves in Section 09 90 10, Pipeline Coating and Lining.

- (3) Strap bonds shall be as manufactured by Erico Products, Continental Industries, Hoff Company, or approved equal. Third party manufactured strap bonds shall be approved by the Engineer for conformance with the requirements of this specification and proper thermite welding.

- c. Use of manufactured steel bonding clips will not be permitted with heat shrink sleeve coated joints.

D. Flange joints:

1. Flanged joint bonds shall be one of the following types at the CONTRACTOR's option:
 - a. Exposed or Buried Joints:
 - (1) Steel rod, 5/8-inch diameter, length as required, arc welded to flange.
 - (2) Steel rod bonds will not be allowed where welding to the flange is not approved by the Engineer.
 - b. Buried Joints:
 - (1) Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE insulation, 18 inches long, with a formed copper sleeve on each end of the wire.
 - (2) Required bond where welding to the flange is not allowed by Engineer.
2. Quantity of joint bonds per pipe joint shall be as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
Steel Rod	36" or less	72" or less	Over 72"
#2 AWG Wire	NA	30" or less	Under 60"

3. Connection of wire joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for bond type used.
4. Coat steel rod bonds with fast curing epoxy after welding to joint as specified in this Section, except when pipe is specified to be coated in accordance with Section 09900, PAINTING.

E. Sleeve Coupling, Flanged Coupling Adapter, and Other Non-standard Joints:

1. Ductile Iron Pipe:
 - a. Bond: No. 2 AWG wires, 24 inches long, HMWPE insulation, with two 12-inch long THHN insulated No. 12 AWG wire pigtails,
 - b. Manufacturer: Erico Products Inc. (Cadweld), Cleveland, OH, Hoff Company, Denver, Colorado, or equal.
2. Bond Quantity per Joint: Provide the quantity of bonds per pipe diameter as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
Copper Strap	NA	54" or less	Over 54"

No. 2 Wire Bond	NA	54" or less	Over 54"

3. Connection of wire or copper strap joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for the bond type used.

F. Insulated Sleeve Coupling Joints:

1. Ductile Iron Pipe:
 - a. No. 8 AWG wire, 18-inch long, with one 12-inch long THHN insulated No. 12 AWG wire pigtail.
 - b. Manufacturer: Erico Products Inc. (Cadweld), Cleveland, OH, Hoff Company, Denver, Colorado, or equal.
 - c. R
2. Bond Quantity per Joint: Provide the quantity of bonds per pipe diameter as defined below:

Bond Type	One Bonds	Two Bonds	Three Bonds
Copper Strap	Up to 36"	36" to 60"	Over 60"
No. 2 Wire Bond	Up to 36"	36" to 60"	Over 60"

2.05 CATHODIC PROTECTION TEST STATIONS

A. Post Style, Steel Conduit:

1. Test Box:
 - a. Cast aluminum with thread hub suitable for mounting to a 2-inch x 3-inch reducer.
 - b. Manufacturer and Product:
 - (1) Type T, C, and I Stations: Gerome Manufacturing, Testox 700 series (rectangle), except where Type TR stations required for remote monitoring capable.
 - (2) Type F, A, and TR Stations: Gerome Manufacturing, Testox 2000 series (rectangle) with 2" threaded hub.
2. Street Reducer:
 - a. Hot dipped galvanized 2-inch x 3-inch reducer and close nipple.
 - b. Reducing bushings will not be permitted.
 - c. Test stations provided with 3-inch threaded hub shall be directly mounted on steel conduit.
3. Terminal Block:
 - a. Plastic or glass-reinforced laminated, 1/4-inch thick with seven terminals for Type T, C, and I test stations.
 - b. Plastic or glass-reinforced laminated, 1/4-inch thick with eleven terminals for Type F, A, and TR test stations.
 - c. Terminal heads shall have special heads to keep them from turning or shall be easily accessible from both sides of the terminal block without requiring its removal.

-
- d. Terminal studs, washers, and nuts shall be stainless steel.
 - 4. Mounting Structure:
 - a. Rigid hot dipped galvanized steel conduit 3-inches diameter, threaded at one end (minimum), length as required for installation requirements.
 - b. PVC long radius sweep elbow, 1-inch diameter, for wire protection as shown on Drawings.
 - 5. Terminal Block:
 - a. Plastic or glass-reinforced laminate, 1/4-inch thick with five terminals.
 - b. Terminal heads shall have special heads to keep them from turning or shall be easily accessible from both sides of the terminal block without requiring its removal.
 - c. Terminal studs, washers, and nuts shall be stainless steel.
 - 6. Hardware:
 - a. Conduit - Hot dipped galvanized conduit and conduit bodies
 - b. Mounts - Unistrut support or two piece, one hole, malleable iron strap and clamp back, O. Z. Gedney 14-100G and 143G or equal.
 - c. Two-hole straps will not be permitted.

2.06 VINYL LABELS

- A. Test station Identification labels shall be vinyl labels as shown on the Drawings.
- B. Labels shall be silk screened printed with graphics and text as shown on Drawings with UV resistant clear coat protection.
- C. Label shall be vinyl, self-adhesive, waterproof, weatherproof, UV resistant to fading or color change, and provide 10-year service life on properly prepared and cleaned surface.

2.07 REFERENCE ELECTRODES:

- A. Prepackaged Copper-Copper Sulfate Reference Electrodes:
 - 1. Material: Permanent type, copper-copper sulfate reference electrode suitable for direct burial with a minimum design life of 25 years.
 - 2. Lead Wire:
 - a. As specified under wire, this section,
 - b. Length of 25 feet or as required for splice free installation.
 - 3. Backfill: As recommended by the reference electrode manufacturer.

2.08 DEEP WELL GROUNDBED

- A. Surface Casing
 - 1. PVC well casing, conforming to ASTM F-480, Schedule 40.
- B. Casing Sanitary Seal and Fill Material
 - 1. General

-
- a. Sealing materials for wells shall conform to the State of Utah water well regulations or as specified herein, whichever is more stringent.
 2. External Sanitary Seal (annulus area between the surface casing and soil):
 - a. Bentonite Grout:
 - (1) Mixture of granular bentonite and water in a ratio of not less than 8 pounds of bentonite or expansive clay per gallon of water.
 - (2) Slurry shall not be less than 50 percent expansive clay with the grain size of the remainder to be not greater than coarse sand.
 - (3) Bentonite shall be commercially produced product specifically designed for well sealing. Acceptable products are Aquaguard, Quick-Grout, Plug-Gel, Shur-Gel, Enviro-Plug, or equivalent material.
 - b. Unhydrated Bentonite Chips
 - (1) Material: Unhydrated sodium bentonite, specifically designed for well sealing.
 - (2) Gradation: Medium chips, 1/4 inch, minimum, to 3/8 inch, maximum, dust and fines not to exceed 2 percent by weight.
 - (3) Application Restrictions:
 - (a) Not allowed for sanitary sealing casings over 50 feet in length,
 - (b) Gravity feeding from the surface at depths greater than 30 feet or with water in the hole shall require monitor rod to insure bentonite chips do not bridge and that annular space fills from bottom to top.
 - (4) Manufacturers:
 - (a) Wyoming Ben, Enviroplug Medium
 - (b) Baroid, Holeplug
 - (c) Or Equal
 3. Casing Internal Seal (inactive column area): Unhydrated Bentonite chips.
- C. Vent Pipe:
1. Active Column Vent
 - a. Loresco "Allvent", 1-inch diameter, solvent welded joints, slotted PVC vent pipe as manufactured by Loresco International, Hattiesburg, MS.
 - b. Slotted vent pipe shall be installed in the active anode column area and extend 15 feet into the inactive column.
 2. Inactive Column Vent
 - a. Inactive column vent pipe shall be 1-inch, schedule 40 PVC with solvent welded joints.
 3. Surface Vent:
 - a. ASTM A53-90b standard hot dipped galvanized steel pipe, 1-inch diameter with 180-degree gooseneck at the top.
 - b. Coat threads and any damage to the galvanized coating with one coat of inorganic zinc rich primer.
- D. Anode Centralizers
1. Metal assemblies that can be securely attached to the anodes to center them in the drilled well as recommended by the anode manufacturer.
 2. No sharp edges or bolts will be permitted on the centralizers.

-
3. Centralizers shall not block the well or impair installation of the anode, anode wires, or coke breeze.
- E. Deep Well Seal:
1. Two-piece cast iron seal with a rubber packer to form a watertight seal.
 2. Seals shall permit conduit and vent pipe penetrations through the seal with the rubber packing sealing the annular space watertight.
 3. Provide plugs for all unused holes.
 4. Seal installation shall be watertight.
 5. Manufactured by Campbell Manufacturing, Inc., Bechtelsville, PA; Berkeley Pump Company; Jacuzzi Brothers Inc.; or equal.

2.09 IMPRESSED CURRENT ANODES

A. Mixed Metal Oxide Anodes

1. Mixed metal oxide (MMO) anodes as shown in the plans.
2. Lead Wire:
 - a. No. 8 AWG stranded copper with insulation as specified under WIRE, this section.
 - b. Lead wire shall be of sufficient length to extend splice-free from anode connection to the anode junction box.
 - c. Connection of lead wire to the anode shall be by the manufacturer's standard connection and shall be stronger than the wire.
3. Packaging:
 - a. Lead wire shall be coiled and bound in such a manner as necessary to protect insulation from damage during shipment.
 - b. Anodes shall be protected from breakage.
 - c. Damaged anodes or lead wire will be cause for replacement of the lead wire and anode.
4. Wire Labels: Label the end of each deep well anode wire with the anode number and lead wire length. Number anodes sequentially from bottom to top.

2.10 COKE BREEZE:

A. Coke breeze shall be lubricated calcined petroleum of the following composition:

Volatile Matter	0.7 to 1.8 percent
Ash	1.3 percent maximum
Sulfur	1.9 percent maximum
Fixed Carbon	95.0 percent minimum
Particle Size	100 percent less than 16-mesh
Density	68 pounds per cubic foot, minimum

- B. Acceptable coke breeze shall be Loresco SC-3 as manufactured by Loresco International, Hattiesburg, MS.

2.11 ANODE JUNCTION BOXES

- A. Terminal Box:
 - 1. Size and Type: NEMA 250-85, Type 3R, with minimum inside dimensions of 12 inches by 12 inches by 4 inches deep or as required for the quantity of anodes. Size may need to be increased to accommodate the design in the plans.
 - 2. Material: 14-gauge Type 304 stainless steel or equivalent
- B. Material and Coating: Type 304 Stainless steel
- C. Hardware: Secure door with stainless steel quick release latches and hinges. Screw or bolt secured doors will not be acceptable.
- D. Terminals and Connectors: Furnish a separate panel board, buss bar, and terminal strip or terminal block connectors, and nickel plated brass fasteners for connecting the anode lead terminals to the rectifier positive lead. Provide separate terminal and shunt for each anode lead. Quantity of terminals shall be as shown on the Drawings for quantity of anodes per groundbed
- E. Shunts: Holloway Type JB, 0.01 ohm.
- F. Equipment Tags: Provide each junction box with original manufacturer's equipment tag that identifies the original equipment manufacturer, model number, serial number, and any applicable electrical ratings. **Equipment tags with vendor or distributor name will not be acceptable.**
- G. Manufacturer: Anode junction box shall be Universal Model ATB or ATB-S as manufactured by Universal Rectifiers Inc., Rosenberg, TX or equal.

2.12 RECTIFIER:

- A. Rectifiers shall meet NEMA MR-20 standards and the following construction and operational parameters.
- B. All rectifier components and wiring shall be fully enclosed and protected within a case meeting the following requirements:
 - a. Cooling: air cooled
 - b. Mounting: pole mounting
 - c. Material: Type 304 Stainless steel, 11-gauge.
 - d. Other Requirements:
 - (1) Case shall be provided with hinge doors on the front and one side, minimum, with slide out rack assembly.
 - (2) Doors with hasp for padlocking
 - (3) Stainless steel hardware.
 - (4) Case shall be sealed to protect rectifier components from weather and nest building insects, rodents, or birds.
- C. AC Input Voltage:

-
1. 120/240 volt, single phase, 60-Hz
 2. Designed to operate continuously at full rated output at an ambient temperature of 45 degrees C The rectifier shall be capable of operation at 110 percent of rated input without damage to the rectifier components.
 3. Push button type circuit breakers for ac input or secondary ac breaker shall not be permitted.
- D. DC Output:
1. DC voltage and current shall be as shown on the Drawings, minimum.
 2. Output voltage shall be controlled with a minimum of 24 evenly divided transformer tap settings.
 3. DC rectifier stack shall be a full wave bridge, silicon diode.
 4. DC stack shall be protected from over voltage surge with metal oxide varistors and over current with current-limiting devices.
 5. DC Output Control:
 - a. Constant current with solid state controller.
 - b. Solid state output control circuit boards shall maintain the current output within 2 percent of the set value while varying the voltage or current from 1 to 100 percent of the rated dc voltage.
 - c. Controller boards shall be fully encapsulated and/or plated as required to prevent corrosion of the boards, components, and connections in an industrial exposure.
- E. Lightning protection devices shall be provided on the ac input and dc output of rectifier.
- F. Supply rectifier with panel mounted DC voltage and current meters and external shunt in series with the ammeter.
1. Meters shall be d'varsonal-jeweled movement and accurate to within 2 percent of the actual voltage and current output.
 2. Meters shall be tested and calibrated at the factory.
 3. Meters will be tested in the field for accuracy. Manufacturer shall replace inaccurate meters.
- G. Documentation and Spare Parts
1. Provide each rectifier with equipment tag that identifies:
 - a. Original equipment manufacturer name,
 - b. Rectifier model number and serial number
 - c. AC input voltage and phase.
 - d. DC voltage and amperage output rating.
 - e. **Equipment tags with vendor or distributor name will not be permitted and will be rejected and replaced by the CONTRACTOR.**
 2. Supply each rectifier with an operation and maintenance manual that includes an electrical schematic of the rectifier, parts list with replacement part numbers, and troubleshooting procedures.
 3. Provide each rectifier with a set of spare fuses packaged in a sealed, waterproof bag, if fuses are used.
 4. One spare solid-state controller card, minimum.

-
5. Two spare solid-state controller cards for CP systems that include more than five (5) rectifiers.

H. Rectifier Manufacturer:

1. Universal Rectifiers Inc. Rosenberg, Texas.
2. Or approved equal.

2.13 AC ELECTRICAL SERVICE:

A. Electrical Service from Existing Panels

1. Electrical Subpanel:
 - a. Heavy-duty, outdoor, NEMA 3R or NEMA 4 stainless steel enclosure rated at 240 volts, single phase, 60 amperes, and six single pole circuit capacity, minimum.
 - b. Supply with thermal break circuit breakers sized for electrical loads and voltages as follows:

(1) Rectifier Circuit:	Two Pole, 30 amperes.
(2) Convenience Outlet:	Single pole, 20 amperes.
2. Duct bank and Conduit:
 - a. Include spare conduit with each electrical service from existing panels for SCADA communications by others.
 - b. As specified under Raceway and Duct Banks

B. Grounding

1. Ground Rod: Copper-clad steel, 5/8-inch diameter, 8-feet long.
2. Ground Wire and Clamp: No. 6 AWG solid copper wire with a high copper content alloy or bronze bolt-on ground rod clamp.

2.14 RACEWAY AND DUCT BANKS:

A. Outdoors, Exposed Conduit

1. Conduit: Rigid PVC coated steel, 1-inch diameter, minimum, or as shown on Drawings.
2. Fittings and outlet bodies: PVC Coated steel.
3. Joints: Threaded, watertight.

B. Buried or Concrete Encased Conduit:

1. Conduit: Rigid, electrical grade, schedule 40 gray PVC, 1-inch diameter, minimum, or as shown on Drawings.
2. Joints: Solvent welded or threaded, watertight.
3. Sweep elbows: PVC coated rigid steel with threaded joints.

C. Flexible conduit:

1. Use of flexible conduit shall be minimized and shall be acceptable for use only where other fittings and elbows are not readily available.
2. Flexible conduit for ac power from the entrance switch to the rectifier shall be PVC coated, waterproof flexible conduit.

- D. Conduit Hardware and Supports;
 - 1. Conduit Mounting – Stainless steel Unistrut modular supports and hardware.
 - 2. Locknuts, conduit clamps, and other miscellaneous hardware shall be stainless steel. Two hole straps will not be permitted.
 - 3. All miscellaneous hardware shall be stainless steel or the same material as the conduit.
- E. Duct Bank Spacers: Interlocking module spacers as manufactured by Formex, or approved equal.
- F. Link Seal: Link seal shall be modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the space between the conduit and the wall opening. Link seal shall be suitable for use in a core-drilled and pre-cast wall openings and shall be manufactured by Pipeline Seal & Insulator, Inc or approved equal.
- G. Precast Electrical Boxes:
 - 1. Cover: HDPE or Fiberlyte cover, 3,000 lbs vertical load minimum, or as required for application, whichever is greater, 10-inch by 15-inch minimum dimensions.
 - 2. Body: Fiberlyte or polymer concrete, slope sides, minimum depth 18-inches.
 - 3. Hardware: Stainless steel hex cover lock.
 - 4. Load Requirements: As required for location as follows.
 - a. Open or non-traffic areas: 3,000 lbs vertical
 - b. Parkway or Greenbelt: 3,000 lbs vertical
 - c. Intermittent Light Vehicle Traffic: 12,000 lbs vertical
- H. Protective Coatings:
 - 1. Stainless steel or hot dipped galvanized when stainless steel is not available.
 - 2. Galvanized items shall be hot-dipped galvanized in accordance with ASTM A153.

2.15 PROTECTIVE BARRIERS

- A. CP Station Railing
 - 1. Posts: New steel pipe, standard weight, 4-inch diameter, 8 feet maximum on center spacing.
 - 2. Post Caps: Welded steel plate with vent hole or concrete filled at CONTRACTOR's option.
 - 3. Rails: New steel pipe, standard weight, 2-inch diameter
 - 4. Joints: Welded, except for front rails which shall be bolted.
 - 5. Coating: Hot dipped galvanized, in accordance with ASTM A153 after fabrication.
 - 6. Bolts: Galvanized steel or Type 304 stainless steel
 - 7. Configuration and Size: As shown on the Drawings.
- B. Deep Well Railing
 - 1. Posts: New steel pipe, standard weight, 2-inch diameter

-
2. Post Caps: Welded steel plate with vent hole or concrete filled at CONTRACTOR's option.
 3. Rails: New steel pipe, standard weight, 2-inch diameter
 4. Joints: Welded
 5. Coating: Hot dipped galvanized, in accordance with ASTM A153 after fabrication.
 6. Configuration and Size: As shown on the Drawings.

2.16 THERMITE WELD MATERIALS:

A. General:

1. Thermite weld materials consist of wire sleeves, welders, and weld cartridges according to the weld manufacturer's recommendations for each wire size and pipe or fitting size and material.
2. Welding materials and equipment shall be the product of a single manufacturer. Interchanging materials of different manufacturers is not acceptable.

B. Molds: Graphite, as recommended by manufacture for pipe and wire size.

C. Adapter Sleeves:

1. For No. 12 AWG and No. 2 AWG wires.
2. Prefabricated factory sleeve joint bonds or bond wires with formed sleeves made in the field are acceptable. Attach field-formed joint bonds sleeves with the appropriate size and type of hammer die furnished by the thermite weld manufacturer.
3. Extend wire conductor 1/8 inch beyond the end of the adapter sleeve.

D. Cartridges:

1. Steel: 32 grams, maximum.
2. Cast and Ductile Iron: 45 grams, maximum, XF-19 Alloy

E. Welders and Cartridges: For attaching copper wire to pipe material:

Pipe Material	Weld Type	Cartridge Size, Max.
No. 6 AWG Wire & Smaller		
Steel	HA, VS, HC	15 gm
Ductile or Cast Iron	HB, VH, HE	25 gm
No. 2 Wires		
Steel	FS	32 gm
Ductile or Cast Iron	FC	45 gm

F. Welding Materials Manufacturers:

1. Erico Products Inc. (Cadweld), Cleveland, OH.

-
2. Continental Industries, Inc. (Thermo-Weld), Tulsa, OK.

2.17 COATING REPAIR MATERIAL FOR PIPE AND FITTINGS

- A. General:
1. Complete coating repairs in accordance with recommendations of the pipe or fitting manufacturer.
 - 2.
- B. Coating Requirements:
1. Steel Pipe s:
 - a. Coal tar based coatings: Koppers Bitumastic 50 or Denso or Tapecoat wax tape coatings; or equal, 20 mils dry film thickness, minimum.
 - b. Polyurethane or Epoxy Coatings: Fast cure epoxy, 20 mils dry film thickness, minimum
 - c. Tape Wrap or Extruded Polyethylene Coating: Thermite Weld Cap, Canusa CRP Patch, or Raychem PERP patch, or equal
 - d. Cement Mortar Coating: Same as required for Concrete Cylinder Pipe.
 2. Ductile iron Pipe:
 - a. Fast cure epoxy
 - b. Thermite weld cap
- C. Coating Materials:
1. Thermite Weld Caps:
 - a. Royston Laboratories Handi-Cap IP, prefabricated primerless thermite weld cap and coating system.
 - b. Provide primer unless specifically stated in product data sheet that no primer is required.
 2. Fast Cure Epoxy Coating:
 - a. 100 percent solids, fast curing epoxy suitable for submerged or buried conditions.
 - b. Acceptable products or equal:
 - (1) Denso Protal 7125 (low temperature) or Protal 7300
 - (2) Tapecoat TC 7010
 - (3) 3M ScotchKote 323

2.18 CONCRETE

- A. ASTM C94-90, Option A
- B. Cement: ASTM C150-89, type II with minimum cement content of 6.5 bags (611 pounds) per cubic yard.
- C. Coarse Aggregate Size: $\frac{3}{4}$ inches
- D. Minimum Compressive Strength: 4,000 psi at 28 days with maximum water-cement ratio of 0.45.

- E. Air Entrainment:
 - 1. ASTM C260, nontoxic after 30 days and containing no chlorides.
 - 2. Not less than 5 nor more than 7.5 percent entrained air at the project site.

2.19 MISCELLANEOUS MATERIALS

- A. Equipment Supports
 - 1. Material: Steel, ASTM A36, 6-inch minimum standard channel shape, 2-inch minimum steel pipe, or as shown on drawings.
 - 2. Protective Coating: Hot-dip galvanized supports after fabrication in accordance with ASTM A153.
- B. Mounting Hardware: Type 304 or 3016 Stainless steel nuts, bolts, and washers as required for equipment mounting.
- C. Test Station Wire Terminations: One-piece, tin-plated crimp-on ring tongue connector as manufactured by Burndy Co. or Thomas and Betts.
- D. Shunts: Shunts shall be 0.01-ohm Holloway Type RS.
- E. Compression Connectors:
 - 1. Compression connectors for in-line and tap splices shall be "C" taps made of conductive wrought copper, sized to fit the wires being spliced.
 - 2. Compression connectors shall be applied with the crimp tool and die recommended by the manufacturer for the wire and tap connector size. Connectors shall be Burndy Type "YC", or equal.
- F. Electrical Tape:
 - 1. Linerless rubber high-voltage splicing tape and vinyl electrical tape suitable for moist and wet environments.
 - 2. Use Scotch 130 C and Scotch 88 as manufactured by 3M Products.
- G. Equipment Supports
 - 1. Material: Steel, ASTM A36, standard channel shape, size as shown on drawings.
 - 2. Coating: Hot dipped galvanized after fabrication in accordance with ASTM A153.

2.20 CASING INSULATORS AND SEALS

- A. Casing Isolators
 - 1. Insulators shall be molded high-density polyethylene with plastic runners and shall consist of bolted segments. Insulators shall be sized to properly support the pipe weight without deformation or settlement.
 - 2. Supply with stainless steel bolts for assembly.
- B. Casing Seals

-
1. Seals shall be flexible molded rubber with stainless steel clamps for sealing at the casing and carrier pipe.
 2. Split seals shall be not be acceptable, unless approved by the ENGINEER.

C. Manufacturers:

1. T. D. Williamson, Inc, Tulsa, OK
2. Plico, Houston, TX
3. Approved equal.

2.21 INSULATING JOINTS

A. General:

1. Insulating joints shall be dielectric unions, flanges, or couplings.
2. The complete assembly shall have an ANSI rating equal to or higher than that of the joint and pipeline.
3. All materials shall be resistant for the intended exposure, operating temperatures, and products in the pipeline.

B. Insulating Flanges:

1. Flange:
 - a. As specified in applicable pipe sections or in conformance with AWWA C207, whichever is more stringent.
 - b. Bolt holes may be oversized not more 1/4 inch over nominal bolt diameter where required for insulating flange assembly.
2. Gaskets:
 - a. Full-face, fiberglass (G10) with O-ring seal gasket. Buried insulating flanges shall be full face gaskets only.
 - b. Complete assembly shall have an ANSI rating equal to the flanged joint.
 - c. Gasket materials shall be resistant to intended chemical exposure, operating temperatures, and pressures in the pipeline.
3. Insulating Sleeves: Full-length Mylar or fiberglass reinforced epoxy (NEMA G-10 grade).
4. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).
5. Steel Washers: Plated, hot-rolled steel, 1/8-inch thick.
6. Manufacturers:
 - a. GPT Industries, Houston, Texas
 - b. Advanced Products and Systems, Scott, LA
 - c. Central Plastics Co., Shawnee, OK.

C. Insulating Couplings:

1. Coupling: As specified in Section 15136.
2. Dielectric Boot: Rubber boot suitable for immersion service, two boots required per insulating joint.
3. Manufacturers:
 - a. Style IC400, Romac Industries
 - b. Style 39, Dresser Industries

-
- D. Insulating Unions: O-ring sealed with molded and bonded insulating bushing to union body, as manufactured by Central Plastics Company, Shawnee, OK; or equal.
 - E. Well Casing to Pump Column Isolation:
 - 1. Custom manufactured isolation sheet and associated washers and sleeves for bolts.
 - 2. Isolation Materials:
 - a. Isolation Sheet:
 - (1) 1/8-thick phenolic or G10 fiberglass, minimum,
 - (2) Shall be suitable for continuous exposure to water leakages, lubricating oils, and other fluids associated with pump motor and pump.
 - b. Washers and sleeves for mounting bolts shall be G-10 fiberglass
 - 3. Manufactured well head isolation sheet to match well head discharge head and well casing configuration and as shown on the Drawings.
 - 4. Well head isolation sheet shall be supplied as two half sheets to permit installation and removal while pump column is installed within the well.
 - 5. Contractor to field verify well head size, shape and dimensions, along with all hole openings required for other components and shall determine mounting bolt quantity, diameter, and length of sleeve required.

2.22 DC BLOCKING DEVICES

- A. DC isolation devices shall be solid-state electronic devices capable of passing ac current while blocking dc current.
- B. Device shall have electrical rating of 3KA fault current at 30 cycles and 40 amperes steady state ac current, minimum.
- C. DC isolation devices shall be as manufactured by Dairyland Electrical Industries, Inc., Stoughton, Wisconsin.

2.23 CONCRETE

- A. ASTM C94-90, Option A
- B. Cement: ASTM C150-89, type II with minimum cement content of 6.5 bags (611 pounds) per cubic yard.
- C. Coarse Aggregate Size: 3/4 inches
- D. Minimum Compressive Strength: 4,000 psi at 28 days with maximum water-cement ratio of 0.45.
- E. Air Entrainment:
 - 1. ASTM C260, nontoxic after 30 days and containing no chlorides.
 - 2. Not less than 5 nor more than 7.5 percent entrained air at the project site.

2.24 PROTECTIVE BARRIERS**A. Bollards**

1. Posts: Steel pipe, Schedule 40, 6-inch diameter, hot dipped galvanized in accordance with ASTM A153.
2. Reflective Tape: High intensity reflective tape, 5 mils minimum, yellow, 4-inch width.

2.25 CONDUIT, LOCKNUTS, AND STRAPS:**A. Outdoors, Exposed Conduit**

1. Rigid conduit shall be rigid galvanized steel.
2. Fittings, junction boxes, pull boxes, and outlet bodies shall be hot-dipped galvanized iron.
3. Locknuts, conduit clamps, and other miscellaneous hardware shall be hot dipped galvanized steel. Galvanized items shall be hot-dipped galvanized in accordance with ASTM A153.
4. Conduit clamps shall be two-piece, malleable iron, one hole, strap and clamp back spacer, O. Z. Gedney 14-100G and 143G or similar, for mounting to surfaces with either lag bolts or concrete wedge anchors, as shown on the Drawings.

B. Buried Conduit:

1. Conduit shall be rigid electrical grade schedule 40 gray PVC
2. Locknuts, two-hole straps, and other miscellaneous hardware shall be galvanized steel. Galvanized items shall be hot-dipped galvanized in accordance with ASTM A153.

C. Flexible conduit:

1. Flexible conduit for ac power from the entrance switch to the rectifier shall be PVC coated, waterproof flexible conduit.
2. Use of flexible conduit shall be minimized and shall be acceptable for use only where other fittings and elbows are not readily available.

2.26**PART 3 WORKMANSHIP****3.01 GENERAL:**

- A. The installation of the facilities herein specified and described shall conform to the latest applicable NEC rules.
- B. The workmanship shall be of the highest grade and shall be in strict accordance with material manufacturer's instructions. Equipment or materials damaged in shipment or in the course of installation shall be replaced.

-
- C. The CONTRACTOR shall examine all Drawings and coordinate his work so as to avoid conflicts, errors, delays, and unnecessary interference with the construction of the facilities and to avoid duplication of the work such as excavation, filling, etc. In the event of any conflicts in the Specifications, the ENGINEER shall be consulted.

3.02 STORAGE AND HANDLING:

- A. Store all prepackaged anodes off the ground and keep them dry at all times. Protect against weather, condensation, and mechanical damage.
- B. Immediately remove from the project site all mechanically damaged anodes.
- C. Galvanic anodes shall not be lifted or held by the lead wire.
- D. Anode backfill material that has become wet will not be acceptable.

3.03 DEEP WELL GROUND BED INSTALLATION:

A. General:

1. Drilling, electrical logging of well, lowering of anodes, coke breeze placement, and backfilling shall be done in a continuous operation and shall be observed by the ENGINEER.
2. CONTRACTOR shall be a certified water well driller in current standing in the state of Utah and shall obtain all drilling permits, start cards, submit notification of work completion, and submit drilling logs in accordance with state regulations.
3. Driller will be solely responsible for all aspects of the drilling and well construction until well completion.
4. Drilling of the groundbed shall be in accordance with the methods and procedures of the best recognized drilling practices and shall comply with the rules and regulations of the State, County, City, or other governing bodies having jurisdiction.
5. Deep well groundbeds shall be sealed as specified herein or as required by well drilling regulations. The most stringent requirements shall apply.
6. Take necessary precautions to avoid entrance of foreign matter, movement of soil strata, or collapsing of the well during the progress of the work. Should movement of soil strata or collapse of the drilled well interfere with proper completion of the ground bed, recover the wires and anode strings, where possible, and ream or redrill the well.
7. The driller shall maintain a log describing the depth and type of formations encountered during drilling. Copies of the log shall be submitted to the ENGINEER and appropriate government authorities.
8. Wells not completed in accordance with the State water well or other applicable regulations and this specification will be subject to rejection and replacement at the CONTRACTOR's sole expense.

B. Drilling:

-
1. Coordinate the actual location of the ground bed in the field with the ENGINEER before drilling begins. Verify and locate all buried utilities prior to beginning drilling operations.
 2. CONTRACTOR shall provide a holding sump to contain and store drilling fluids and cuttings.
 3. Excavation of a temporary mud pit on the project site will not be permitted.
 4. CONTRACTOR shall provide drilling mud containment and disposal system to prevent mud from entering drainages, storm drains, gutters, streams, or leaving the project site.
 5. CONTRACTOR shall size the holding sump for the project and take all precautions necessary to prevent spillage or overflow of drilling fluids. All overflow or spillage shall be contained. CONTRACTOR shall be responsible for cleaning all spills and overflows and, if necessary, will clean drainages, storm drains and manholes impacted by uncontained drilling fluids.
 6. CONTRACTOR shall transport and dispose of all drilling fluids and cuttings to an approved disposal location.
 7. Spillage or leakage of oil or hydraulic fluids shall be contained and controlled by the Driller. All oil contamination on the drilling site resulting from drilling equipment shall be contained, cleaned up, and properly disposed off the project site.
 8. Over drill well to compensate for sloughing or heaving during anode installation.

C. Casing

1. Construct the well and set surface casing straight and plumb. Casing length as shown on drawings is the minimum length, contractor shall determine casing requirements based on anticipated drilling conditions and as defined in this section.
2. Surface casing shall be set prior to completion of the first 100 feet of the well.
3. Casing, other than surface casing, shall not be installed or left in the well unless in the driller's estimation it is necessary for successful completion of the well.
4. Plastic casing may be installed in the inactive column, at the CONTRACTOR's option, but shall not extend into the active column.
5. If steel casing is installed into the active column, it shall be cut 100 feet below the ground surface and the top portion jacked up to provide a 25 foot, minimum, separation between the upper casing and the top of the active column. Complete cutting of the steel casing before anodes are installed. Jacking operations must be completed before installation of anodes.
6. Drilled hole for surface casing shall be 4 inches in diameter greater than casing outside diameter, minimum.
7. Surface casing shall be provided with a sanitary seal as specified herein and in accordance with State water well regulations, whichever is more stringent.

D. Placement of Casing Seals:

1. External Sanitary Seal
 - a. Install sanitary seal in annular space between casing and soil.
 - b. Place casing sanitary seal by tremie pipe and pumping of bentonite grout if casing is greater than 50 feet or groundwater is present within the well.
 - c. The seal placement shall be done continuously and in a manner that will ensure the entire filling of the annular space in one operation.

-
- d. No drilling operations will be permitted until neat cement or grout has cured.
 - (1) Curing time for portland cement, Type I or II, is a minimum of 72 hours and for type III a minimum of 36 hours.
 - (2) Addition of an accelerator will be permitted subject to written approval from the State Water Engineer.
 - (3) Bentonite grout set time shall be determined based on manufacturer's recommendations or observations of a mixed grout sample taken from the pumped stream.
 - 2. Casing Internal Seal
 - a. After the coke breeze settlement is completed and anode settlement is stopped, the casing shall be filled with the specified sealing material.
 - b. Placement of the sealing material will be with plastic tremie pipe only for slurry type seals. Inserting of the tremie pipe shall be performed in a manner that will not damage the wire insulation.
 - c. Granular sealing materials may be top loaded but shall be performed at a rate that will not result in bridging of the seal material.
 - E. Electrical Logging:
 - 1. Flush the well and electrically log the well in the presence of the ENGINEER to determine the soil characteristic along the length of the well.
 - 2. Electrical Logging Method: Measure current output of first anode as it is lowered into the well. Test using suitable meters, connections to a low resistance ground, and a method to measure the down hole wire length or provide footage identification markings on the wire.
 - 3. Record current output readings and depth from the surface continuously or at 5-foot increments for the entire well depth. Note depth of groundwater at time of electrical logging.
 - F. Lowering of Anodes:
 - 1. Anode installation to be observed by the ENGINEER
 - 2. Install anodes and coke breeze the same day as the completion of the drilling and electrical logging.
 - 3. If loading is delayed more than 8 hours after drilling is completed or if loading cannot be completed before sunset or end of working hours, whichever comes first, the drill stem and bit should be reinserted and run back to the bottom of the well with sufficient rotation and circulation to ensure that the drilled well is prepared for anode installation.
 - 4. If the well is drilled with mud, the well shall be flushed out with clean water in a continuous process before or after the anodes are lowered, at the CONTRACTOR's option, until the return fluid has a mud weight of not more than 9.2 pounds per gallon to allow for proper settlement of coke. The ENGINEER shall inspect the return fluid before coke breeze pumping will be permitted to begin.
 - 5. Attach anode centralizers to each of the anodes prior to lowering. Attach deepest anode to the vent pipe. Lower anode and vent pipe to the bottom of the well. Lower the remaining anodes individually until all anodes are suspended in the well.

-
6. The bottom of the vent pipe shall be capped and each joint of pipe solvent welded in accordance with the manufacturer's recommendations. Drilling of the vent pipe to prevent floating is prohibited and will result in rejection of the vent pipe.
 7. CONTRACTOR shall prevent foreign matter from entering the vent pipe during anode installation and casing seal placement. The CONTRACTOR shall clear any blockage of the vent pipe. Failure to clear the vent pipe will result in rejection of the ground bed. Vent pipe shall be permitted to flow water during coke breeze pumping to flush any mud and cuttings from within the vent.
 8. Any damage to anodes or cut, gouged, or scraped wire insulation will result in rejection of the anode and lead wire. CONTRACTOR shall implement means to protect the anode lead wires during and following anode installation.
- G. Backfilling of Anode Well:
1. Keep well full of water during installation of the coke breeze.
 2. Prepare coke breeze slurry with potable water in accordance with the manufacturer's written recommendations. Pump the slurry into the well through a steel or plastic tremie pipe. Pump coke breeze in an even and continuous manner from the bottom of the well to the top as the tremie pipe is slowly withdrawn. Top-loading the coke breeze, by pouring coke breeze into the well will not be permitted.
 3. Throughout coke breeze pumping, displaced water and mud shall be collected and stored for disposal. Discharge of mud and water into the storm drains or public rights-of-way, or roadways will not be allowed. CONTRACTOR will be responsible to determine and provide the storage capacity required. Should the water and mud storage capacity be inadequate for the project, work will be terminated until adequate capacity is provided. Loss of materials or collapse of the well due to termination of the loading operation will be at the CONTRACTOR's sole expense.
 4. Care shall be taken during pumping of the coke breeze to avoid coke breeze bridging or collapse of the well. If the well collapses or coke breeze bridges, the CONTRACTOR shall take necessary steps to resolve the problem at his sole expense.
 5. Restrain anodes from settling during and following coke breeze installation for 24 hours, minimum, for coke breeze settlement and compaction. Maintain anode restraint until all anode settlement stops.
 6. After the coke breeze is installed and has settled for 24 hours the ENGINEER shall measure the depth to the top of the coke breeze column. If required, additional coke breeze shall be added by pumping or top loading to the specified elevation. Coke breeze shall not be greater than +15 feet nor less than -5 feet from inactive column elevation as shown on the Drawings. CONTRACTOR shall remove any excess coke breeze at his sole expense.
 7. When the coke breeze has properly settled and has been placed to the proper depth, fill the inactive column with the specified sealing material to within 4 feet of ground surface.
- H. Anode Wire Terminations:
1. The CONTRACTOR shall cut a smooth hole in the side of the casing for routing wires to the anode junction box. All below grade penetrations of the surface casing shall be watertight.

-
2. Anode wires shall be installed in conduit from the ground bed to the anode junction box. The completed electrical conduit shall be watertight.
 3. Seal both ends of all conduits from the ground bed with urethane foam to prevent ground bed gases from entering the conduit, anode junction box, or rectifier.
 4. Anode lead shall be terminated in numerical order in correspondence to anode depth.
- I. Groundbed and Vent Pipe Termination:
1. Connect the surface pipe directly to the plastic vent pipe with a solvent welded by threaded connection adapter.
 2. Terminated vent pipe as shown on the Drawings.
 3. After all wire terminations and vent pipe connections are completed, complete filling of the inactive column with the specified sealing material.
 4. Plumb and support vent pipe during seal placement and while the seal sets or compacts.
- J. Cleanup:
1. The drilling site shall be kept neat and orderly under all circumstances.
 2. All excess equipment and cuttings shall be removed daily when required by the prevailing conditions at the drilling site.
 3. CONTRACTOR shall remove all mud, waste products, and tailings from the project site and dispose of at an approved disposal site.
 4. The project sites shall be restored to a condition equivalent to their original condition before construction started and to the satisfaction of the ENGINEER.
 5. Damage to sidewalks, curbs, roads, and driveways shall be restored to original condition or better.

3.04 ANODE TERMINAL BOX INSTALLATION

- A. Connect the rectifier positive wire and anode wires to the anode junction box terminals.
- B. Label wires in the terminal box with permanent tags identifying the anode number and rectifier lead.
- C. Connect numbered anodes in consecutive order from top to bottom with anode terminals starting at number 1 on the top left-hand side.
- D. Maintain sufficient slack to keep the wire from being unduly stressed, damaged, or broken during backfill.
- E. All conduits entering the anode junction box shall be sealed with urethane foam to prevent groundbed gases from entering the junction box.
- F. Anode junction boxes shall be not less than 24 inches above the concrete slab. Concrete slabs shall be not less than 3 inches above finish grade and provided with soil retention curbing or walls in finish grades with slopes greater than 1:3

3.05 CATHODIC PROTECTION STATION INSTALLATION:

- A. CONTRACTOR shall install a cathodic protection (CP) station, which includes rectifier mounting pole, ac power from the disconnect switch to the rectifier, and all AC and DC electrical hardware necessary for the rectifier installation.
- B. Contractor to furnish and install AC electrical service.
- C. Cathodic protection (CP) station installation and location shall be as shown on the Drawings, except when the Drawings and local or State electrical codes are contradictory. In such cases, local or State electrical codes shall prevail. Final site location and orientation shall be adjusted in the field for site conditions and installation requirements and shall be approved by the Engineer.
- D. CONTRACTOR shall install and connect an AC power service to each CP Station location as shown on Drawings.
- E. DC leads to the rectifier shall be as specified this section and shown on the Drawings:
 - 1. Rectifier wire connections as shown on Drawings to be performed by Others. CONTRACTOR shall complete installation of existing wires provided by Others from property line to rectifier and make all connections to the rectifier.
 - 2. Splicing of the wires will not be permitted without Engineer's approval.
 - 3. DC wires shall be in conduit and accordance with Trenching and Backfill, this section.
 - 4. All wire leads shall be free of splices.
 - 5. Insulation on leads shall be free of cuts or abraded areas.
- F. Upon completion of CP station installation CONTRACTOR to perform functional test of system in accordance with Quality Control Testing, this section.

3.06 AC ELECTRICAL SERVICE:

- A. General
 - 1. Electrical power service shall be installed by the CONTRACTOR in accordance with local electrical utility requirements and shall meet or exceed local or NEC codes.
 - 2. Electrical service shall be underground unless shown otherwise on the Drawings.
 - 3. Electrical service shall be installed by a licensed electrician.
 - 4. CONTRACTOR shall obtain a local building permit and coordinate inspection of the completed electrical service, where required.
- B. Underground electrical service to rectifier disconnect switch shall be provided by the CONTRACTOR in accordance with Section ELECTRICAL, and as shown on the Drawings.

3.07 AC ELECTRICAL DUCTWORK:

- A. Underground AC duct bank shall be installed by a Utah licensed electrician.

- B. AC electrical conduits shall be separate conduits in an underground, red concrete encased duct bank installed in accordance with NEC codes and as shown on the Drawings.
- C. All duct banks less than 5 feet long may be sand backfilled or concrete encased at CONTRACTOR's option. Duct banks greater than 15 feet long shall be backfilled with red dyed concrete as shown on the Drawings.
- D. CONTRACTOR shall provide all materials, trenching, backfill, compaction, conduit, grounding, and red dyed concrete necessary for installation of duct bank.
- E. Underground conduit shall not be greater than 250 feet long with not more than 360 degrees of combined bends between pull boxes without written approval of the ENGINEER.
- F. Conduit shall have solvent welded joints, ends capped, and free of dirt and debris.
- G. Electrical contractor shall furnish and installed AC conductors, circuit breakers, and all associated hardware for electrical service to rectifier from subpanel.
- H. Electrical contractor to complete all raceway connections to existing electrical panels and RTU panels within vaults and rectifier enclosures.

3.08 DUCT BANKS

A. General:

- 1. Coordinate duct bank routing with ENGINEER and OWNER.
- 2. Use existing building penetrations, where available, or core concrete wall and provide sealed penetration as shown on Drawings.
- 3. Coordinate conduit routing and panel connection locations within vaults with ENGINEER and OWNER.
- 4. Secure conduits entering cabinets, junction boxes, or terminal boxes with double locknuts, one on the outside and one on the inside.
- 5. Install insulated bushings and insulated throat connectors on the ends of rigid metallic conduit.
- 6. Use watertight couplings and connections. Install and equip boxes and fittings to prevent water from entering the conduit or box. Seal unused openings.
- 7. Reducer couplings are not allowed, except where shown or specifically identified on the Drawings.

B. Concrete Encased Duct Banks:

- 1. Concrete to be dyed red with 12 pounds, minimum, red dye per yard.
- 2. Concrete shall be 2,000 psi compressive strength, minimum, unless otherwise specified.

-
3. Tie and fasten all conduits to prevent floating and stake at intervals shown on the Drawings.
 4. Provide a minimum of two #4 steel reinforcement bars for the full length of the duct bank.
 5. Spacers shall be utilized with concrete encasement. Spacers shall be placed between 4 foot and 10 foot intervals depending on size and quantity of conduits and as required by the spacer manufacturer, whichever is greater.
 6. All spacers shall be supported on concrete blocks.
 7. Spacers shall be plastic spacers with interlocking capabilities that relieves the conduit of both horizontal and vertical stresses.
 8. Minimum spacing between conduits shall be 1.5-inches. Concrete encasement shall be 4-inches minimum cover on top, bottom, and sides of conduits.
 9. Backfill trenches as specified this section after concrete has cured.
 10. Allow for thermal expansion of conduit for temperature rise as concrete cures, by allowing free end to expand or pouring concrete from center of run or from one tie-in point.
 11. Provide No. 10 TW, THWN, or USE2 insulating tracer wire centered over the full length of the concrete encased duct bank.

3.09 THERMITE WELD WIRE CONNECTIONS:

- A. Use thermite weld method for electrical connection of copper wire to steel, ductile iron, and cast iron surfaces. Observe proper safety precautions, welding procedures, thermite weld material selection, and surface preparation as recommended by the material manufacturer. Assure that pipe or fitting wall thickness is of sufficient thickness that the thermite weld process will not damage the pipe or fitting wall's integrity or damage the lining in any way.
- B. Before the connection is made, the surface shall be cleaned to bare metal by making a 2-inch by 2-inch window in the coating, and then filing or grinding the surface with a vitrified wheel to produce a bright metal finish. Wire sleeves shall be installed on the ends of the wire before welding to the metal surface.
- C. After the weld connection is cooled, remove slag, visually inspect, and physically test wire connection by tapping with a hammer. Remove and replace any defective connections.
- D. Make wire connections to concrete cylinder pipe by thermite welding to the shop welded steel plates provided on the pipe for this purpose.
- E. Coat each completed wire connection as specified, this section. If lining is damaged by welding, repaired in accordance with the lining applicator's recommendations.

3.10 TRENCHING AND BACKFILL

- A. General:

-
1. Complete excavations and trenching regardless of the type, nature, or condition of materials encountered, and as required to accomplish specified construction to lines and grades shown.
 2. CONTRACTOR shall complete all utility notifications prior to performing trenching and excavations work.
 3. Take care to avoid damage to existing structures and utilities during excavating and trenching process. CONTRACTOR may modify location, where approved by the ENGINEER, to minimize possible damage to existing structures.
 4. Trench shall be of uniform depth and width, level, smooth, and free of sharp objects.
- B. Trench Depths:
1. Trench depths provided are minimum requirements. CONTRACTOR shall meet minimum requirements listed, as required by local utilities, ordinances, or regulations, or as shown on the Drawings, whichever is more stringent.
 2. Minimum depths for cathodic protection or corrosion monitoring work shall be as follows:
 - a. Electrical Service: 30-inches (ductbank)
 - b. Pipeline Test wires, roadways 24-inches (conduit)
 - c. Rectifier Connection Wires, developed 24-inches (conduit)
 - d. All other 30-inches
- C. Safety
1. Slope, shore, or brace excavations and trenches in accordance with OSHA regulations.
 2. Provide shoring as necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, property, workers, and the public.
 3. CONTRACTOR shall have sole responsibility for ensuring safety of trenches and conformance to OSHA trench safety requirements.
- D. Backfill and Compaction
1. Backfill trench with excavated backfill materials, unless excavated material is unsuitable for meeting compaction requirements.
 2. Provide imported backfill material where indicated on the Drawings or where excavated material is unsuitable for compaction.
 3. All trenches shall be compacted to 90 percent, minimum, or as specified for the pipeline whichever is more stringent.
 4. Concrete slab base material and trenches within 5 feet of roadways, paved areas, or other traffic areas shall be compacted to 95 percent, minimum.
 5. Within roadways or where required by local entities, provide a control low strength material (CLSM) to cover the pipe for a minimum of 12-inches or to fill vacuum holes within paved areas. CLSM shall meet the following performance requirements:
 - a. Total calculated air content: Not less than 8.0 percent nor greater than 12.0 percent.
 - b. Minimum unconfined compressive strength: Not less than 50 pounds per square inch measured at 28 days.
 - c. Maximum unconfined compressive strength: Not greater than 150 pounds per square inch measured at 28 days.

-
- d. Wet Density: No greater than 132 pounds per cubic foot.
 - 6. Do not use backfill material of frozen or consolidated debris. Leave the trench with the excess backfill material neatly mounded, but not more than 4 inches above the existing ground level, for the entire width of the trench in undeveloped areas.
 - 7. Replace topsoil in developed, landscaped, or cultivated areas as specified in Surface Restoration, this section.

3.11 CONCRETE:

- A. Concrete used for slabs shall conform to the requirements for concrete in Section CONCRETE.
- B. CONTRACTOR shall finish all concrete work to a smooth troweled or broom finish with radius edges.
- C. All forms shall be removed from concrete work prior to final acceptance and removed from the project site.

3.12 PIPE JOINT BONDING, NEW PIPE

- A. To form an electrically continuous pipeline and associated appurtenances, all metallic pipe joints shall be electrically bonded; including buried, vault, and manhole pipe, fittings, fire hydrants, and restrained joints; except joints that are threaded, welded, or insulated.
- B. Install the quantity of joint bonds at each joint required to be bonded as specified this section or shown on the Drawings. Should the specifications and drawings conflict, the larger quantity shall apply.
- C. Electrical connection of bonds to pipe and fittings shall be by thermite or arc welding process. Bolted, compression, or mechanical connections will not be permitted.
- D. CONTRACTOR shall test each bonded joint for electrical resistance as specified under CONTRACTOR QUALITY CONTROL TESTING, this section.

3.13 CONTINUITY REPAIR BONDING, EXISTING PIPE

- A. General:
 - 1. To form an electrically continuous pipeline all rubber gasket joints shall be electrically bonded on pipe sections shown on the Drawings.
 - 2. Install the quantity of joint bonds at each joint required to be bonded as specified this section or shown on the Drawings. Should the specifications and drawings conflict, the larger quantity shall apply.
 - 3. Electrical connection of bonds to pipe and fittings shall be by thermite or arc welding process. Bolted, compression, or mechanical connections will not be permitted.
- B. External Bonding:

-
1. All pipe less than 30-inches in diameter shall be externally bonded as shown on the Drawings.
 2. External bonding shall include excavation of electrically discontinuous pipe joints, removal of existing coating, installation of joint bonds, and recoating of the bonds and pipe as shown on the Drawings.
 3. Excavation method is to be determined by the Contractor with preference for minimum surface disturbance excavation methods and remote thermite welding where possible.
- C. External Bond Discontinuity Location and Repair
1. Location of electrically discontinuous pipe joints shall be performed by the divide and locate method under the direction of the Engineer and the following procedures:
 2. Temporary test wire will be installed at midsections, as directed by the Engineer, to electrically subdivide the pipe.
 3. Temporary test wire installation shall include excavation to top of pipe, removal of existing coating, installation of temporary wire, recoating of the wire and pipe as shown on the Drawings, and backfill of excavation.
 4. Temporary test wires shall be installed at additional locations as directed by the Engineer until each electrically discontinuous joint is isolated to within three pipe joints, maximum.
 5. Once isolation is to three joints or less, the contractor shall then excavate pipe joints for either test wire installation or external joint bonding as directed by the Engineer.
 6. Contractor shall allow time between temporary wire excavations for Engineer to perform continuity tests. While electrical LPR continuity testing on each subdivided section is generally less than 5 minutes in duration, additional time could be required when test difficulties or wire damage by others occurs.
 7. Contractor shall be responsible for measuring distance to subsequent temporary wire excavations or to locate joint bonds based on the pipeline lay sheets.
 8. Contractor shall conduct an examination of all excavations for the presence of a pipe joint and then mark joint locations for reference as continuity repair work proceeds. Contractor shall protect and preserve all joint location markings.
 9. Temporary wire connections may be covered with steel plates or backfilled at the Contractor's option after wire installation and verification that wire is continuous by Engineer. Contractor should anticipate that some temporary wire excavations may need to be steel plate covered when in close proximity to discontinuous joints.
 10. All excavations for external bonding shall have surface improvements restored as specified in SURFACE RESTORATION, this section.
- D. Internal Joint Bonding
1. All pipes with a diameter of 30-inches or more shall have all rubber gasket joints internally bonded as indicated and shown on the Drawings.
 2. Internal access to the pipe will be provided at existing access manholes, turnouts, or air vents locations as shown on the Drawings.
 3. Internal bonding work shall include providing personnel ingress, egress, and transportation within the pipe, material handling inside the pipe, cement mortar lining removal and patching, joint bond installation, and all other incidental work required to complete bonding of all rubber gasket joints listed in the Internal Bonding Schedule shown on the Drawings.
 4. OWNER will dewater the pipe and open manholes necessary for pipe ventilation and contractor access to pipe interior.

-
5. Contractor shall be responsible for assuring access vault are secured throughout the project work.
 6. Ventilation and Environmental Exposures:
 - a. Contractor shall be responsible for removal of residual water remaining in the pipe as necessary to complete internal work.
 - b. Contractor shall provide forced air ventilation equipment on both the upstream and downstream access manhole that will provide a minimum of two air changes per hour and shall maintain thermite welding smoke or cement dust from cement mortar lining scoring and removal at or below OSHA maximum PEL for personnel working inside the pipe.
 - c. Contractor shall provide temporary bulkheads at upstream and downstream access manholes to restrict ventilation to the work area.
 - d. Contractor shall provide safe pipe ingress and egress in conformance with OSHA regulations.
 - e. Interior of the pipe is classified as confined space. Contractor shall be solely responsible for implementing and maintaining OSHA compliant confined space permitting and controls, personnel safety, hazardous conditions, and environmental exposures.
 7. Location of joints indicated on the Internal Bonding Schedule shown on the Drawings, were based on original pipeline lay sheets.
 8. Contractor shall be responsible for completing all measurements and field verifications necessary to locate rubber gasket joints while excluding welded joints.
 9. Welded joints locations within discontinuous sections are indicated on the Internal Bonding Schedule shown on the Drawings with stationing based on the pipeline lay sheets.
 10. Joint Bond Installation:
 - a. Joint bond installation shall be with the specified low profile bonding strap with thermite welds as shown on the Drawings.
 - b. Cement lining shall be scored prior to removal to prevent damage to the lining beyond the identified work area.
 - c. Metal surfaces shall be ground or sanded to white metal prior to completing thermite welds.
 - d. Personnel performing thermite welding shall be trained and qualified on proper thermite weld procedures and shall demonstrate welding procedures before work proceeds. Only trained and qualified welders shall be used for internal bonding.
 - e. Patching of the cement mortar lining shall be with fast cure epoxy over all exposed copper and a cement mortar patch with a tolerance of +0 to +1/8 inch relative to the existing lining.
 - f. Fast cure epoxy shall be dry to touch or can pass a thumbnail test before cement mortar patching will be allowed.
 11. Quality Control Testing:
 - a. Contractor shall perform quality control testing of each internal joint bond using a digital low resistance ohmmeter with a minimum resolution of 0.001 milliohms.
 - b. All joint bonds shall be less than the allowable joint bond resistance specified under Quality Control Testing, this section.
 - c. Upon completion of each discontinuous pipe section, the Engineer shall test the section using the Lineal Pipe Resistance Test method for final continuity acceptance.

3.14 TEST STATION INSTALLATION

A. General:

1. Test station location, type, and style shall be as shown on the Drawings.
2. CONTRACTOR may relocate test station up to ± 25 feet for site conditions without ENGINEER approval. Relocation greater than ± 25 feet must be approved by the ENGINEER.
3. CONTRACTOR shall maintain records showing actual pipeline stationing of test station wire connections to the pipe.
4. Records of actual pipeline stationing shall be provided to ENGINEER prior to preliminary electrical continuity testing.
5. Test stations shall be generally located as follows:
 - a. Install Type T test stations or other type test stations as required or at 1/4 mile intervals, but not greater than 1,500 feet.
 - b. Install a Type F test station where pipe crosses a foreign-owned metallic pipeline under cathodic protection.
 - c. Install a Type C test station at both end of cased crossings.
 - d. Install a Type I test station at all buried insulated joints.
6. Locate post-mounted test stations directly over the pipe and, where possible, at protected locations such as structures, fences, manholes, power poles, or edges of cultivated land.
7. Locate flush mounted test stations directly over the pipeline, except in areas of heavy traffic conditions. When heavy traffic conditions exist, offset the test stations to the side of the street.
 - a. All offset test station wires shall be protected with PVC coated rigid steel conduit from pipeline centerline to within 6-inches of test station as shown on the Drawings. Do not connect rigid conduit to test station.
 - b. Test stations shall not be mounted inside of vaults, manholes, or other confined spaces.

B. Style:

1. Test station style shall be as shown on the Drawings and as follows:
2. Post mount style test stations shall be wood, plastic, steel, or conduit style as shown on the Drawings.
 - a. Wood, plastic, or steel post style test stations shall be used for Type C, F, or I test stations or any other test station type which has four or more wires and for type T test stations where self-support is required.
3. Conduit post style test station shall be used for Type T test stations where support is available in the form of fence posts, pipe marker posts, or aboveground manholes.
4. Flush mount style test stations shall be used for all type test stations in roads or areas where aesthetic requirements restrict use of aboveground facilities.

C. Installation:

1. Post mounted test station:
 - a. Height shall be between 36 to 42 inches above finish grade.
 - b. In areas with livestock, test station height shall be between 48 to 60-inches above finish grade.
 - c. Post shall be concrete encased as shown on the Drawings.

-
2. Flush Mounted Test Stations
 - a. Place in concrete pad or sidewalk with cast iron cover as shown on Drawings.
 - b. Place concrete box on top of 3-inch base of compacted sand.
 - c. In unimproved areas provide blue "Carsonite" utility marker with yellow reflector on each side 1 foot from test box or as directed by the ENGINEER.
- D. Test Wires:
1. Wires shall be attached to the pipe as specified under WIRE CONNECTIONS, this section.
 2. Wire connections shall be an individual connection with not less than 6-inches separation from other connections. Common connections will not be allowed. Where a steel tab is welded to pipe for test wire connections, a separate tab shall be provided for each wire connection.
 3. Wires to foreign-owned pipelines shall be connected to the pipe by the CONTRACTOR unless the foreign pipeline owner has indicated otherwise in writing. The CONTRACTOR shall coordinate this work with the owner of the foreign pipeline.
 4. Where foreign owners refuse test wire installation to their pipe, the Bidder shall obtain a written refusal from the field representative and install a Type T test station.
 5. Wires shall be buried a minimum of 24 inches below finished grade, except in undeveloped or cultivated areas where test wires shall be a minimum of 30-inches below finished grade.
 6. Wires shall be direct buried except where test station offset is required. Offset wires shall be installed in PVC coated rigid steel conduit from the centerline of the pipeline to 6-inches from test station. Rigid conduit shall not be connected to the test station.
 7. Provide 12-inch diameter loop in wires at the pipeline connection, at each end of rigid conduit when required, and below post mounted test stations to prevent wires from being stressed or broken.
 8. Maintain sufficient slack in flush mount test wires to permit extension of terminal block 18-inches above test station. Connect all wires to a terminal board as specified.
 9. Make wire connections to test station terminals with crimp-on ring tongue terminals, except where solid wire is specified.

3.15 VINYL LABEL INSTALLATION

- A. Vinyl identification labels shall be applied on all post mounted test stations.
- B. Label shall be visible from the nearest access road.
- C. Conduit surface shall be prepared as required by the label manufacturer.
- D. Metal surfaces shall be cleaned of all concrete residue, dirt, dust, oils, and greases with hand or power tool cleaning followed by an MEK solvent wipe prior to application of the vinyl sticker.

3.16 REFERENCE ELECTRODE INSTALLATION

-
- A. Remove plastic or paper wrapper and place reference electrode within the pipeline trench excavation 6 inches from pipe in a vertical position and activate reference electrode per manufacturer's written instructions.
 - B. Install reference electrode at Type F test stations equidistant from each pipeline at the location as shown on the Drawings.
 - C. Backfill hole with select native material in 6-inch layers and hand tamp each layer around anode. Use only native soil for backfill; do not use sand or flowable fill. Exercise care not to strike reference cell or lead wire with tamper.
 - D. Terminate reference electrode wire in test station on separate terminal.

3.17 THERMITE WELD WIRE CONNECTIONS:

- A. Use thermite weld method for electrical connection of copper wire to steel, ductile iron, and cast iron surfaces. Observe proper safety precautions, welding procedures, thermite weld material selection, and surface preparation as recommended by the material manufacturer. Assure that pipe or fitting wall thickness is of sufficient thickness that the thermite weld process will not damage the pipe or fitting wall's integrity or damage the lining in any way.
- B. Before the connection is made, the surface shall be cleaned to bare metal by making a 2-inch by 2-inch window in the coating, and then filing or grinding the surface with a vitrified wheel to produce a bright metal finish. Wire sleeves shall be installed on the ends of the wire before welding to the metal surface.
- C. After the weld connection is cooled, remove slag, visually inspect, and physically test wire connection by hitting with a hammer. Remove and replace any defective connections.
- D. Make wire connections to concrete cylinder pipe by thermite welding to the shop welded steel plates provided on the pipe for this purpose.
- E. Coat each completed wire connection as specified, this section. If lining is damaged by welding, repaired in accordance with the lining applicator's recommendations.

3.18 TRENCHING AND BACKFILL

- A. General
 - 1. Complete excavations and trenching regardless of the type, nature, or condition of materials encountered, and as required to accomplish specified construction to lines and grades shown.
 - 2. CONTRACTOR shall complete all utility notifications prior to performing trenching and excavations work.

3. Take care to avoid damage to existing structures and utilities during excavating and trenching process. CONTRACTOR may modify location, where approved by the ENGINEER, to minimize possible damage to existing structures. Trench shall be of uniform depth and width, level, smooth, and free of sharp objects.

B. Trench Depths:

1. Trench depths vary for conditions and requirements. Trench depths provided are minimum requirements. CONTRACTOR to meet minimum requirements or that required by local utilities, ordinances, or regulations, whichever is more stringent.
 - a. Minimum depths for corrosion monitoring work shall be as defined herein or shown on the Drawings. If in conflict, the more stringent shall apply.

(1) Pipeline Test wires, undeveloped	24-inches (direct bury)
(2) Pipeline Test wires, roadways	30-inches (conduit)
(3) All other	30-inches

C. Safety

1. Slope, shore, or brace excavations and trenches in accordance with OSHA regulations as necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, property, workers, and the public.
2. CONTRACTOR shall have sole responsibility for ensuring safety of trenches and conformance to OSHA trench safety requirements.

D. Backfill and Compaction

1. Backfill trench with excavated backfill materials, unless otherwise specified.
2. Compaction requirements shall be as specified for the pipeline or 90 percent compaction, whichever is more stringent. Backfill within 5 feet of roadways, paved areas, or other traffic areas shall be compacted to 95 percent.
3. Do not use backfill material of frozen or consolidated debris. Leave the trench with the excess backfill material neatly mounded, but not more than 4 inches above the existing ground level, for the entire width of the trench in undeveloped areas.
4. Replace topsoil in developed, landscaped, or cultivated areas.

3.19 SURFACE RESTORATION:

- A. Contractor shall restore all existing surface improvements, except for trees and shrubs within the pipeline easement removed in the performance of this work.
- B. Surface improvements shall be as follows:
 1. Landscaped Area:
 - a. Areas classified as landscaped include residential yards with sod or grass, flowers, shrubs, trees, and/or fencing.
 - b. Trees and shrubs removed within the pipeline right of way are excluded from restoration work.

-
- c. All irrigation system damage, grass or sod, gardens and fencing shall be restored to original condition. Sod shall match existing sod or grass. Fencing shall match existing fence or shall be removed and salvaged for replacement.
 - 2. Asphalt Paving:
 - a. All asphalt paved areas within roadways, parking lots, driveways or trails.
 - b. Asphalt repairs to be completed at 3-inch minimum thickness, as shown on the Drawings, or in conformance with local municipality standards and regulations for asphalt roads. Where conflicts between the local regulations and standards and these specifications occur, the most stringent requirement shall apply.
 - 3. Concrete Sidewalks:
 - a. Any concrete sidewalks, driveway, or concrete pad.
 - b. Concrete sidewalk replaced with minimum 4-inches thickness or in conformance with standards and regulations for concrete sidewalks for the local municipality with jurisdiction, whichever is more stringent.
 - c. Driveways and concrete pads replaced to match existing.
 - 4. Concrete Curbing:
 - a. Any formed concrete curb along roads, driveways, or trails.
 - b. Curbing to be replaced in conformance with the standards and regulations for concrete curbing of the local municipality with jurisdiction.
- C. Contractor to complete surface restoration as specified herein and shown on the Drawings.

3.20 CONDUITS

- A. Secure conduits entering cabinets, junction boxes, or terminal boxes with double locknuts, one on the outside and one on the inside.
- B. Install conduit parallel to walls, floors, or posts, and either plumb or horizontal. All changes in direction shall be at 90 degrees using either radius bends or outlet boxes. Conduit crossings shall be perpendicular to the other conduit or pipe.
- C. Install insulated bushings and insulated throat connectors on the ends of rigid metallic conduit.
- D. Use watertight couplings and connections. Install and equip boxes and fittings to prevent water from entering the conduit or box. Seal unused openings.

3.21 CONCRETE:

- A. Concrete used for slabs shall conform to the requirements for concrete in Section CONCRETE.
- B. CONTRACTOR shall finish all concrete work to a smooth trowelled finish with radius edges.

-
- C. All forms shall be removed from concrete work prior to final acceptance and removed from the project site.

3.22 INSULATED JOINTS

- A. Install insulated joints to electrically isolate the pipeline from other pipes or structures where shown on the Drawings.
- B. Install insulated joints as shown on the Drawings.
- C. Align and install insulating joints according to the manufacturer's recommendations to avoid damaging insulating materials.
- D. Install a Type I test station at each buried insulated joint.
- E. Provide a DC blocking device on all insulating joints, except buried joints, as specified herein and shown on the Drawings.
- F. The CONTRACTOR shall test each insulated joint for electrical insulation as specified in this section. Defective insulating joints shall be repaired by the CONTRACTOR at his sole expense. All damaged or defective insulation parts shall be replaced.

3.23 DC BLOCKING DEVICES

- A. Install dc blocking devices in ground wire at all motor operated valves and where indicated on the Drawings.
- B. DC blocking devices be installed at each electrical power connection to the pipeline and shall be placed as close to the pipe as reasonable possible and shall have no conduit supports between the pipe and the dc blocking device.
- C. Support of dc blocking device shall be on either a 2-inch diameter hot-dipped galvanized steel pipe support, 4-inch hot dipped galvanized channel support, or shall be mounted to a concrete wall at the CONTRACTOR's option. ENGINEER shall review and approve the applicable equipment support based on the conditions present.
- D. All electrical conduits connecting or attaching to the pipeline shall be electrically isolated from pipeline. Conduit connections to the pipe or equipment mounted on the pipe or associated appurtenances shall be electrically isolated with an insulating union located within 6-inches of the connection and shall have no conduit supports between the insulating union and the pipeline.
- E. CONTRACTOR is responsible for proper installation of dc blocking devices and electrical conduit isolation where necessary to achieve complete electrical isolation of all electrical grounding from the pipeline. The CONTRACTOR shall be responsible for requesting installation guidance from the ENGINEER under complex field conditions, where

grounding isolation cannot be achieved, or clarification of the electrical isolation requirements are needed.

- F. Upon completion of electrical system ground isolation from the pipeline, the ENGINEER shall review the completed installation for proper installation. Improperly installed conduit isolation or dc blocking devices shall be corrected at the CONTRACTOR's sole expense.

3.24 QUALITY CONTROL TESTING

A. General:

1. Contractor shall correct all construction defects identified during testing.
2. Provide engineer with 7 days advance notice of completion for Engineer acceptance testing.
3. Contractor required testing as defined herein shall be performed by a Corrosion Expert, with qualifications as specified this section, whom is an employee or subcontractor to the Contractor.

B. Functional Testing of Cathodic Protection Stations

1. Contractor shall perform a function test of each cathodic protection station installed.
2. Functional testing shall demonstrate the following items are functional and ready for Engineer performed energizing and testing:
 - a. AC power service from meter base to rectifier circuit breaker is operational and functional.
 - b. Rectifier produces dc voltage and current output up to the maximum dc current output rating of the rectifier.
 - c. Rectifier controller cards are fully functional and providing control of the rectifier output as specified.
 - d. All impressed current anodes are discharging dc current.
 - e. Remote monitoring system is installed and correctly wired.
3. Upon completion of functional testing, the rectifier shall be left in a de-energized state for Engineer performed System Tests and Inspection.
4. If electrical service is not installed at the time of the functional test, the contractor shall provide a generator with the wattage and voltage output necessary to power the system from the meter base utility connection terminals and complete all testing as defined for functional testing.

C. Joint Bond Resistance Test:

1. General

- a. The CONTRACTOR shall test completed joint bonds for electrical continuity using a digital low resistance ohmmeter.
- b. Joint bond quality control test shall be performed on all bonded joints after the bonds are installed but before backfilling of the pipe.
- c. Furnish all equipment and materials as required for test.

2. Digital Low Resistance Ohmmeter Test Method:

- a. Required Equipment and Materials:
 - (1) One AVO Model DLRO10 or AMEC 6250 10A Micro-ohmmeter, digital low resistance ohmmeter or equivalent instrument with the following capabilities:
 - (a) Test Current: 10 amperes
 - (b) Resolution: 0.1 micro-ohm or less
 - (c) Display: Digital
 - (2) One set of duplex leads with fixed current and potential points, AVO Model No. 242002-7, or equivalent.
 - b. Test Procedure:
 - (1) Measure the resistance of joint bonds with the low resistance ohmmeter in accordance with the manufacturer's written instructions.
 - (2) Use the helical handspikes to contact the pipe on each side of the joint, without touching the thermite weld or the bond. The contact area shall be cleaned to bright metal by filing or grinding and without any surface rusting or oxidation.
 - (3) Record the measured joint bond resistance on the test form described herein.
 - (4) Repair any damaged pipe coating in accordance with WIRE CONNECTIONS, this section.
3. Joint Bond Acceptance:
- a. Joint bond resistance shall be less than or equal to the maximum allowable bond resistance values shown below.

Joint Type	Max. Allowable Resistance (micro-ohms)		
	Two Bonds/Joint	Three Bonds/Joint	Four Bonds/Joint
No. 2 AWG wire (Steel)	162	108	81
No. 2 AWG wire (DIP)	185	123	93
Copper Strap (12-inch)	64	43	32
Copper Strap (9-inch)	48	32	24
Coupling, 24" No. 2 AWG	212	142	106
Coupling, 24" Copper Strap	128	85	64
MLC Steel Pipe Clips	NA	55	42
Z-bars	142	95	71

- b. For bond quantities greater than shown above obtain maximum allowable bond resistance from the Engineer.

-
- c. The CONTRACTOR shall remove and replace all joint bonds on a joint that exceeds the maximum allowable resistance. Replacement joint bonds shall be retested for compliance with the specified bond resistance.
 - d. Any defective joint bond discovered during SYSTEM TESTS AND INSPECTION shall be located, excavated, repaired, and backfilled by the CONTRACTOR.
 4. Test Records: Records shall be made of each bonded pipeline during the test and submitted to the ENGINEER. These records shall include:
 - a. Description and location of the pipeline tested.
 - b. Starting location and direction of test.
 - c. Date of test.
 - d. Joint type.
 - e. Measured joint bond resistance
 5. Report: CONTRACTOR shall submit a QC report upon completion of joint bond resistance testing which includes the information listed above.
- D. Insulated Joint Isolation Test:
1. CONTRACTOR shall provide a Corrosion Expert to test each insulating joint after assembly with a GAS Electronics Model 601 insulator tester or equivalent instrument in accordance with the manufacturer's written instructions.
 2. The Corrosion Expert shall conduct additional insulating joint testing as required to insure that insulating flanges are not electrically shorted by other equipment or incidental contact with concrete reinforcement.
 3. Conduct test before burial and coating of buried insulating flanges.
 4. CONTRACTOR to replace damaged or defective insulation parts identified during testing.
 5. Electrical Isolation is defined as a condition of being electrically isolated from other metallic structures (including, but not limited to, other piping, concrete reinforcement, casings, and other structures not intended to be cathodically protected) and the environment as defined in NACE Recommended Practice RP0169-83.
 6. CONTRACTOR shall submit a report prepared by the Corrosion Expert certifying insulating joint testing isolation, test method(s), test data, and any corrective action required.
- E. Pump Barrel Isolation Test:
1. CONTRACTOR shall provide a Cathodic Protection Specialist to test electrical isolation on the well at the following locations:
 - a. Between well casing and pump and pump column during installation.
 - b. Between well discharge head and well casing.
 - c. Between well discharge head and discharge pipe.
 - d. Between well discharge head and pump house grounding.

-
2. The Cathodic Protection Specialist shall conduct additional insulating joint testing as required to insure that insulating flanges are not electrically shorted by other equipment or incidental contact with concrete reinforcement or electrical grounding.
 3. Testing between well pump column and well casing shall be performed as the pump and pump column is installed within well.
 4. CONTRACTOR to replace damaged or defective insulation parts identified during testing.
 5. Electrical Isolation is defined as a condition of being electrically isolated from other metallic structures (including, but not limited to, other piping, concrete reinforcement, casings, and other structures not intended to be cathodically protected) and the environment as defined in NACE Recommended Practice RP0169-83.
 6. CONTRACTOR shall submit a report prepared by the Cathodic Protection Specialist certifying insulating joint testing isolation and any corrective action required.

F. Casing Isolation Testing:

1. CONTRACTOR to test each casing and carrier pipe after assembly for electrical isolation before and after filling of casing with the specified fill material.
2. An electrical isolation test method and evaluation criterion to be utilized by Corrosion Expert is to be submitted in writing for approval by ENGINEER prior to beginning field testing.
3. Electrical Isolation is defined as a condition of being electrically isolated from other metallic structures (including, but not limited to, other piping, concrete reinforcement, casings, and other structures not intended to be cathodically protected) and the environment as defined in NACE Recommended Practice RP0169-83.
4. CONTRACTOR to conduct any and all remedial actions necessary to clear all electrical contacts between the carrier pipe and casing before filling of the casing shall be permitted.
5. CONTRACTOR shall submit a written report prepared by the Corrosion Expert certifying casing isolation, testing method(s), test data, and any corrective action required.

G. Pump Column Isolation Test (New pump column Installation only):

1. CONTRACTOR shall provide a Cathodic Protection Specialist to test electrical isolation on the well at the following locations:
 - a. Between well casing and pump column during installation.
 - b. Between well discharge head and well casing.
 - c. Between well discharge head and discharge pipe.
 - d. Between well discharge head and pump house grounding.
2. The Cathodic Protection Specialist shall conduct additional insulating joint testing as required to insure that insulating flanges are not electrically shorted by other equipment or incidental contact with concrete reinforcement or electrical grounding.
3. Testing between well pump column and well casing shall be performed as the pump and pump column is installed within well.

-
4. CONTRACTOR to replace damaged or defective insulation parts identified during testing.
 5. Electrical Isolation is defined as a condition of being electrically isolated from other metallic structures (including, but not limited to, other piping, concrete reinforcement, casings, and other structures not intended to be cathodically protected) and the environment as defined in NACE Recommended Practice RP0169-83.
 6. CONTRACTOR shall submit a report prepared by the Cathodic Protection Specialist certifying insulating joint testing isolation and any corrective action required.

H. Well Casing to Pump Column Isolation Testing:

1. CONTRACTOR to test between well casing and pump column for electrical isolation.
2. An electrical isolation test method and evaluation criterion to be utilized by Corrosion Expert is to be submitted in writing for approval by ENGINEER prior to beginning field testing.
3. Electrical Isolation is defined as a condition of being electrically isolated from other metallic structures (including, but not limited to, other piping, concrete reinforcement, casings, and other structures not intended to be cathodically protected) and the environment as defined in NACE Recommended Practice RP0169-83.
4. CONTRACTOR to conduct any and all remedial actions necessary to locate and clear all electrical contacts between the well casing and pump column.

I. Concrete Reinforcement Isolation Test:

- (1) Pipe penetrations as listed below shall be tested for electrical isolation from electrical grounding and concrete reinforcement by a Corrosion Expert.
- (2) Contractor to perform concrete reinforcement isolation tests where concrete reinforcement isolation is required on the Drawings.
- (3) Electrical isolation test method and evaluation criterion to be utilized by Corrosion Expert is to be submitted in writing for approval by ENGINEER prior to beginning field testing.
- (4) Testing shall be conducted prior to concrete placement and shall be monitored during concrete placement to ensure no electrical shorts between the pipe and tank occur.
- (5) Corrosion Expert shall prepare a report certifying the concrete reinforcement is properly isolated and describe test method used to verify electrical isolation upon completion of the isolation test.
- (6) Electrical shorts detected and identified during Engineer performed SYSTEM TESTS AND INSPECTIONS, shall be located and repaired by the Contractor at Contractor's sole expense.

-
2. CONTRACTOR shall submit a written report prepared by the Corrosion Expert certifying concrete reinforcement isolation, testing method(s), test data, and any corrective action required.

3.25 SYSTEM TESTS AND INSPECTION

A. General

1. All testing specified herein shall be performed by the Engineer and shall include:
 - a. Preliminary electrical continuity testing of the full pipeline.
 - b. Cathodic protection system energizing and testing.
2. CONTRACTOR shall correct all construction defects identified during testing.
3. Provide ENGINEER with one week advance notice of completion of cathodic protection work.

B. Cathodic Protection System Energizing and Testing:

1. After the installation of the cathodic protection system is completed, the ENGINEER shall energize and adjust the system and ensure proper installation of the cathodic protection system.
2. Test data obtained shall be tabulated and submit in a report of the system operation, test methods, and protection levels. Test data from all testing performed shall be submitted in tabular and electronic form.
3. Energizing and Testing procedures shall, as a minimum, include the following:
 - a. Static pipe-to-soil potentials at each test station on each wire in the test station.
 - b. Test station wire continuity at each test station
 - c. Final electrical continuity of pipeline between each test station.
 - d. 'ON' pipe-to-soil potentials at each test station
 - e. Anode current output at each anode test station
 - f. Interference potentials at all crossing metallic pipelines.
 - g. Polarized 'ON' potentials after four weeks operation, minimum and three months, maximum.
 - h. Verification of electrical isolation of all insulating joints.
 - i. GPS positions in latitude and longitude format using a WGS 84 datum for all test stations. Locations shall be identified by GPS location, test station type, and street address. Accuracy of GPS positional measurements shall be sub-meter or better.

C. Electrical Continuity Testing:

1. Preliminary Continuity Test By Engineer
 - a. After the pipeline construction is completed and all test stations have been installed, the ENGINEER shall test all pipelines with joint bonds for electrical continuity using the four-wire lineal pipe resistance test method.
 - b. Test will be conducted with a minimum test current of 15 amperes using a portable rectifier or dc welder.
 - c. An electrically continuous pipeline will be defined as a pipe or section of pipe that has a linear electrical resistance equal to or less than the sum of the

-
- resistance of the pipe plus the maximum allowable joint bond resistance for each joint as specified in this section.
- d. The CONTRACTOR shall locate electrically discontinuous joints at his sole expense as specified herein.
 - e. Each discontinuous section of pipe shall be retested by the Engineer after all continuity repairs are completed to demonstrate that the pipeline is electrically continuous. Engineer retesting costs shall be at the Contractor's expense.
2. Electrical Discontinuity Location:
- a. CONTRACTOR shall be solely responsible for location and repair of all discontinuous or high resistance joints bonds using a test method determined by the CONTRACTOR. Regardless of test method used to locate discontinuous joints, final acceptance of discontinuous sections shall be determined by the lineal pipe resistance method.
 - b. After all discontinuous or high resistance joint bonds are repaired, the repaired section shall have a resistance less than or equal to the calculated allowable lineal pipe resistance as determined by the initial final continuity testing.
 - c. Existing joint bonds damaged during excavation of the pipe for repairs or temporary wire connections shall be repaired by the CONTRACTOR.
 - d. Existing test stations shall be protected from damage. When damage occurs CONTRACTOR shall complete repairs while the excavation is open. Undisclosed test station damage that requires repairs to be made after backfilling the excavation will be repaired at the CONTRACTOR sole expense.
 - e. Upon completion of continuity repairs, the ENGINEER shall retest the continuity of repaired sections at the CONTRACTOR's expense in accordance with the General Conditions.

END OF SECTION

SECTION 26 42 15

IMPRESSED CURRENT CATHODIC PROTECTION

PART 1 GENERAL

1.01 WORK INCLUDED:

- A. This section covers the work necessary to furnish and install an impressed current cathodic protection system, electrical isolation, test stations, pipe joint bonds, and electrical continuity, complete.
- B. CONTRACTOR to install electrical service to each cathodic protection (CP) station as shown on the Drawings.

1.02 STANDARDS

- A. The following standards are included by reference:
 - 1. NACE SP-0169
 - 2. NACE SP-0177

1.03 QUALITY CONTROL

- A. Contractor performed quality control testing shall include the following tests, which shall be performed as defined this section.
 - 1. Quality Control Testing, Joint Bond Resistance test
 - 2. Quality Control Testing, Casing Isolation testing (before and after casing fill)
 - 3. Quality Control Testing, Insulating Joint Testing
 - 4. Quality Control Testing, Concrete Reinforcement Isolation Testing
 - 5. Functional testing of cathodic protection stations
 - 6. Other Testing as specified in Section 13115, Cathodic Protection
- B. Energizing and testing of cathodic protection system, and other tests as defined under "System Tests and Inspections" shall be performed by the corrosion expert provided by contractor.

1.04 DEFINITIONS

- A. Active column: Active column of a Deep Well groundbed shall be that portion of the groundbed which discharges current and consist of anodes and coke breeze.

-
- B. Inactive column: Inactive column of a groundbed shall be that portion of the column that does not discharge current, and consist of the backfill, casing, and/or grout or concrete seal that is above the active column.
 - C. Cathodic Protection Station: A cathodic protection station or CP Station shall consist of the rectifier, remote monitoring, electrical service, subpanel or safety disconnect switch, all conduits, and concrete slab required for a complete and functional station.
 - D. Foreign-Owned: Buried pipe or cable not specifically owned or operated by the OWNER.
 - E. Electrically Continuous Pipeline: A pipeline that has a linear electrical resistance equal to or less than the sum of the resistance of the pipe plus the maximum allowable joint bond resistance for each bonded pipe joint as specified in this section.
 - F. Electrical Isolation: The condition of being electrically isolated from other metallic structures (including, but not limited to, piping, concrete reinforcement, casings, etc.) and the environment as defined in NACE Recommended Practice SP0169.

1.05 SUBMITTALS:

- A. Shop Drawings: Catalog cuts and other information for products proposed for use.
- B. Quality Assurance Submittals:
 - 1. Field Test Reports.
 - 2. Qualifications of NACE Accredited Personnel.

PART 2 MATERIALS

2.01 GENERAL:

- A. Like items of materials provided hereunder shall be the end product of one manufacturer to achieve standardization for appearance, maintenance, and replacement.
- B. Materials and workmanship as specified in this section shall be installed concurrently with pipe installation. Coordinate all work specified herein with related sections.

2.02 SUPPLIERS:

- A. Alternate suppliers will be considered, subject to approval of the ENGINEER. Address given is that of the general office; contact these offices for information regarding the location of their representative nearest the project site.
 - 1. Corpro, Inc., Chicago, IL www.corpro.com
 - 2. Farwest Corrosion Control, Gardena, CA www.farwestcorrosion.com
 - 3. Hoff Company, Inc., Denver, CO www.pipelinesupplies.com

-
4.	MESA Products, Tulsa, OK	www.mesaproducts.com
5.	Northtown Products, Huntington Beach, CA	www.northtownproducts.com

2.03 WIRE:

- A. Rectifier DC Wires:
 - 1. No. 2 AWG wire shall be single-conductor, stranded copper wire with 600-volt, high molecular weight polyethylene (HMWPE) insulation, black.
- B. Impressed Current Anode Wire:
 - 1. Single-conductor, No. 8 AWG stranded copper.
 - 2. Deep Well Anodes: 20-mil thick cross-linked Kynar or ECTFE fluoropolymer (Halar) primary insulation and high molecular weight polyethylene (HMWPE) outer insulation or equivalent.
- C. Test Wires:
 - 1. Pipe Test Wires: No. 10 AWG wire, single-conductor, stranded copper with 600-volt, TW, THWN, or HMWPE insulation. Color coded insulation as specified.
 - 2. Reference Electrode Wires: No. 12 AWG wire single-conductor, stranded copper with 600-volt, TW, THWN, USE2, or HMWPE insulation. Color coded insulation as specified.
 - 3. Insulation Color: Color shall indicate the function of each test wire and shall be as follows:

a. Pipe:	White
b. Reference electrodes:	Yellow
c. Casings:	Orange
d. Foreign Pipe:	Blue (Water) or Red (Gas or oil)
e. Insulating Joints:	White and Green as shown on Drawings
f. Corrosion Coupons:	Green
- D. AC Power Service:
 - 1. Subpanel to Rectifier: No. 10 AWG, minimum, stranded copper wire, Type THHN or THWN cable with quantity of conductors as required for source voltage and phasing with ground wire. Colors in conformance with NEC requirements.
 - 2. Underground Service: No. 8 AWG, minimum, stranded copper wire, Type UF or USE2 cable, quantity of conductors as required for source voltage and phasing with ground wire. Size wire for maximum circuit amperes in accordance with NEC requirements.
- E. Reference Electrode Wires: 12 AWG wire single-conductor, stranded copper with 600-volt, TW, THWN, USE2, or HMWPE insulation. Color code insulation as specified. Wire length of 25 feet or as required for splice free installation.
- F. Pipe Cross Bond Wire: No. 2 AWG, stranded copper, HMWPE Insulated.
- G. Pipe to Structure Grounds: No. 1/0 AWG, Stranded copper, with THHN, THWN, or HMWPE wire, green insulation.

2.04 JOINT BONDS

A. General:

1. All joint bonds provided either by pipe manufacturer or Contractor shall meet the following minimum requirements:
 - a. All connections on a joint bond shall be welded or soldered.
 - b. Mechanical or compression type connections will not be permitted.
 - c. Bonds and welds shall exhibit sufficient strength and flexibility to allow thermal movement of the pipe after pipe backfill without cracking or breakage.
 - d. Bond connections to pipe shall be with an Engineer approved welding method.
2. All joint bonds shall be insulated wire or coated copper and all exposed copper, steel, or iron surfaces field coated as specified this section.

B. Ductile or Cast Iron Pipe, External Bonds:

1. Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE insulation, 18 inches long, with formed copper sleeve on each end of the wire.
2. Quantity of joint bonds per pipe joint by pipe diameter shall be as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
#2 AWG Wire	16" or less	42" or less	Over 42"

3. Connection of wire joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for bond type used.
4. Bonds shall be as manufactured by Erico Products, Continental Industries, or approved equal. Third party manufactured bonds shall be approved by the Engineer for conformance with the requirements of this specification and proper thermite welding.

C. Coated Steel Pipe, External Bonds:

1. Rolled joint or Carnegie joint bonds shall be one of the following types at the CONTRACTOR's option:
 - a. Wire Bond: Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE or THWN insulation, 18 inches long, with a formed copper sleeve on each end of the wire.
 - b. Strap Bond:
 - (1) Solid copper strap, 1-1/4-inch wide by 1/16-inch thick, equivalent to 1/0 AWG wire, with two punched holes for thermite welding to the pipe. Strap holes shall be sized for the thermite weld mold and shall provide for physical centering of the mold over the hole.
 - (2) Strap bond shall be 12-inches long with dielectric coating applied to the center 8-inches of the strap bond. Strap bonds provided without a dielectric coating shall be coated prior to installation with filler mastic as specified for heat shrink sleeves in Section 09 90 10, Pipeline Coating and Lining.
 - (3) Strap bonds shall be as manufactured by Erico Products, Continental Industries, Hoff Company, or approved equal. Third party manufactured

- strap bonds shall be approved by the Engineer for conformance with the requirements of this specification and proper thermite welding.
- c. Use of manufactured steel bonding clips will not be permitted with heat shrink sleeve coated joints.

D. Flange joints:

1. Flanged joint bonds shall be one of the following types at the CONTRACTOR's option:
 - a. Exposed or Buried Joints:
 - (1) Steel rod, 5/8-inch diameter, length as required, arc welded to flange.
 - (2) Steel rod bonds will not be allowed where welding to the flange is not approved by the Engineer.
 - b. Buried Joints:
 - (1) Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE insulation, 18 inches long, with a formed copper sleeve on each end of the wire.
 - (2) Required bond where welding to the flange is not allowed by Engineer.
2. Quantity of joint bonds per pipe joint shall be as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
Steel Rod	36" or less	72" or less	Over 72"
#2 AWG Wire	NA	30" or less	Under 60"

3. Connection of wire joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for bond type used.
4. Coat steel rod bonds with fast curing epoxy after welding to joint as specified in this Section, except when pipe is specified to be coated in accordance with Section 09900, PAINTING.

E. Sleeve Coupling, Flanged Coupling Adapter, and Other Non-standard Joints:

1. Ductile Iron Pipe:
 - a. Bond: No. 2 AWG wires, 24 inches long, HMWPE insulation, with two 12-inch long THHN insulated No. 12 AWG wire pigtails,
 - b. Manufacturer: Erico Products Inc. (Cadweld), Cleveland, OH, Hoff Company, Denver, Colorado, or equal.
2. Bond Quantity per Joint: Provide the quantity of bonds per pipe diameter as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
Copper Strap	NA	54" or less	Over 54"
No. 2 Wire Bond	NA	54" or less	Over 54"

3. Connection of wire or copper strap joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for the bond type used.

F. Insulated Sleeve Coupling Joints:

1. Ductile Iron Pipe:
 - a. No. 8 AWG wire, 18-inch long, with one 12-inch long THHN insulated No. 12 AWG wire pigtail.
 - b. Manufacturer: Erico Products Inc. (Cadweld), Cleveland, OH, Hoff Company, Denver, Colorado, or equal.
 - c. R
2. Bond Quantity per Joint: Provide the quantity of bonds per pipe diameter as defined below:

Bond Type	One Bonds	Two Bonds	Three Bonds
Copper Strap	Up to 36"	36" to 60"	Over 60"
No. 2 Wire Bond	Up to 36"	36" to 60"	Over 60"

2.05 CATHODIC PROTECTION TEST STATIONS

A. Post Style, Steel Conduit:

1. Test Box:
 - a. Cast aluminum with thread hub suitable for mounting to a 2-inch x 3-inch reducer.
 - b. Manufacturer and Product:
 - (1) Type T, C, and I Stations: Gerome Manufacturing, Testox 700 series (rectangle), except where Type TR stations required for remote monitoring capable.
 - (2) Type F, A, and TR Stations: Gerome Manufacturing, Testox 2000 series (rectangle) with 2" threaded hub.
2. Street Reducer:
 - a. Hot dipped galvanized 2-inch x 3-inch reducer and close nipple.
 - b. Reducing bushings will not be permitted.
 - c. Test stations provided with 3-inch threaded hub shall be directly mounted on steel conduit.
3. Terminal Block:
 - a. Plastic or glass-reinforced laminated, 1/4-inch thick with seven terminals for Type T, C, and I test stations.
 - b. Plastic or glass-reinforced laminated, 1/4-inch thick with eleven terminals for Type F, A, and TR test stations.
 - c. Terminal heads shall have special heads to keep them from turning or shall be easily accessible from both sides of the terminal block without requiring its removal.
 - d. Terminal studs, washers, and nuts shall be stainless steel.
4. Mounting Structure:

-
- a. Rigid hot dipped galvanized steel conduit 3-inches diameter, threaded at one end (minimum), length as required for installation requirements.
 - b. PVC long radius sweep elbow, 1-inch diameter, for wire protection as shown on Drawings.
5. Terminal Block:
- a. Plastic or glass-reinforced laminate, 1/4-inch thick with five terminals.
 - b. Terminal heads shall have special heads to keep them from turning or shall be easily accessible from both sides of the terminal block without requiring its removal.
 - c. Terminal studs, washers, and nuts shall be stainless steel.
6. Hardware:
- a. Conduit - Hot dipped galvanized conduit and conduit bodies
 - b. Mounts - Unistrut support or two piece, one hole, malleable iron strap and clamp back, O. Z. Gedney 14-100G and 143G or equal.
 - c. Two-hole straps will not be permitted.

2.06 VINYL LABELS

- A. Test station Identification labels shall be vinyl labels as shown on the Drawings.
- B. Labels shall be silk screened printed with graphics and text as shown on Drawings with UV resistant clear coat protection.
- C. Label shall be vinyl, self-adhesive, waterproof, weatherproof, UV resistant to fading or color change, and provide 10-year service life on properly prepared and cleaned surface.

2.07 REFERENCE ELECTRODES:

- A. Prepackaged Copper-Copper Sulfate Reference Electrodes:
 - 1. Material: Permanent type, copper-copper sulfate reference electrode suitable for direct burial with a minimum design life of 25 years.
 - 2. Lead Wire:
 - a. As specified under wire, this section,
 - b. Length of 25 feet or as required for splice free installation.
 - 3. Backfill: As recommended by the reference electrode manufacturer.

2.08 DEEP WELL GROUNDBED

- A. Surface Casing
 - 1. PVC well casing, conforming to ASTM F-480, Schedule 40.
- B. Casing Sanitary Seal and Fill Material
 - 1. General
 - a. Sealing materials for wells shall conform to the State of Utah water well regulations or as specified herein, whichever is more stringent.
 - 2. External Sanitary Seal (annulus area between the surface casing and soil):

-
- a. Bentonite Grout:
 - (1) Mixture of granular bentonite and water in a ratio of not less than 8 pounds of bentonite or expansive clay per gallon of water.
 - (2) Slurry shall not be less than 50 percent expansive clay with the grain size of the remainder to be not greater than coarse sand.
 - (3) Bentonite shall be commercially produced product specifically designed for well sealing. Acceptable products are Aquaguard, Quick-Grout, Plug-Gel, Shur-Gel, Enviro-Plug, or equivalent material.
 - b. Unhydrated Bentonite Chips
 - (1) Material: Unhydrated sodium bentonite, specifically designed for well sealing.
 - (2) Gradation: Medium chips, 1/4 inch, minimum, to 3/8 inch, maximum, dust and fines not to exceed 2 percent by weight.
 - (3) Application Restrictions:
 - (a) Not allowed for sanitary sealing casings over 50 feet in length,
 - (b) Gravity feeding from the surface at depths greater than 30 feet or with water in the hole shall require monitor rod to insure bentonite chips do not bridge and that annular space fills from bottom to top.
 - (4) Manufacturers:
 - (a) Wyoming Ben, Enviroplug Medium
 - (b) Baroid, Holeplug
 - (c) Or Equal
 - 3. Casing Internal Seal (inactive column area): Unhydrated Bentonite chips.
- C. Vent Pipe:
- 1. Active Column Vent
 - a. Loresco "Allvent", 1-inch diameter, solvent welded joints, slotted PVC vent pipe as manufactured by Loresco International, Hattiesburg, MS.
 - b. Slotted vent pipe shall be installed in the active anode column area and extend 15 feet into the inactive column.
 - 2. Inactive Column Vent
 - a. Inactive column vent pipe shall be 1-inch, schedule 40 PVC with solvent welded joints.
 - 3. Surface Vent:
 - a. ASTM A53-90b standard hot dipped galvanized steel pipe, 1-inch diameter with 180-degree gooseneck at the top.
 - b. Coat threads and any damage to the galvanized coating with one coat of inorganic zinc rich primer.
- D. Anode Centralizers
- 1. Metal assemblies that can be securely attached to the anodes to center them in the drilled well as recommended by the anode manufacturer.
 - 2. No sharp edges or bolts will be permitted on the centralizers.
 - 3. Centralizers shall not block the well or impair installation of the anode, anode wires, or coke breeze.
- E. Deep Well Seal:

1. Two-piece cast iron seal with a rubber packer to form a watertight seal.
2. Seals shall permit conduit and vent pipe penetrations through the seal with the rubber packing sealing the annular space watertight.
3. Provide plugs for all unused holes.
4. Seal installation shall be watertight.
5. Manufactured by Campbell Manufacturing, Inc., Bechtelsville, PA; Berkeley Pump Company; Jacuzzi Brothers Inc.; or equal.

2.09 IMPRESSED CURRENT ANODES

A. Mixed Metal Oxide Anodes

1. Mixed metal oxide (MMO) anodes as shown in the plans.
2. Lead Wire:
 - a. No. 8 AWG stranded copper with insulation as specified under WIRE, this section.
 - b. Lead wire shall be of sufficient length to extend splice-free from anode connection to the anode junction box.
 - c. Connection of lead wire to the anode shall be by the manufacturer's standard connection and shall be stronger than the wire.
3. Packaging:
 - a. Lead wire shall be coiled and bound in such a manner as necessary to protect insulation from damage during shipment.
 - b. Anodes shall be protected from breakage.
 - c. Damaged anodes or lead wire will be cause for replacement of the lead wire and anode.
4. Wire Labels: Label the end of each deep well anode wire with the anode number and lead wire length. Number anodes sequentially from bottom to top.

2.10 COKE BREEZE:

A. Coke breeze shall be lubricated calcined petroleum of the following composition:

Volatile Matter	0.7 to 1.8 percent
Ash	1.3 percent maximum
Sulfur	1.9 percent maximum
Fixed Carbon	95.0 percent minimum
Particle Size	100 percent less than 16-mesh
Density	68 pounds per cubic foot, minimum

- B. Acceptable coke breeze shall be Loresco SC-3 as manufactured by Loresco International, Hattiesburg, MS.

2.11 ANODE JUNCTION BOXES

A. Terminal Box:

-
1. Size and Type: NEMA 250-85, Type 3R, with minimum inside dimensions of 12 inches by 12 inches by 4 inches deep or as required for the quantity of anodes. Size may need to be increased to accommodate the design in the plans.
 2. Material: 14-gauge Type 304 stainless steel or equivalent
- B. Material and Coating: Type 304 Stainless steel
- C. Hardware: Secure door with stainless steel quick release latches and hinges. Screw or bolt secured doors will not be acceptable.
- D. Terminals and Connectors: Furnish a separate panel board, buss bar, and terminal strip or terminal block connectors, and nickel plated brass fasteners for connecting the anode lead terminals to the rectifier positive lead. Provide separate terminal and shunt for each anode lead. Quantity of terminals shall be as shown on the Drawings for quantity of anodes per grounded
- E. Shunts: Holloway Type JB, 0.01 ohm.
- F. Equipment Tags: Provide each junction box with original manufacturer's equipment tag that identifies the original equipment manufacturer, model number, serial number, and any applicable electrical ratings. **Equipment tags with vendor or distributor name will not be acceptable.**
- G. Manufacturer: Anode junction box shall be Universal Model ATB or ATB-S as manufactured by Universal Rectifiers Inc., Rosenberg, TX or equal.

2.12 RECTIFIER:

- A. Rectifiers shall meet NEMA MR-20 standards and the following construction and operational parameters.
- B. All rectifier components and wiring shall be fully enclosed and protected within a case meeting the following requirements:
- a. Cooling: air cooled
 - b. Mounting: pole mounting
 - c. Material: Type 304 Stainless steel, 11-gauge.
 - d. Other Requirements:
 - (1) Case shall be provided with hinge doors on the front and one side, minimum, with slide out rack assembly.
 - (2) Doors with hasp for padlocking
 - (3) Stainless steel hardware.
 - (4) Case shall be sealed to protect rectifier components from weather and nest building insects, rodents, or birds.
- C. AC Input Voltage:
1. 120/240 volt, single phase, 60-Hz

SECTION 31 09 13

GEOTECHNICAL INSTRUMENTATION AND MONITORING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section presents requirements for installation, monitoring, and removal of instrumentation for monitoring of ground movements before, during, and after tunnel construction.

1.02 RELATED WORK

- A. Related Specification Sections include but are not limited to:
1. 31 71 00 – Tunnel Excavation and Initial Support
 2. 31 73 00 – Contact Grout
 3. 31 74 23 – Carrier Pipe Installation and Backfill
 4. 31 75 00 – Construction Shafts
 5. Geotechnical Baseline Report (GBR), Lithos Engineering/GEI Consultants
 6. Geotechnical Investigation Report (GIR), RB&G Engineering

1.03 DEFINITIONS

- A. GOVERNING AGENCY: Agency which owns and/or operates the property in which the tunnel work will be conducted.
- B. INSTRUMENT SPECIALIST: Party responsible for the installation, maintenance, and monitoring instrumentation.
- C. INSTRUMENTATION SURVEYOR: Party responsible for performing survey and establishing baseline readings for surface survey points, monitoring point arrays, and utility monitoring points.
- D. MONITORING POINT: General terminology referencing a Surface Survey Point and/or Utility Monitoring Point.
- E. MONITORING POINT ARRAY: A series of Surface Survey Points arranged in a row to monitor surface movement.
- F. RESPONSE VALUES: Recorded differential movement at which point a necessary change to the construction means and methods needs to be implemented to prevent damage to overlying or adjacent existing road surfaces or utilities.
- G. ROAD PRISM: Low-profile optical survey target used as a surface monitoring point to monitor settlement and deformation of pavement.

- H. SURFACE SURVEY POINT: Monitoring locations at which the ground surface will be monitored for horizontal and vertical movement during tunnel and shaft construction.
- I. See Related Specification Section 31 71 00 – Tunnel Excavation and Initial Support for additional definitions.

1.04 GENERAL

- A. Monitor, at a minimum, all locations noted on the Contract Drawings for movement during and after tunnel construction.
- B. Minimum requirements are presented herein. It is the Contractor's responsibility to implement the monitoring plan as specified herein or as necessary to ensure the safe completion of the work and prevent damage to existing infrastructure.

1.05 REQUIREMENTS

- A. Minimum instrumentation and monitoring requirements are presented herein.
 - 1. Designate an Instrumentation Specialist to oversee installation and monitoring of instrumentation. The Instrumentation Specialist will develop the instrumentation plan then supervise and be responsible for the instrument installation, maintenance, and monitoring. As built and baseline surveys associated with the instrumentation shall be under the direction of and reviewed by the Instrumentation Surveyor.
 - 2. Positively identify all utilities within the project location.
 - 3. Obtain applicable permits from Governing Agencies and utility owners to perform instrumentation and monitoring work.
 - 4. Remove or abandon in place all instrumentation in accordance with applicable laws, regulations, and guidelines following completion of construction.
 - 5. As a minimum install all instrumentation as shown in the Contract Drawings and in accordance with this specification.

1.06 QUALIFICATIONS

- A. Instrumentation Specialist: The Instrumentation Specialist shall have experience working on tunneling projects where installation, maintenance and monitoring of geotechnical instrumentation similar to those specified herein are required. The Instrumentation Specialist will have had direct involvement in directing or installing instrumentation and monitoring and working with the Instrumentation Surveyor to monitor and collect survey data. The Instrumentation Specialist shall have served in a similar capacity on a minimum of two tunnel projects in the previous five years.
- B. Instrumentation Surveyor: The Instrumentation Surveyor shall be a licensed Professional Surveyor in the State of Colorado and shall have served in a similar capacity on a minimum of two tunnel projects in the previous five years.

1.07 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two weeks before the scheduled start of the applicable activity:
 - 1. Qualification Documentation. Submit Instrumentation Specialist and Instrumentation Surveyor as stated in Section 1.06 Qualifications.
 - 2. Geotechnical instrumentation and monitoring work plan:
 - a. Description of methods and materials for installing and protecting instruments and monitoring points.
 - b. Submit all applicable Manufacturer literature describing operation and maintenance of survey and monitoring equipment. Provide Manufacture brochures, product descriptions and drawings of all equipment. Manufacturer literature should indicate the equipment to be used can perform to the specified accuracy and observation frequency stated in Section 2.02 specified herein. A certificate issued by the instrument Manufacturer stating that the Manufacturer has inspected, calibrated, and tested each instrument before it leaves the factory is to be included.
 - 3. Location of any monitoring points and instruments to be installed, highlighting any points and instruments that are not included in the contract drawings.
 - 4. Permits. List permits, third party approvals including but not limited to roadway, traffic control plans if within roadways, owners of structures, and approval contract submittals required to perform the work.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
 - 1. Installation Records. Within five days of installation of each instrument and prior to the start of tunnel construction, submit documentation including:
 - a. The installed instrument location, instrument identification number, instrument type, installation date, initial baseline elevations and coordinates, and offset and stationing to alignment.
 - b. Furnish details of installed instruments showing all dimensions and materials used, a separate statement describing installation procedures for each instrument, and as-built drawings of each instrument including lengths, elevations, and dimensions.
 - 2. Data. Provide results of initial baseline readings within two days of measurement. Provide initial monitoring results to the Engineer verbally immediately following measurement. Monitoring measurements shall then be provided to the Engineer in writing within one day of measurement.

PART 2 EQUIPMENT, PRODUCTS AND MATERIALS

2.01 GENERAL

- A. Surface Survey will be flush or countersunk with the ground or roadway surface in areas where the instrument may be damaged or be an impediment to other activities.

2.02 PRODUCTS

- A. Surface Survey Points: Surface survey points indicated on the drawings installed in pavement are to consist of one Road Prism and/or one PK nail. Each Surface Survey Point is to be tagged or marked to indicate the identification number, tunnel station and offset from centerline. Surface survey points indicated on the drawings to be installed in pavement are to consist of one Road Prism and/or one PK nail.
 - 1. Road Prisms are to be the Polymer Road Prism as Manufactured by Geo Instruments or approved equivalent. Survey prisms are to be installed at locations shown on the Drawings or as approved by the Engineer. Prisms are to be mounted in accordance with Manufacturer's recommendations.
 - 2. PK nails installed in pavement are to be nails that are driven into the pavement. PK nails are to be installed adjacent to the Road Prism and serve as a backup means of monitoring in the event the Road Prism is damaged or removed from the pavement surface.
- B. Survey Equipment: The selected survey equipment shall have an accuracy of 0.01 feet.

PART 3 EXECUTION

3.01 GENERAL

- A. Installation. Instrumentation shall be installed at the locations shown on the Contract Drawings or as directed or approved by the Engineer. All instrumentation shall be installed, and the initial readings recorded three days prior to the start of shaft and tunnel construction, as described in Section 3.05.
- B. Access. Provide and facilitate safe access to the instrumentation for the Instrumentation Surveyor and Engineer.
- C. Existing Conditions. Locate conduits and underground utilities in all areas where utility monitoring points are to be installed.
- D. Identification. All instruments shall be clearly marked, labeled, and protected to avoid being obstructed or otherwise damaged by construction operations or the general public.
- E. Instrument Designation. A unique instrument identification number shall be assigned to each survey point. The instrument identification number shall be clearly marked on each instrument.
- F. Surveying. Following installation, survey the location of the top of all survey points to provide baseline horizontal and vertical coordinates. Provide data to the Engineer. Re-survey from control points monthly or more frequently to address potential disturbance or resolve conflicting data as directed by the Engineer.

3.02 QUALITY CONTROL

- A. Perform all work in accordance with all current applicable regulations and codes of federal, state, and local agencies. In the event of conflict, comply with the strictest or most restrictive applicable requirements.
- B. Installation:
 - 1. Provide written notice to the Engineer at least 24 hours before installing monitoring instrumentation.
 - 2. Should actual field conditions prevent installation of instruments at the location and elevations shown on the Contract Drawings or specified herein, obtain prior acceptance from the Engineer for new instrument location and elevation.

3.03 SAFETY REQUIREMENTS

- A. Methods of installing the instrumentation are to be such as to ensure the safety of the work, project participants, the public, third parties, and adjacent property, whether public or private.
- B. Maintain safe access to instrumentation for the Instrumentation Surveyor and Engineer at all times as necessary to satisfy the monitoring requirements specified herein.

3.04 INSTALLATION

- A. Surface Survey Points: Install surface Survey Points at locations as shown on the Contract Drawings or as approved or directed by the Engineer. Monitor surface survey points for movement in the x, y, and z directions for each reading.
- B. After completion of installation, determine as-built location of all instruments and monitoring points and provide to the Engineer. Determine horizontal positions to an accuracy of ± 0.01 ft and the elevations to an accuracy of ± 0.01 ft.

3.05 MONITORING

- A. Initial Readings: Take initial readings of all instruments to establish a baseline three days prior to the start of shaft construction and provide the Engineer with this data within one working day of the recorded measurement.
- B. Frequency:
 - 1. Provide the Engineer with these data within one working day of data collection.
 - 2. At a minimum, maintain the following reading schedule:

Instrument Type	Instrument Reading Schedule		After Tunneling Completion ^(b)
	During Shaft Construction	During Tunneling ^(a)	
Surface Monitoring Points	Twice Weekly	Twice Daily	Once Daily / Once Weekly

Notes:

- a. Daily readings must be taken around the same time each day and at least four hours apart.
 - b. Daily measurements shall be taken for four days after all tunnel construction is complete. Weekly measurements shall be taken one, two, and three weeks after tunnel construction is complete or as determined by the Engineer and monthly thereafter until the Tunnel Contractor demobilizes from the site.
 3. Perform additional monitoring as necessary to control construction and to ensure safe work completion. Closer interval readings shall be taken during periods of high precipitation or as instructed by the Engineer.
- C. Reporting: Provide final data from readings of all monitoring locations to the Engineer within one working day of the recorded measurements. When available, provide copies of field instrumentation data verbally to the Engineer immediately after the data are collected in the field. The data shall include, but are not limited to, the following:
1. A copy of the data sheets containing a cumulative history of readings and proximity of tunnel excavation to the instrument location at the time of each reading.
 2. A copy of the plot of measured values versus time, including a time history of construction activity likely to influence such readings if readings begin to approach Response Values, as determined by the Engineer.
 3. If applicable, provide the Engineer with access to a web-based portal where data is stored.
- D. Interpretation: Provide interpretations of monitoring data and submit them to the Engineer along with the data. Data or interpretations shall not be published or disclosed to other parties without advance written permission of the Owner or Engineer. The Engineer may make his/her interpretations of the data available to the Contractor.

3.06 RESPONSE VALUES:

- A. Abide by the following response values:

Instrument Type	Response Values	
	Threshold Value	Shutdown Value
Surface Monitoring Points	0.02 feet in Z 0.02 feet in any of X or Y	0.0 feet in Z 0.04 feet in any of X or Y

- B. When a given response value is reached, respond in accordance with the following:

1. Threshold Value: Notify the Engineer immediately. Meet with the Engineer and Owner to: 1) review interpretation of the data and results, 2) review the construction means and methods, and 3) determine what changes, if any, shall be made to better control movement.
2. Shutdown Value: Notify the Engineer immediately. Safely secure the tunnel taking all measures to prevent further settlement, completely close all openings at the excavation face, and stop all work inside the tunnel immediately. Upon closing the face, meet with the Engineer and Owner and notify affected parties including Governing Agencies and other property Owner(s) to develop a plan of action before work is resumed. Work inside the tunnel can continue if a plan of action is agreed upon by all affected parties and if substantial risk to monitored facilities is determined to not increase with further construction activity.

3.07 MAINTENANCE

- A. Damaged Instruments: Protect the instruments from damage. Damaged installations shall be replaced or repaired by the Instrument Specialist and approved by the Engineer prior to continuing construction at the Instrument Specialist's expense. Provide new baseline readings if instruments are substantially damaged by as determined by the Engineer.

3.08 FINAL DISPOSITION

- A. Surface Survey Points. Remove all Surface Survey Points in accordance with applicable laws, regulations, and guidelines.

END OF SECTION

SECTION 31 11 00 – CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies site preparation which consists of clearing, grubbing and demolition.

1.2 JOB CONDITIONS

A. Existing Conditions

The Contractor shall determine the actual condition of the site as it affects this portion of work. The contractor shall make a video tape of the project site(s) prior to beginning construction.

B. Protection

Site preparation shall not damage structures, landscaping or vegetation adjacent to the site. The Contractor shall repair, or replace any damaged property.

PART 2 - EXECUTION

2.1 GENERAL

The Contractor shall notify the Construction Manager when site preparation is complete. Further work shall not be started until the conditions of paragraph 02100-2.02 are satisfied.

2.2 PERFORMANCE

A. CLEARING AND GRUBBING

Unless otherwise specified, the Contractor shall remove obstructions such as brush, trees, logs, stumps, roots, heavy sod, vegetation, rock, stones larger than 6 inches in any dimension, broken or old concrete and pavement, debris, and structures where the completion of the work requires their removal.

Material that is removed and is not to be incorporated in the work shall be lawfully disposed of off the site by the contractor.

B. DEMOLITION AND REMOVAL

1. Structures: Demolition and removal of structures consist of removal of abandoned superstructures, foundation walls, footings, slabs and any other structures. Excavations caused by existing foundations shall be cleared of waste, debris and loose soil, and refilled as specified.

2. Pavement: When portions of asphalt pavements and concrete pads are to be removed and later construction is to be connected, edges shall be saw cut, on a neat line at right angles to the curb face or edge of pavement.
3. Salvage: The Owner has the right to salvage any items scheduled for removal. The Contractor shall notify the Construction Manager 5 days prior to any salvage or demolition work to determine the disposition of items to be removed. The Construction Manager will mark items to be salvaged. Such items shall be properly disconnected, removed from their foundations, cleaned, and delivered to a location of the owner's facilities as specified.

C. UTILITY INTERFERENCE

Where existing utilities interfere with the prosecution of the work, the Contractor shall relocate them in accordance with Article 4 of the General Conditions.

END OF SECTION

SECTION 31 20 00 – EARTHWORK AND DEWATERING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section includes materials, testing and other requirements of earthwork for excavation, trenching, backfilling, compaction and grading necessary for the construction of the work. The excavation shall include the removal and disposal of materials of whatever material encountered, including all dewatering, and contaminated soils and groundwater removal, treatment and disposal, that would interfere with the proper construction and completion of the work

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. The following is a list of standards which may be referenced in this section:
1. 29 CFR 1926, OSHA Safety and Health Standards for Construction.
 2. ASTM C 117, Test Method for Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing.
 3. ASTM C 136, Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 4. ASTM C 150, Portland Cement.
 5. ASTM C 618, Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
 6. ASTM D 75, Practice for Sampling Aggregates.
 7. ASTM D 422, Test Method for Particle-Size Analysis of Soils.
 8. ASTM D 1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 9. ASTM D 1557, Test Method for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft³).
 10. ASTM D 1633, Test Method for Compressive Strength of Molded Soil- Cement Cylinders.
 11. ASTM D 2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

12. ASTM D 2487, Classification of Soils for Engineering Purposes (Unified Soil Classification System).
13. ASTM D 2922, Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
14. ASTM D 4253, Test Method for Maximum Index Density of Soils Using a Vibration Table.
15. ASTM D 4254, Test Method for Maximum Index Density of Soils and Calculations of Relative Density.
16. ASTM D 4318, Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
17. ASTM D 4632, Test Methods for Grab Breaking Load and Elongation of Geotextiles.
18. ASTM D 4832, Test Method for Unconfined Compressive Strength.

1.3 CONTRACTOR SUBMITTALS

- A. Between 60 and 30 days before beginning trenching on each parcel or group of parcels, meet with each land owner, farmer, ditch operator, irrigator, storm drain owner, land drain owner, utility. Per paragraph 3.02 coordinate all water handling work for each parcel and submit bulleted summary of coordinated water handling work (by parcel) to Construction Manager at each weekly meeting. Submit copies of Construction dewatering and construction storm water permits and conditions obtained from UDEQ. Submit results of all water quality tests sent to UDEQ.
- B. Submittals shall be in accordance with the requirements of Section 01 33 00, SUBMITTALS.
- C. Submit a description and location of proposed sources of imported material.
- D. Submit samples of all materials proposed to be used in the Work to demonstrate material conformance with these Specifications. Sample sizes shall be as determined by the Construction Manager.
- E. Test for conformance and submit certification and test records of all materials showing that they meet the applicable requirements. Obtain favorable review of test and certification submittals prior to commencing placement of the

materials for the Work.

- F. Perform material testing per this section.
- G. Submit manufacturer catalog data, samples, and installation instructions for filter fabric, earth reinforcing systems with their related materials.
- H. Submit property owner earthwork disposal site releases.
- I. Submit pipe locating tape manufacturer data.

1.4 PROCESSED (OR IMPORTED) EARTH MATERIALS

- A. Processed, or imported, earthen materials are subject to the following requirements:
 - 1. Make all tests and other work necessary to locate acceptable processed materials. Submit certification(s) that the material conforms to the requirements along with copies of test results from a qualified commercial testing laboratory and representative samples of materials. Samples shall be representative and clearly marked to show material source and intended use. Sample processed materials per ASTM D75 or ASTM C136, with appendixes and provide compaction characteristics of materials per ASTM D1557. Allowance of the processed material may be based on inspection of the source, processing method and/or certified test results. No processed materials shall be delivered to the site or used in the Work until the proposed source, processing methods, and materials tests have been allowed by the Construction Manager. Final allowance of materials will be based on tests made on samples of material taken from the installed and compacted material(s).
 - 2. Make periodic tests on samples taken at the place of production prior to delivery to the site. Make tests at the rate of one test per day, one test per thirty trucks of material, or as requested by the Construction Manager, whichever is more. If tests show out of conformance materials, the Construction Manager may require increased frequency of tests. In addition, sample and test the finished in-place product. The Construction Manager may select the location of the samples and tests to be performed by the Contractor.
 - 3. Submit gradation test results within 24 hours after

sampling. Deliver other test results upon completion of the tests.

4. If tests conducted by the Contractor or the Construction Manager indicate that the material does not meet the requirements, the material placement shall be terminated until the requirements are met. Material that does not conform to the requirements and is placed in the Work shall be removed and replaced at no additional cost to the Owner. Sampling and testing performed by the Contractor shall be done at the Contractor's expense.

1.5 MATERIALS TESTING

- A. The Contractor shall perform and be responsible for all sampling and testing of materials as required for quality assurance/control of the Work. The Contractor shall pay for all costs associated with the day-to-day quality assurance/control to maintain all material within specified or approved limits. The Contractor shall retain a registered geotechnical engineer, independent from the Contractor, and a testing laboratory, whose qualifications are each acceptable to the Construction Manager by submittal, to perform all compliance testing described below. The Construction Manager may have an independent testing laboratory perform additional tests at no cost to the

Contractor, however the Contractor shall provide materials for testing at no additional cost to the Owner.

- B. Perform particle size analysis of soils and aggregates in accordance with ASTM C 136 Sieve Analysis of Fine and Coarse Aggregate and ASTM C 117 Materials Finer than No. 200 Sieve in Mineral Aggregate by Washing.
- C. Determine sand equivalent in accordance with ASTM D 2419. Unified Soil Classification System: References to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of ASTM D 2487 in the interpretation of soil classifications.
- D. Where soil material is required to be compacted to a percentage of maximum dry density, the maximum dry density at optimum moisture content will be determined in accordance with ASTM D 1557. In the field, determine the density of soil in place by the sand cone method, ASTM D 1556 or by nuclear methods, ASTM D 6938 and D 3017.
- E. Apply rock correction factors as applicable. In case the test of

the fill or backfill shows non-compliance with the required density, perform remedies as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Construction Manager and paid for by the Contractor.

- F. Compaction tests shall be performed for each lift or layer. If nuclear methods are used for in-place density determination, verify the accuracy with one sand cone test, and one maximum laboratory dry density test, for every 2 weeks nuclear tests are used if the backfill material is processed fill or visually consistent. The Construction Manager shall be the sole judge of visual consistency. More sand cone and dry density tests will be required if the backfill material is visually variable. The minimum depth for the sand cone test hole shall be 12 inches. The minimum size shall be 8 inches and size 16/30 or 10/20 silica sand shall be used.
- G. Determine laboratory moisture-density relations of soils by ASTM D 1557. If nuclear methods are used for in-place density determination, the compaction test results for maximum dry density and optimum water content shall be adjusted in accordance with ASTM D 4718. This will be required for determination of percent relative compaction and moisture variation from optimum.
- H. Determine the relative density of cohesion-less soils by ASTM D 4253 and D 4254. Sample backfill materials by ASTM D 75. "Relative Compaction" is the ratio, expressed as a percentage, of the in-place dry density to the laboratory maximum dry density.
- I. After an acceptable compaction procedure is established, compaction tests shall be taken at 300 foot intervals along the trench and at vertical intervals at random locations and not necessarily vertical in line. A minimum of two tests will be required for each production day in the trench. Tests shall also be taken near structures, manholes, etc., and where designated by the Construction Manager. Embankment and fill areas shall have at least one compaction test performed each production day and no fewer than one test for each 1,000 cubic yards. Copies of all test reports shall be submitted to the Construction Manager by the next working day.
- J. Location for compaction tests shall be prepared and submitted to the Construction Manager for approval prior to testing.

- K. Compaction and other tests may be taken by the Construction Manager at intervals along the trench as described above to verify compliance with these requirements. Accommodate the Construction Manager in conducting these tests. Provide access and exploratory excavation as required to collect samples or conduct tests. Allot sufficient time during construction for the performance of any such compaction testing.
- L. Compaction shall be deemed to comply with the specifications when no compaction test falls below the specified relative compaction. Pay the costs of any retesting of work not conforming to the specifications. Should the compaction methods used fail to achieve the required degree of compaction, revise compaction method to achieve the required compaction.
- M. If a compaction fails to meet the specified requirements, remove and replace the backfill at proper density or bring the density up to specified level by other means acceptable to the Construction Manager. Pay for all subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density. Frequency of confirmation tests for remedial work shall be double that amount specified for initial confirmation tests.

1.6 DEFINITIONS

- A. Pipe Zone: The pipe zone shall include the full width of trench from the bottom of the pipe bedding to a horizontal level above the top of the pipe, as specified below. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipe bedding to a horizontal level above the top of the highest or topmost pipe. Thickness of pipe zone above the highest top of pipe or conduit shall be 12 inches unless otherwise shown in the Drawings or otherwise described in the specifications for the particular type of pipe installed.
- B. Pipe Base or Bedding: The pipe bedding zone is defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width on which the pipe is bedded. Thickness of pipe bedding zone shall be 6 inches minimum unless otherwise shown in the contract documents for the particular type of pipe installed.
- C. Road Zone: The 12 inches of material immediately below the subgrade of existing and planned road pavements, shoulders, curbs and sidewalks.
- D. Segregation: Nesting of larger particles in a soil mass such

that finer particles do not completely fill the voids. Segregation also refers to lenses or layers of finer material that are not locally intermixed with coarser particles in accordance with the specified gradation.

- E. Suitable Material: Suitable material is defined as selected or processed earth material free of expansive and deleterious material which conforms to these Specifications. Materials used shall meet the gradations and quality requirements of these Specifications.
- F. Trench Zone: The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the road zone at gravel or asphalt surfaced roads or to the finished ground surface in areas without roads.
- G. Unsuitable Materials: Unsuitable Materials include but are not limited to:
 - 1. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use. See paragraph 2.06.C.
 - 2. Soils which, when classified under ASTM D 2487, fall into the classifications of Pt, OH, CH, MH or OL.
 - 3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.
 - 4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing on-site soils.
 - 5. Topsoil, except as allowed below.
- H. Well Graded: A earth material with a wide range of grain sizes so that the uniformity coefficient "Cu" is over 6.0. "Cu" is the ratio (D_{60} / D_{10}) = (the particle diameter at which 60% of the mass is finer than / the particle diameter at which 10% of the mass is finer than) with enough fines to bind the material together so that, when compacted, it produces a strong and relatively incompressible soil mass free of detrimental voids.
- I. Dewatering: the pumping and/or draining, treatment and removal from construction site both groundwater and

surface water (i.e. unwatering) to keep the construction work free from the deleterious effects of water in a manner that complies with all laws and regulations and does not damage adjacent lands and property. It includes water handling and conveying through the project site any water which comes into the site through rivers, creeks, sloughs, land drains, ditches (including irrigation ditches), springs, precipitation, groundwater, wells, and other means.

1.7 USE OF FILL AND BACKFILL TYPES

- A. Fill and backfill types shall be used in accordance with the following provisions, unless otherwise shown on the Drawings:
1. Roadway or Fill Embankments: Use earth fill material.
 2. Trench Backfill: Varies: see paragraph 2.07.
 3. Pipe Zone: Use pipe zone material.
 4. Pipe Base or Bedding: Use pipe zone material.
 5. Gravel Road Surfaces: Use UBC (road base) material per Section 32 11 23.
 6. Gravel Road Base for AC Paved Roads: Use UBC (road base) material per Section 32 11 23.
 7. Backfill Around Structures: Use structural backfill material.
 8. Backfill beneath Structures: Use structural backfill under structures, unless noted otherwise.
 9. Fill Over Structure Roofs: Use structural backfill over structure roofs.
 10. For 20-feet outside vault walls, CLSM fill under pipelines the space above the excavated subgrade and the bottom of pipe zone.

PART 2 - MATERIALS

2.1 EARTH FILL/EARTH BACKFILL

- A. Earth fill and earth backfill shall be excavated material that is free from organic matter, roots, debris, and rocks larger than 6-inches in the greatest dimension. Nested rocks larger than 3-inches are not allowed unless otherwise indicated on the plans and specifications. All fills shall be earth fills. Earth fill materials shall have an expansion index of not more than 40 when tested in

accordance with ASTM D 4829.

2.2 STRUCTURAL BACKFILL

- A. Structural backfill shall be free of clay balls and shall have a sand equivalent greater than 30 per ASTM D 2419 and have the following gradation:

<u>Sieve Size</u>	<u>Percent Passing By Weight</u>
3/4 inch	100
1/2 inch	95—100
3/8 inch	50—100
No. 4	20—65
No. 8	10—40
No. 40	0—20

No. 2000—5Material excavated onsite may be used for structural backfill provided it conforms to this specification.

2.3 GRANULAR BORROW FOR ROAD ZONE (OR STREET ZONE)

- A. The top 12-inches of the road subgrade (below untreated base course) is the road zone (or street zone). Granular borrow material shall conform to UDOT Standard Specification 02056.2.3. (it is Classification A-1-a, meets AASHTO 145, is non-plastic, and passes a 3 inch sieve).

2.4 UNTREATED BASE COURSE (UBC, ROAD BASE, OR AGGREGATE BASE COURSE)

- A. UBC, road base, or aggregate base course, shall be per Section 32 11 23.

2.5 PEA GRAVEL

- A. Pea gravel shall be the same material as Drain Rock, except the maximum particle size shall be ½ inch.

2.6 PIPE ZONE MATERIAL

- A. Pipelines 24-inches and smaller.
1. Use imported pipe zone material as follows: a processed, well-graded, compactible sand or gravel per AASHTO M145 A-1-a with 3/4-inch max particle size and between 5% and 15% fines (per ASTM C117) for

binder. Compact pipe zone to 90% relative compaction per ASTM D1557. A 3/4-inch UDOT road base gradation (per paragraph 2.04) is acceptable.

2. Alternately, use controlled low strength material (CSLM) per paragraph 2.12.

- B. 36- to 48-inch Sewer Pipelines. Use controlled low strength material (CSLM) per paragraph 2.12.

2.7 TRENCH ZONE MATERIAL

- A. Pipelines 24-inches and smaller: Use imported pipe zone material. A 3/4-inch UDOT road base gradation (per paragraph 2.04) is acceptable.

- B. 36- to 48-inch sewer pipelines:

1. Beneath paved and gravel roads and their shoulders, use a 3/4-inch UDOT road base gradation.
2. In other areas (except cutoff walls), use either imported pipe zone material (UDOT road base is acceptable); or, if it can be shown to consistently exceed 90 percent compaction, then native excavated.

trench material (not topsoil) may be used – provided it is free from organic matter, or other deleterious matter, and meets the requirements for earth fill as specified. To prevent fines migration in trench zone, native open graded sands and gravels may not be used in trench zone.

2.8 DRAIN ROCK

- A. Drain rock, or crushed rock, shall consist of hard, durable particles of stone, crushed to the required gradation shown below per AASHTO T-27 or ASTM C 136, and shall be free from organic matter, lumps of clay, and other deleterious matter:

<u>Sieve Size</u>	<u>Percent Passing By Weight</u>
1 inch	100
3/4 inch	90—100
1/2 inch	30—60

3/8 inch	0—20
No. 4	0—5

2.9 SAND

- A. Sand shall be granular material free from clay balls, organic matter, and other deleterious substances. Sand shall have a sand equivalent of 30 per

ASTM D 2419 and conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing By Weight</u>
3/8 inch	100
No. 4	75—100
No. 30	12—50
No. 100	5—20
No. 200	0—10

- B. Test sand to see that it is not salty or corrosive to steel as follows:

1. Electrical Resistivity shall be greater than 10,000 ohm-cm (per ASTM G-57, soil box method)
2. PH shall be greater than 7 (per ASTM G-52)
3. Chloride shall be less than 50 mg/kg of soil (EPA Test Method 325)
4. Sulfate shall be less than 100 mg/kg of soil (EPA Test Method 375)

2.10 TOPSOIL

Topsoil shall be per Section 31 11 00

2.11 WATER FOR COMPACTION

- A. Water shall be free of organic materials, a pH of 7.0 to 9.0, a max chloride concentration of 500 mg/L, and a max sulfate concentration of 500 mg/L. Provide all work needed to transport water for earthwork including piping, valves, pumps and trucks, to convey water to the point of use.

2.12 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. CLSM shall consist of a mixture of Portland cement, aggregate, fly ash, water, and admixtures conforming

to the following:

1. Portland Cement: ASTM C 150, Type II.
 2. Aggregate: Concrete sand, or processed material from the excavations meeting the requirements of sand as herein specified. Aggregate size shall be maximum 3/8 inch per ASTM C 33. The soluble sulfate content, shall not exceed 0.3 percent by dry weight.
 3. Water: Potable quality.
 4. Fly Ash: Class C per ASTM C 618.
 5. The minus 200 sieve fraction shall be non plastic.
- B. CLSM shall be flowable, non-segregating, self-consolidating and non-shrink.
- C. The unconfined compressive strength at 28 days shall be a minimum of 50 and a maximum of 150 psi per ASTM D 4832. For bidding, assume 100 pounds of cement and 100 pounds of fly ash per cubic yard of CLSM.
- D. Sample CLSM at least once a day, four cylinders each time. Perform two cylinder breaks per four-cylinder sample at 7 days, the same as for concrete. Do not move cylinders for 72 hours after making.
- E. The temperature of the CLSM discharged into the trench shall be below 70 degrees and above 45 degrees Fahrenheit. Do not place CLSM if ambient temperatures are below 10 degrees F.
- F. The aggregate, cement, and water shall be proportioned either by weight or volume. The water content shall be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while being placed. Prepare CLSM in accordance with ASTM C 94.
- G. Water content shall match trial batch content. Do not add water after batching.

2.13 ROCK REFILL (OR TRENCH STABILIZATION MATERIAL)

- A. Rock refill shall be crushed rock free from clay balls, organic material, and debris, and having the following gradation:

<u>Sieve Size</u>	<u>Percent Passing By Weight</u>
EARTHWORK AND DEWATERING	31 20 00 - 12

3 inches	100
1-1/2 inches	80—100
3/4 inch	5—30
No. 4	0—8
No. 200	0—2

2.14 GEOTEXTILES

- A. See Section 31 35 00, GEOTEXTILES.

2.15 LOCATING (MARKING) TAPE AND (TRACER) WIRE

- A. Locating (or Marking) Tape (over all pipelines).
Pipe locating tape, or marking tape, shall be non degradable blue polyethylene material, 6- to 12-inches wide, at least 8 mils thick, and labeled in 4- to 10-inch high bold permanent letters, "CAUTION WATER MAIN" or "CAUTION SEWER MAIN", by Reef Industries, Allen Makline, or equal. Inert polyethylene shall be impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
- B. Tracer Wire (over all pipelines). Center on pipe (atop pipe zone) HMWPE- coated #6 solid copper tracer wire. Tie each end to a CT Station and cathodically protect each wire, by a CT Station shunt, to an anode.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Earth Stockpile Limitation to Protect Pipelines from Differential Settlement. Protect installed pipelines after installation from differential settlement of ground as follows. After backfilling water, sewer or storm drain pipelines, do not ever allow over 3-feet of stockpile or fill to be placed above existing grade within 15-feet horizontally of the pipe.
- B. Prevent dust from damaging homes, businesses, public and private facilities, crops, cultivated fields, and other improvements, or causing a nuisance to persons. Perform dust control for the duration of the project.
- C. Legally dispose of all excavated materials unsuitable for backfill, and other unused excavated materials. Excavated materials suitable for backfill may temporarily be stored at the site so-as not to interfere with public traffic or concurrent work

or to mix with other stockpiled material.

- D. Provide adequate facilities for drainage of water from stockpiled excavated material and adequate facilities for handling of storm drainage from storage and other area.

3.2 SAMPLING, TREATMENT, AND DISPOSAL OF CONTAMINATED SOILS AND GROUNDWATER

- A. There is a historic landfill adjacent to 700 North. This landfill has the potential to affect the quality of the groundwater on the project site. Special containment, sampling, and testing is required for groundwater pumped from this project site.
- B. CONTRACTOR shall provide for containment of all dewatering groundwater using frac tanks. The number of tanks shall provide for:
 - 1. Adequate storage volume to provide for six (6) days as follows:
 - a. Typical construction: three (3) days
 - b. Weekends: two (2) days
 - c. One emergency day: one (1) day
- C. OWNER, through his consultant, will provide for all groundwater sampling and testing. OWNER will sample groundwater from CONTRACTOR provided frac tanks. OWNER will sample up to once each day.
- D. In addition to storage for groundwater sampling, CONTRACTOR shall provide for reduction of elevated Total Suspended Solids through best management practices before discharging the contained groundwater.
- E. CONTRACTOR shall store water in frac tanks until test results are received. If groundwater quality is within the discharge limits of the permit, CONTRACTOR may discharge groundwater stored in frac tanks into waterways adjacent to the project site.
- F. OWNER will provide test results within 36 hours of sampling, not including weekends and holidays.
- G. If test results exceed the permit limits OWNER shall notify the CONTRACTOR. The OWNER and the CONTRACTOR shall then prepare a plan to treat and/or dispose of the water in accordance with the permit.

3.3 DEWATERING

- A. Contractor bid shall include all costs to plan, coordinate, and perform all dewatering and handle all groundwater and all surface water for the duration of the project work, including, but not limited to:

30 days before beginning construction work on each parcel, or group of parcels, meet with each land owner, farmer, ditch operator, irrigator, storm drain owner, land drain owner, utility owner, and/or other persons affected by the work. Clarify and agree with each affected party how irrigation and drainage will be maintained during the construction. Address how to protect private and public properties from damage resulting from uncontrolled irrigation or dewatering flows and shall finalize agreements as to the locations and construction of channels downstream of the dewatering areas that will be used for discharge or dewatering flows to the Great Salt Lake.

1. Address farmer, irrigator and land owner descriptions of locations, depths, sizes, materials, and functions of all buried drains, pipes, power, communications, and other public and private utilities of which land owner, farmer and irrigator are aware. Specifically ask for this information from older farmers and irrigators who have worked the land for more than 20 years.
2. Address diverting, conveying and handling and timing of water inflows into the parcel (stream, slough, spring, irrigation ditch, irrigation runoff, storm runoff, surface and buried land drain, well, precipitation, etc)
3. Address keeping surface flows from entering excavations by diversions (dams, trenches, pipes, pumping etc), well points, freezing or grouting ground, or other methods acceptable to Construction Manager. Address dewatering excavations and construction site. Address treatment, handling and disposal of all water in compliance with laws and regulations, including contaminated groundwater and soils.
4. Address construction water treatment method(s) to be used (well points, ponds, socks, etc)
5. Address construction water discharge location(s) and the conveyance (drains, ditches or pipes) to the Great Salt Lake, and cleaning and maintenance of downstream conveyance ditches or pipes.

Address water handling including temporary relocation of

land drain ditches and irrigation ditches around the work site and providing piping to keep drainage flows and irrigation maintained through the construction work.

Report as a weekly agenda item, the coordinated water handling described in this specification, to the Construction Manager.

- B. Perform all required dewatering and water handling regardless of quantity or quality of water encountered. Include all costs for water handling and dewatering in the project bid regardless of the quantity or quality of the water.
- C. Provide and operate equipment adequate to keep excavations and trenches free of water. Dewater subgrade to below bottom of excavation. Keep trench dewatered until backfilling has been completed. Remove water during period when CLSM is being deposited, when pipe is being installed, and during the placing of backfill. Prevent settlement of pipe and all nearby pipes and structures.
- D. Dispose of water in a manner that will not damage adjacent property. When dewatering open excavations, dewater from outside the structural limits and from a point below the bottom of the excavation.
- E. Obtain and comply with applicable UPDES discharge permits when discharging into any waterway.
- F. Design, furnish, install, operate, monitor, maintain, and remove dewatering systems such that the dewatering system is sufficient to render and maintain required excavations in a dewatered and hydrostatically relieved condition (including at the bottom of the excavation), and allow required excavations and other construction operations to be performed in the dry.
- G. The dewatering system shall include all equipment, appurtenances, and earthwork required to perform the function. Contractor is responsible for the dewatering system performance. Provide adequate pumping, piping and other equipment to accomplish dewatering. Such equipment shall include, but may not be limited to sumps, wells, motor and/or engine driven pumps with adequate lift capacity, discharge piping, hoses and pipelines, valves, intakes, and flow measuring devices.
- H. Construct trenches with DIP fittings to prevent surface runoff from running into trenches and leaving salt deposits in trenches. Prevent excessive storm runoff and irrigation runoff from entering excavations and from damaging the work. Remove seepage water and precipitation water from

excavations. In addition to dewatering of the trench excavation and adjacent areas, perform other dewatering as necessary to maintain the construction operations free of water and permit construction unhampered by the presence of water that may interfere with construction, damage in-place work or excavated surfaces, or cause other adverse effects.

- I. Locate, construct and maintain ditches and/or sumps to collect and control seepage and runoff into excavations. Locate, construct and maintain ditches to prevent ponded water from seeping into, and adversely affecting, adjacent lands and facilities.
- J. If Owner-provided lands are to be used for de-silting settling ponds, liners may be needed if native soils are porous and/or result in excessive infiltration into adjacent construction trenches.
- K. Damage to the work, including work in place and excavations, including bottom heave, and floating of pipeline, resulting from negligence, inadequate performance, or mechanical or electrical failure of dewatering system components shall be repaired or replaced, including removal and replacement of material and pumping out excavations, by and at the expense of the Contractor, subject to approval by Construction Manager.
- L. Restore areas used for dewatering ditches and ponds, to their pre- construction condition (after the work is complete).
- M. The dewatering systems shall be designed consistent with sound engineering principles and practices, in accordance with best modern practice, and in accordance with the following:
 - 1. Experience: The dewatering systems shall be designed by a registered professional engineer or hydrogeologist with a minimum of five years of responsible experience in the design, installation, and operation of dewatering systems of complexity comparable to that required for this contract. All designs drawings, calculations, data, and other documents shall bear the designer's seal.
- N. Submittal of the dewatering systems is required. The dewatering systems shall be designed consistent with sound engineering principles and practices, in accordance with best modern practice, and in accordance with the following:

1. Experience: The dewatering systems shall be designed by a registered professional engineer or hydrogeologist with a minimum of five years of responsible experience in the design, installation, and operation of dewatering systems of complexity comparable to that required for this contract. All designs drawings, calculations, data, and other documents shall bear the designer's seal.
2. Data: Logs of borings and other soil and water-level data are addressed in the geotechnical report. It shall be the Contractor's responsibility to gather any additional data necessary to properly design the dewatering systems, and the work shall be performed at the Contractor's expense.
3. Dewatering:
 - a. Portable electric generators utilized shall have 100 percent standby electric-generating equipment.

The electrical system and controls shall be designed so that failure of any one pump, or the need to disconnect a pump, does not adversely affect operation of any other pump.

- b. Petroleum-fueled (diesel, liquid petroleum gas, gasoline) driven units utilized shall have 100% standby equipment.
 4. Facilities for dewatering shall include discharge lines, flow-measuring devices, settling ponds, treatment facilities, and supplemental pumping capacity to provide the necessary lifts to discharge water as needed.
- O. Installation and operation of the dewatering system shall be under the direct supervision of qualified personnel with a minimum of five years of responsible experience in the installation and operation of dewatering systems of complexity comparable to that required for this contract. The dewatering representative shall be responsible for ensuring that all materials, equipment, methods, and procedures utilized in the installation, operation, and maintenance of dewatering system conform to the requirements of:
 1. The UDWQ approved dewatering plan, and

- 2. All State and local statutes; conducting all required testing, inspection, and monitoring of the dewatering system.
- P. System maintenance shall include, as a minimum, 24-hour supervision by personnel skilled in the operation, maintenance, and repair and replacement of system components, and sufficient standby and spare equipment and features to effectively prevent interruption in dewatering operations.
- Q. Desilting ponds and dewatering operations shall not interrupt the ability of the land owner to irrigate or drain their land of irrigation, precipitation, and artesian groundwater / spring water.
- R. De-silting pond inverts shall not be more than about 18 inches below original ground. Stockpile topsoil removed for de-silting pond construction and restore it to pre-construction depth and location when ponds are removed. Provide adequate freeboard for all de-silting ponds. Maintain de-silting ponds by removing sediment when pond is 30 percent full of sediment.
- S. Incorporate erosion control SOPs into trench dewatering and de-silting facilities to avoid or minimize adverse ground and surface water quality impacts.
- T. Maintain ditches downstream of de-silting ponds free of debris and sediment to prevent flooding or other adverse impacts downstream.

3.4 SUPPORT OF EXCAVATIONS

- A. See Section 31 20 01, UTILITY TRENCHES.

3.5 EXCAVATION

- A. Excavation is unclassified.
- B. Perform all excavation (including dewatering and rock removal) – as part of the work in the Bid Schedule - regardless of the type, nature, or condition of the material encountered to accomplish the Work.
- C. Where trenching or excavation occurs in paved areas, saw cut the pavement, regardless of the thickness, and curbs, gutters, and sidewalks prior to excavation of the trenches with a pavement saw or pavement cutter. Remove and dispose of pavement and concrete materials off the site in accordance with local regulations. Do not use for backfill.

- D. Perform excavation for structures and pipelines to comply with the dimensions, clearances and grades indicated for the structures and pipelines. Excavate to such width outside the lines of the structure to be constructed as may be required for proper and safe working methods, the erection of forms, and the protection of the work.
- E. At excavation subgrades for structures compact the top 12 inches of subgrade to 95 percent relative compaction. Fill holes and depressions to the required line, grade, and cross sections with structural backfill or other material approved by the Construction Manager.
- F. The finished subgrade for structures shall be within a tolerance of plus or minus 0.10 of a foot of the grade and cross section indicated, shall be smooth and free from irregularities, and shall be at the specified relative compaction. The subgrade shall be considered to extend over the full width and extend 1 foot beyond the edge of the structure foundation or the fill.
- G. Notify the Construction Manager when excavations for structures are complete. Do not place forms, reinforcing steel, concrete, or precast structure until the excavated area has been inspected by the Construction Manager.
- H. Excavation shoring systems shall be designed consistent with sound engineering principles and practices, in accordance with best modern practice, and in accordance with the following:
 - Experience: The shoring systems shall be designed by a registered professional engineer with a minimum of five years of responsible experience in the design, installation, and operation of shoring systems of complexity comparable to that required for this contract. All designs drawings, calculations, data, and other documents shall bear the designer's seal.
 - Submittal of the shoring systems shall is required.
- I.

3.6 TRENCH EXCAVATION

- A. Remove and stockpile native topsoils separately per Section 31 11 00.

- B. Construct the trench to the grades and shapes as indicated on the plans. Accurately grade the bottom of the trenches to provide uniform bedding areas for each section of pipe except for portions of pipe sections where bell holes are required to weld joints. Excavate bell holes and depressions to the depth and width required to properly complete and inspect the joint. Remove stones and hard objects protruding above grade as necessary to avoid point bearing.
- C. Locate trench stockpiled material at least 15 feet away from the tops of open trench excavation slopes.
- D. Place excavated material within the construction limits or within another location acceptable to Construction Manager. Do not obstruct any roadways or streets. Conform to federal, state, and local codes governing the safe loading of trenches with excavated material and equipment.
- E. After setting pipe to grade, do not jerk or move shoring in such a way as to cause pipe to be out of grade. After pipe is backfilled, such that pipe will not move, shoring may be moved.
- F. Provide room (typically 18-inches min) between pipe and trench invert/walls/ shoring - to allow for manned entry for welding, joint coating, and inspection.
- G. Pipe zone and compacted trench zone materials shall extend to edge of excavated trench, not to inside face of shoring. Fill gaps left when shoring is removed. If trench is excavated beyond that required, refill over excavated trench at no additional cost to the Owner with the pipe zone and trench zone materials required in specs.

3.7 LENGTH OF OPEN TRENCH

- A. Limit open trench length to 600 feet or the amount of pipe installed in 1 day, whichever is less.
- B. During nonworking hours, cover trenches or fence-enclose them.
- C. Native slope and trench wall collapses into an open excavation during construction are the complete responsibility of the Contractor. This includes any clean-up work, re-excavation, re-backfill and compaction or related work to complete the pipeline as it is required in the plans and specifications. See Section 02260, Excavation, Support, and Protection

3.8 OVEREXCAVATION

- A. Trench foundation stabilization (trench bottom stabilization) material is allowed beneath pipe zone of all pipelines that are more than 0.5 miles away from the North Temple Landfill property. Wrap trench bottom stabilization material in geotextile to prevent fines migration into the open graded rock. Over-excavation is always allowed as required to construct trench dams.
- B. No additional payments will be made for over excavation and placement of structural backfill, rock refill, or other suitable material not required by the contract or directed by the Construction Manager. No compensation will be made for over excavation and placement of such material for the Contractor's convenience

3.9 CLSM TRENCH CUTOFF WALLS (TRENCH PLUGS)

- A. Provide CLSM trench cutoffs (i.e. trench plugs) to seal the bottom and sides of the trench against water movement along the trench. CLSM shall be installed across the full width of the over excavation, pipe zone and trench zone. The CLSM material shall be installed from the bottom of the trench and at a minimum of 12-inches below the bottom of the pipeline up to 2-feet below finished grade. Over-excavation may be required at the location of the cut-off walls.
- B. Install CLSM trench plugs and shown on the plans and at the following locations:
 - 1. At stations shown on drawings, and
 - 2. At property lines, so groundwater won't cross property lines in trenches
 - 3. At both sides of road intersections.
 - 4. At least every 300 feet. Construction Manager shall approve these locations for trench plugs if they are not shown on plans.

3.10 COLD WEATHER LIMITATIONS IN PLACING FILL AND BACKFILL

- A. Unless allowed in the authorized Cold Weather Construction Plan, earth fills and backfills requiring 95 percent or higher relative compaction shall not be placed when either atmospheric temperature, or the temperature of the existing ground or the fill being placed, are below 35 degrees Fahrenheit unless both the existing ground and the

fill being placed are both non-frost susceptible materials.

- B. Earth fills and backfills requiring 90 percent or lower relative compaction may be placed when temperatures are below 35 degrees Fahrenheit if the required compaction is achieved. If the required compaction is not achieved, the work shall be removed and re-compacted.
- C. Do not place any fill or backfill materials which require 95 percent, or higher, relative compaction if the excavation or subgrade contains frozen moisture (snow, ice, sleet, etc.), frozen earthen materials, or earthen materials which have been deposited in the excavation due to freezing, thawing, precipitation, or other inappropriate means.
- D. Do not place fill materials which contain frozen moisture (snow, ice, sleet, etc.) except as allowed in the paragraphs above.
- E. Work performed outside the required temperature limitations is subject to rejection, removal and replacement.

3.11 PLACING AND COMPACTING FILL

- A. Remove form materials and trash from excavation before placing fill material. Remove un-compacted fill, loose and disturbed soils until firm soils or formational material are exposed. Removed materials may be used as compacted fill if they meet specifications.
- B. Under earth fills, scarify the exposed surface to a depth of 6 inches, moisture condition to within 2 percent of optimum moisture content, and compact to at least 95 percent relative compaction.
- C. Obtain Construction Manager inspection and authorization to begin backfill on the exposed surface before starting placement of fill.
- D. Add water to the backfill material or dry the material, as necessary, to obtain a moisture content within 2 percent of optimum. Obtain a uniform moisture content throughout the material of each layer being compacted.
- E. If the backfill material is saturated from groundwater, rains or any other source, remove and replace the unsatisfactory material with suitable material compacted to the specified density. No additional payment will be made for removal and replacement of unsatisfactory material.

- F. Where earth fills are to be constructed on slopes steeper than 5:1, excavate an equipment width keyway beneath the toe at the base of the fill. The keyway will have a minimum width of 10 feet and slope at least 2 percent into the slope. Continue benching into competent material as the fill progresses up slope. All benching shall be inspected and authorized by the Construction Manager before fill placement begins.
- G. Place all fills in 6- to 8-inch lifts, brought to within 2 percent of optimum moisture content, and compacted to 90 percent min relative compaction. Do not place rocks larger than 6 inches in maximum dimension in the fills.
- H. Provide special attention to compaction along the top and outer edge of the earth fill slopes during construction. Back roll fill slopes after each fill lift is completed. Perform additional rolling and trimming as may be required at the finish of the slope construction to correct local surficial slumping.

3.12 PLACING AND COMPACTING STRUCTURAL BACKFILL

- A. Place structural backfill material around structures, channels, vaults, manholes, and other structures to the lines and grades shown or specified. Limit loose lift depths to 8 inches or less, or, if hand compaction equipment is used, limit loose lift depths to 6-inches or less.
- B. Compact each lift as hereinafter specified. Stop structural backfill at least 6 inches below finished grade in areas where topsoil is to be replaced.
- C. Do not operate earthmoving equipment within 5 feet of any concrete structure. Structural backfill shall not be placed until the concrete has developed to at least 75 percent of the minimum 28-day compressive strength, and in all cases not less than 24 hours after the last pour.
- D. Place and compact fill or backfill adjacent to concrete structures using hand- operated tampers, roller wheels, or other equipment that shall not damage structure.

3.13 BACKFILL OF TRENCHES (AND FILLS) AND COMPACTION

- A. Unless otherwise shown in the plans or specifications, relative compaction in shall conform to ASTM D 1557 (modified proctor) and shall be as follows:

Location or Use of Fill	Relative Compaction (Unless
Trench Zone not under structures, pavement or roads	90 percent (but do not compact for 6" below
Trench Zone if pipes are under paved (AC or conc) or gravel roads and within 10-feet horizontally of paved or gravel roads (i.e. existing and future road shoulders), under future roads and future fills, sidewalks, curbs, beside structures and below slopes	95 percent or 80 percent relative density
CLSM Pipe Zone - sewer or water pipes	50 psi to 150 psi
Granular Pipe Zone (AASHTO M145 A-1-a) alternate pipe zone for water	95 percent or 80 percent relative
Trench Bottom Stabilization	85 percent, or 75 percent relative
Drain Rock under concrete structures	95 percent or 80 percent relative
Backfill and fill around structures	95 percent
Topsoils	Uncompacted
Aggregate base (road base) & aggregate surfacing for access	97 percent
Road Zone	95 percent

- B. Place bedding and backfill materials to the lines, grades, and cross sections indicated on the Plans. Place bedding and backfill materials in horizontal, uncompacted lifts not exceeding 8 inches in thickness. The difference in level on either side of a pipe shall not exceed 12 inches.
- C. Protect the pipe from damage during construction. Replace or repair broken or damaged pipe or pipe coatings. For tamping of backfill over the pipe, use tampers, vibratory rollers, and other equipment that shall not injure or disturb the pipe. Carefully place backfill around and over the pipe and do not allow it to fall directly upon the pipe to prevent coating damage. Place backfill material carefully and evenly onto the backfill previously placed in the pipe zone to prevent lateral movement of the pipe. Do not permit free fall of the material until at least 2 feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe.

Backfilling of the trench above the pipe zone shall not proceed until the required strength of CLSM in pipe zone has been tested, verified, and accepted by the Construction Manager. Do not allow construction traffic over the pipe trench until the trench backfill has been compacted to a depth of over 3 feet above the top of pipe.

3.14 CLSM PLACEMENT AND SLIDE RAIL SHORING REMOVAL

- A. After surveying and setting pipe to grade, and before welding joints, do not pull up lower slide rail panels - as this causes rock refill material (under pipe zone) to flow under panels and the pipe drops and becomes out of grade.
- B. Complete pipe joint field welding and joint coating.
- C. Place a CLSM "stiff mix" saddle over (to top of pipe zone) and around pipe at intervals that leave bottom of pipe zone with no CLSM between "stiff mix" saddles. Obtain initial set of "stiff mix" saddles. This helps lock WSP into surveyed grade before placing the rest of the CLSM.
- D. Place "fluid mix" CLSM in lower part of pipe zone in a way that prevents the pipe from floating. While it is fluid, pull up lower slide rail panels to just below top of the CLSM just placed. Obtain initial set of initial "fluid mix" CLSM.
- E. Place additional CLSM "fluid mix" layers in a way that prevent the pipe from floating. While it is fluid, pull up lower slide rail panels to just below top of CLSM just placed. Obtain initial set of each CLSM layer before placing the next layer.
- F. When CLSM placement is complete to top of pipe zone, place and compact trench zone material while raising upper slide rail panels so that voids left below removed slide rail panels are filled with material compacted to trench zone requirements.
- G. As upper slide rail panels are removed, remove disturbed native earth materials (used as backfill outside slide rail shoring) at the upper sides of trench and replace them with trench zone material compacted to trench zone compaction requirements.

3.15 OTHER CLSM PLACEMENT REQUIREMENTS

- A. Do not place CLSM when ambient daytime air temperatures

in trench exceed 95 degrees Fahrenheit. If daytime ambient air temperatures in trench exceed 95 degrees Fahrenheit, Contractor shall submit a written plan to the Construction Manager that identifies how Contractor will address temperature control issues when placing the CLSM.

- B. Deliver the CLSM to the trench in ready mix trucks and use pumps or chutes to place the CLSM in the trench. Do not add water after batching. Submit strength break data for both the CLSM "stiff mix" and the CLSM "fluid mix".
- C. Maintain stability of pipe and conduit throughout CLSM placement and curing. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and the pipe placed back on line and grade. Any damage to the pipeline system caused by movement of the pipe shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to Owner. Remove all sloughed material or other debris from top of previously placed CLSM.
- D. Prior to placing pipe zone or trench zone material above CLSM the CLSM shall be allowed to cure a minimum of 24 hours and achieve enough strength such that when walking on CLSM produces no indentations. A shorter cure period will be allowed if it can be demonstrated to the Construction Manager that it will perform its functions (to prevent pipe flotation and/or support pipe and trench zone material).

3.16 COLD WEATHER CLSM PLACEMENT AND CURING

- A. Comply with cold weather placement of CLSM submittals. CLSM placed or cured outside the temperature limitations identified herein is subject to rejection, removal and replacement.
- B. If freezing temperatures are imminent, maintain CLSM at a temperature above 40°F for seven (7) days after placement. CLSM mix and native trench soils (to 12-inches below trench face, floor and walls) must all be 40°F or greater at time of placement. Determine temperature by placing thermometer in CLSM or native soils immediately after sampling CLSM at placement site.
- C. When freezing weather appears imminent, make ready at the placement site insulation and other materials for CLSM protection which have been identified in the cold weather placement of CLSM submittal accepted by Construction Manager. Delay

placement of CLSM until adequate provisions for protection against weather are made. Do not place CLSM bedding when the trench bottom or walls are frozen or contain frozen material.

- D. CLSM Curing: If during CLSM curing, temperatures are below 40 degrees, protect CLSM by insulation as allowed in the cold weather placement of CLSM submittal. Do not place CLSM if ambient temperatures are below 10 degrees F. If CLSM is kept above 40 degrees F until at least 18-inches fill or backfill is placed over the curing CLSM, no further cold weather protection

is required if ambient temperatures are over 10 degrees F and no ambient forced air is circulating through pipe. The native earth temperatures typically keep both the buried pipe and the CLSM above 40 degrees F.

3.17 PLACING LOCATING (MARKING) TAPE AND (TRACER) WIRE

- A. Install marking tape over all pipelines, conduits and ducts. Install at locations shown on the plans. Unless otherwise shown, locate marking tape at the top

of pipe zone and centered over the pipe. Install both marking tape and tracer wire continuously over the top (centerline) of all buried pipes unless required otherwise. Securely attach tracer wire to top of the pipe to prevent movement during backfill. Submit tracer wire splice method.

- B. At each half mile at cathodic test stations, bring tracer wire to the ground surface and attach each end of the wire to an un-used terminal on the test station board. If tracer wire test points are required more often provide them on both water and sewer pipelines.

3.18 SITE GRADING

- A. Perform earthwork to the lines and grades shown on the Plans. Shape, trim, and finish slopes to conform with the lines, grades, and cross sections as shown. Remove exposed roots and loose rocks exceeding 3 inches in diameter. Round tops of banks to smooth curves to not less than a 6-foot radius. Neatly and smoothly trim rounded surfaces. Over excavation and backfilling to achieve the proper grade shall not be permitted.
- B. Shape, trim, and finish slopes around structures as shown on Plans. Maintain a 2 percent grade away from all structures for a minimum of 2 feet all around.

- C. Provide positive drainage away from all structures.
- D. Except where new finished grades are specifically shown, grade the right-of-way to the contours of the original ground and match the adjacent undisturbed ground. Make surfaces free of all cleared vegetation, rubbish, and other construction wastes. Dispose of all excess excavation, surface rocks, and spoil.

3.19 DISPOSAL OF EXCESS MATERIALS

- A. Immediately dispose of unsuitable excavated material. Excess material may be disposed of within a 15 feet wide swath on the north side future 700 North Street up to a thickness of 18-inches. The length from the pump West site west to 7200 West, which is approximately 1,600 feet is available to this contract. East of the pump station site is not available to this contract. Obtain written permission and/or permit(s) from the property owner(s) where excess or unsuitable material will be disposed.
- B. Obtain a release from individual property owner(s) absolving the Owner from any and all responsibility in connection with any offsite disposal of excess material. Provide Construction Manager with two copies of each release and permit.
- C. Haul excavated materials from the work site to approved disposal location(s) during the hours permitted in accordance with local traffic control regulations. Provide traffic control as required by the agency having jurisdiction. Material may be stockpiled temporarily at locations on the work site if approved in writing by Construction Manager.

3.20 TOPSOIL REPLACEMENT

- A. Replace topsoil after completion of backfilling, compaction, and site grading. With the exception of at permanent access roads, structures and rip rap, replace topsoil in the same areas and to the same depths from where the topsoil was originally removed except where imported topsoil is required by the Construction Manager per Sections 31 11 00. Replace topsoils after construction.

END OF SECTION

SECTION 31 20 01 – UTILITY TRENCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Earthwork shall include all structural excavation and trench excavation activities as required to complete the Work under wet and dry conditions in whatever material or class of material is encountered, including all of the following:
1. Contacting and notifying underground utilities, no less than 48-hours before excavating.
 2. Compliance with State and Federal safety regulations.
 3. Designing, furnishing, placing, and removing all sheeting, shoring and bracing needed to safely support sides of utility trenches.
 4. Compliance with applicable agencies' permit conditions for work in public or railroad right-of-way, and for work on private property.
 5. Loosening, excavating, removing, loading, and transporting excess soil from excavations.
 6. Stockpiling, exporting and importing material.
 7. Pumping, ditching, draining, and other required measures to remove or exclude water.
 8. Supporting and protecting structures above and below ground.
 9. Maintaining trees which are not permitted to be removed.
 10. Preparing and stabilizing subgrade for pipe and structures.
 11. Backfilling around structures and all backfilling of trenches.
 12. Compaction testing.
 13. Legal disposal of cleared, grubbed and excess excavated materials.
 14. Restoring fences and other disturbed property.
 15. All other incidental earthwork and supplementary operations needed to complete the Work.
- B. Except as modified herein, earthwork shall conform to Standard Specifications for Public Works Construction (Greenbook) Section 300.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. ASTM C143 Slump of Hydraulic Cement Concrete

- B. ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
- C. ASTM D1556 Density and Unit Weight of Soil in Place by the SandCone Method
- D. ASTM D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort
- E. ASTM D2922 Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
- F. ASTM D4253 Maximum Index Density and Unit Weight of Soils Using Vibratory Table
- G. ASTM D4254 Maximum Index Density and Unit Weight of Soils and Calculation of Relative Density

1.4 DEFINITIONS

- A. Pipe Zone: The pipe zone shall include the full width of trench from the bottom of the pipe bedding to a horizontal level above the top of the pipe, as specified below. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipe bedding to a horizontal level above the top of the highest or topmost pipe. Thickness of pipe zone above the highest top of pipe or conduit shall be 12 inches unless otherwise shown in the Drawings or otherwise described in the specifications for the particular type of pipe installed.
- B. Pipe Base or Bedding: The pipe bedding zone is defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width on which the pipe is bedded. Thickness of pipe bedding zone shall be 6 inches minimum unless otherwise shown in the contract documents for the particular type of pipe installed.
- C. Road Zone: The 12 inches of material immediately below the subgrade of existing and planned road pavements, shoulders, curbs and sidewalks.
- D. Trench Zone: The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the road zone at gravel or asphalt surfaced roads or to the finished ground surface in areas without roads.
- E. Unsuitable Materials: Unsuitable Materials include but are not limited to:
 - 1. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use. See paragraph 2.06.C.
 - 2. Soils which, when classified under ASTM D 2487, fall into the classifications of Pt, OH, CH, MH or OL.

3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.
 4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing on-site soils.
 5. Topsoil, except as allowed below.
- F. Dewatering: the pumping and/or draining, treatment and removal from construction site both groundwater and surface water (i.e. unwatering) to keep the construction work free from the deleterious effects of water in a manner that complies with all laws and regulations and does not damage adjacent lands and property. It includes water handling and conveying through the project site any water which comes into the site through rivers, creeks, sloughs, land drains, ditches (including irrigation ditches), springs, precipitation, groundwater, wells, and other means.

1.5 SUBMITTALS

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION
Catalog Data	Required for soil sterilants per catalog data requirements.
Certificate of Compliance	Submit affidavit of compliance with OSHA requirements prior to beginning excavation on any trench or excavation. Affidavit shall certify compliance with all shoring, bracing, sloping or other protective system provisions required by OSHA for worker protection from the hazard of caving ground during excavation.

1.6 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary trades and crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this section.

1.7 USE OF FILL AND BACKFILL TYPES

- A. Fill and backfill types shall be used in accordance with the following provisions, unless otherwise shown on the Drawings:
1. Trench Backfill: Varies: see paragraph 2.1.C.
 2. Pipe Zone: Use pipe zone material.
 3. Pipe Base or Bedding: Use pipe zone material.
 4. Backfill around Structures: Use structural backfill material.
 5. Backfill beneath Structures: Use structural backfill under structures, unless noted otherwise.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Refer to Section 31 20 00 for basic requirements for products and materials.
- B. Soil and backfill materials shall be prepared to the following specifications:

ITEM	MATERIAL	SPECIFICATION
Granular soil	Sand or gravel	Minimum sand equivalence of 30 Not more than 20% of the material shall pass through a 200-mesh sieve.
Imported sand	Sand	Minimum sand equivalence of 30
Suitable soil material	Imported or excavated material meeting specification	Material free from shale, sod, stones, concrete and clods over (2 inches / 4 inches) in diameter, roots, trash, lumber, organic material, ashes and other debris considered unsuitable by the Owner. Material shall have no unusual color or sulfide odor. Compact to specified densities.
Backfill for over-excavation beneath pipes	Concrete slurry	1-sack cement-sand slurry mix Maximum 6-inch slump per ASTM C143
	Suitable soil material	ASTM D1557 90% compaction
Backfill for over-excavation beneath structures	Concrete	Section 31 23 33 Class A
Backfill for over-excavation beneath general excavation	Suitable soil material	ASTM D1557 or 90% compaction
Loose ground remaining after stripping	Suitable soil material	ASTM D1557 or 90% compaction
Structural excavation and fill	Suitable soil material	ASTM D1557 or 90% compaction Place in 8-inch maximum lifts Remove stones larger than 6 inches in diameter.
Pipe Zone and Pipe Bedding material	See Below	
Trench zone material	See Below	
Surface zone material (upper 12 inches of trench to finish surface in unimproved or landscaped areas)	Topsoil	ASTM D1557 80% compaction Maximum lifts vary with equipment. See below.

- C. The following product design and physical criteria are required:

ITEM	DESCRIPTION
On-site material	Material obtained from required site excavations
Import material	Owner approved material obtained from off-site borrow areas.
Structure backfill	When material for the excavation is unsuitable for use in backfill, it shall be disposed of off-site and suitable material that is capable of being compacted to the required relative density shall be arranged for and furnished by the Contractor at his expense.
Structure bedding	Slabs shall be underlain by a vapor barrier and a layer of clean sand or aggregate as shown on drawings.

ITEM	DESCRIPTION	
Pipe zone material (Material less than 12 inches above top of pipe)	Pipe zone backfill shall be granular native or imported soil	
Trench zone material (Material more than 12 inches above top of pipe and below any street zone)	May contain stones, asphalt pavement or concrete of up to 6-inches in largest dimension so long as such solids are completely surrounded by fines so that no voids are present in the backfill as placed. No material greater than two inches in any dimension shall be placed within one foot of any pipe, valve, or structure. All backfill within 24-inches of ductile-iron fittings or valves shall be clean, washed sand.	
Cement-sand Slurry	Cement (94-lb sacks per cubic yard of mix)	1 sack per cubic yard minimum and not less than that required by applicable agency encroachment permits
	Maximum Slump	6 inches per ASTM C143

2.2 STRUCTURAL BACKFILL

- A. Structural backfill shall be free of clay balls and shall have a sand equivalent greater than 30 per ASTM D 2419 and have the following gradation:

Sieve Size	Percent Passing By Weight
3/4 inch	100
1/2 inch	95 – 100
3/8 inch	50 – 100
No. 4	20 – 65
No. 8	10 – 40
No. 40	0 – 20
No. 200	0 – 5

- B. Material excavated onsite may be used for structural backfill provided it conforms to this specification.

2.3 PIPE ZONE MATERIAL

- A. Pipelines 24-inches and smaller
- Use imported pipe zone material as follows: a processed, well-graded, compactible sand or gravel per AASHTO M145 A-1-a with 3/4-inch max particle size and between 5% and 15% fines (per ASTM C117) for binder. Compact pipe zone to 90% relative compaction per ASTM D1557. A 3/4-inch UDOT road base gradation (per paragraph 2.04) is acceptable.
 - Alternately, use controlled low strength material (CSLM).
- B. 36 to 48-inch Sewer Pipelines. Use controlled low strength material (CSLM).

2.4 TRENCH ZONE MATERIAL

- A. Pipelines 24-inches and smaller: Use imported pipe zone material.
 - 1. A 3/4-inch Untreated Base Course.
- B. 36 to 48-inch sewer pipelines:
 - 1. Beneath paved and gravel roads and their shoulders, use a 3/4-inch UDOT road base gradation.
 - 2. In other areas (except cutoff walls), use either imported pipe zone material (UDOT road base is acceptable); or, if it can be shown to consistently exceed 90 percent compaction, then native excavated trench material (not topsoil) may be used – provided it is free from organic matter, or other deleterious matter, and meets the requirements for earth fill as specified. To prevent fines migration in trench zone, native open graded sands and gravels may not be used in trench zone.

2.5 WATER FOR COMPACTION

- A. Water shall be free of organic materials, a pH of 7.0 to 9.0, a max chloride concentration of 500 mg/L, and a max sulfate concentration of 500 mg/L. Provide all work needed to transport water for earthwork including piping, valves, pumps and trucks, to convey water to the point of use.

2.6 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. CLSM shall consist of a mixture of Portland cement, aggregate, fly ash, water, and admixtures conforming to the following:
- B. Portland Cement: ASTM C 150, Type II.
 - 1. Aggregate: Concrete sand, or processed material from the excavations meeting the requirements of sand as herein specified. Aggregate size shall be maximum 3/8 inch per ASTM C 33. The soluble sulfate content, shall not exceed 0.3 percent by dry weight.
 - 2. Water: Potable quality.
 - 3. Fly Ash: Class C per ASTM C 618.
 - 4. The minus 200 sieve fraction shall be non-plastic.
- C. CLSM shall be flowable, non-segregating, self-consolidating and non-shrink.
- D. The unconfined compressive strength at 28 days shall be a minimum of 50 and a maximum of 150 psi per ASTM D 4832 For bidding, assume 100 pounds of cement and 100 pounds of fly ash per cubic yard of CLSM.

- E. Sample CLSM at least once a day, four cylinders each time. Perform two cylinder breaks per four-cylinder sample at 7 days, the same as for concrete. Do not move cylinders for 72 hours after making.
- F. The temperature of the CLSM discharged into the trench shall be below 70 degrees and above 45 degrees Fahrenheit. Do not place CLSM if ambient temperatures are below 10 degrees F.
- G. The aggregate, cement, and water shall be proportioned either by weight or volume. The water content shall be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while being placed. Prepare CLSM in accordance with ASTM C 94.
- H. Water content shall match trial batch content. Do not add water after batching.

2.7 ROCK REFILL (OR TRENCH STABILIZATION MATERIAL)

- A. Rock refill shall be crushed rock free from clay balls, organic material, and debris, and having the following gradation:

Sieve Size	Percent Passing By Weight
3 inches	100
1-1/2 inches	80 - 100
3/4 inch	5 - 30
No. 4	0 - 8
No. 200	0 - 2

2.8 GEOTEXTILES

- A. See Section 31 32 19 – Geosynthetics.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The Contractor's attention is directed to the possible existence of pipe and other underground improvements which may or may not be shown on the Plans. Preserve and protect any such improvements whether shown or not. Where necessary to remove and replace or to relocate such improvements in order to prosecute the Work, they shall be removed, maintained, and permanently replaced by the Contractor at his expense, except as otherwise provided in the Contract Documents.
- B. Contact and notify underground utilities, no less than 48-hours before excavating. Notify Underground Service Alert at 1-800-422-4133.

- C. Control of runoff and groundwater shall comply with the following:
1. Control grading to prevent water running into excavations. Do not obstruct surface drainage. Provide swales, gutters temporary drains or other means of channeling flow without interruption around excavations.
 2. Preserve existing drainage patterns except as otherwise shown. Where construction methods cause temporary obstruction of drainage patterns, provide temporary facilities adequate for expected flows and a means of emergency removal of the obstruction.
 3. Procure permit from appropriate Regional Water Quality Control Board for all groundwater dewatering operations.
 4. Provide and maintain ample means and devices and promptly remove and properly dispose of all water from any source entering the excavation or other parts of Work. Dewatering methods shall ensure preservation of final lines and grades of bottoms of excavations. Said methods may include well points, sump points, suitable rock or gravel placed below required bedding for drainage and pumping purposes, temporary pipelines, and other means that will not be detrimental to the proposed construction. Contractor is responsible for obtaining all water discharge permits required.
 5. Dewatering for the structures and pipelines shall commence when groundwater is first encountered and shall continue until water can be allowed to rise in accordance with the provision of this section.
 6. Do not place concrete footings or floors in water. Do not allow water to rise over Work until concrete or mortar has set at least eight hours. Do not allow water to rise unequally against walls for a period of 28 days. Do not allow groundwater to rise around the pipe until jointing compound in the joints has set hard.
 7. Dispose of water in a suitable manner without damage to adjacent property. Do not drain water into Work built or under construction without prior consent of Owner's Representative. Dispose of water according to permits and in such manner as not to be a menace to public health and public or private property.
- D. Nothing contained in these Contract Documents shall be construed as relieving the Contractor of full responsibility for providing shoring, bracing, sloping or other provisions adequate to guarantee worker protection and safety.
- E. No material shall cause undue interference with public travel. Provide free access to all fire hydrants, water valves, meters, and private drives, or other property or facilities that may have routine or emergency use.
- F. Obtain written permission from Owner prior to any blasting or use of explosives. Explosives, if used, shall be of such quantity and power and shall be used in such locations so as to minimize opening of seams and disturbing of the material outside the prescribed limits of excavation. As excavation approaches its final limits, the depths of holes for blasting and the quantity of explosives used for each hole shall

be reduced so that the underlying or adjacent material will be disturbed or shattered as little as possible.

3.2 INSTALLATION

- A. Refer to Section 31 20 00 for basic execution and installation requirements.
- B. Trench excavation and backfill for pipelines and conduits shall proceed as follows:
 - 1. Alignment and Grades: Alignment and grade for pipe shall be as shown. When flow line is shown, it shall be the invert or interior bottom of pipe. When top of pipe is shown, it shall be the exterior of pipe barrel. In absence of such profile grade, pipe shall be laid on a straight grade to permit complete drainage and to provide a minimum of 36-inches of cover to finish ground or street subgrade unless otherwise shown.
 - 2. Locate trench stockpiled material at least 15 feet away from the tops of open trench excavation slopes.
 - 3. After setting pipe to grade, do not jerk or move shoring in such a way as to cause pipe to be out of grade. After pipe is welded or fused and initial CLSM is placed, such that pipe will not move, shoring may be moved.
 - 4. Pipe zone and compacted trench zone materials shall extend to edge of excavated trench, not to inside face of shoring. Fill gaps left when shoring is removed. If trench is excavated beyond that required, refill over excavated trench at no additional cost to the Owner with the pipe zone and trench zone materials required in specs.
 - 5. Where natural ground above pipeline trench has been overexcavated and/or pipeline is to be placed in new embankment, place and compact embankment material to an elevation of not less than one foot above the top of pipe prior to trench excavation.
 - 6. Length of Open Trench: Except where specified otherwise in Contract Documents or permits, the maximum length of open trench shall be 600-feet or the distance necessary to accommodate the amount of pipe installed in a single day, whichever is the greater. The distance is the collective length at any location, including open excavation, pipe laying, and appurtenance construction and backfill which has not been temporarily resurfaced.
 - 7. Trench Width: Refer to recommendations in the Geotechnical Investigation
- C. Trench bottom preparation shall proceed as follows:
 - 1. Grade trench bottom to provide smooth, firm, and stable foundation at every point throughout length of pipe. Transfer construction stake grades into trench as needed to ensure trench bottom is accurately graded. Place any special bedding required by Contract Documents.

2. Prepare pipe subgrade at trench bottom for specific type of pipe material being installed in accordance with Specifications for said pipe.
3. Should large gravel and cobbles be encountered at the trench bottom or pipe subgrade, remove such items from beneath pipe and replace with granular material compacted to provide uniform support and a firm foundation.
4. Whenever trench bottom does not afford a sufficiently solid and stable base to support pipe or appurtenances, excavate below normal trench bottom and replace it with crushed rock or gravel of sufficient thickness to form an unyielding foundation.
5. If excessively wet, soft, spongy, unstable, or similarly unsuitable material is encountered at subgrade, remove unsuitable material and replace with crushed rock or gravel of sufficient thickness to form an unyielding foundation.
6. Accurately shape pipe subgrade to fit pipe bottom using drag template or other suitable method. At each pipe joint, recess trench bottom to relieve pipe bells, couplings or flanges of all load.
7. Payment for removal of material and additional backfill required shall be in accordance with Contract Documents. However, if necessity for such additional bedding material has been occasioned by an act or failure to act on the part of the Contractor, Contractor shall bear expense of additional excavation and backfill to required depth.
8. The Contractor's attention is called to his responsibilities in maintaining adequate dewatering procedures to ensure that an otherwise stable foundation will not be rendered unfit due to accumulation of water in trench.
9. Where rock is found, removed rock below grade and backfill trench with clean imported sand to provide a compacted foundation cushion with a minimum allowable thickness of 6 inches under the outside diameter of the pipe barrel and a clear space of 6 inches under the pipe bell. Payment for removal of rock and additional backfill shall be in accordance with Contract Documents.

D. Backfill over pipe shall proceed as follows:

1. After pipe has been properly laid, exterior joints grouted and inspected, begin backfilling operations using material as specified above.
2. Contractor will be held responsible for any displacements of pipes or other structures, any damage to them or any instability caused by improper depositing of backfill material or improper use or handling of tools or equipment.
3. Backfill pipe located in public traveled right-of-way at end of each day's operations in accordance with applicable permit requirements. Remove spoil piles from traffic lanes by end of working day.

-
4. Mechanical densification or compaction of backfill shall use rolling, vibrating or impact means, or a combination thereof. Method or methods used shall result in obtaining the compaction of the backfill in the various specified zones and within the maximum lifts specified. Densification or compaction method or methods used shall not damage pipe, adjacent ground, existing improvements, or improvements installed as part of Work.
 5. Place material for mechanically compacted backfill in lifts which, prior to compaction, shall not exceed the depths specified for the various types of equipment.
 - a. Hand directed mechanical tampers - maximum lift depth of 6-inches in pipe zone, 8 inches elsewhere.
 - b. Impact, free-fall, or "stomping" equipment - maximum lift depth of 3-feet. Not appropriate over rigid or cement-mortar lined pipe or PVC.
 - c. Vibratory equipment with smooth contact surface - maximum lift depth of 2-feet.
 - d. Rolling equipment, including, vibratory interrupted surface equipment - maximum depth of 1-foot.
 6. Water settling may not be used in pipe zone and trench.
 7. Control of Trench Backfill by Zones: Backfill shall be constructed by zones, and the compaction requirement for each zone followed unless otherwise specified.
- E. Backfill in pipe zone shall be hand-placed simultaneously on each side of pipe for full trench width, moistened as required to achieve specified compaction. In placing and compacting backfill, give particular attention to underside of pipe and fittings to provide firm support along full pipe length. Take care in backfilling to avoid damage to pipe coating, locating wires, and any conduits that may be installed in the pipe zone. Complete pipe zone compaction before covering it with trench zone material.
- F. Backfill in trench zone shall use mechanical compaction. Complete trench zone compaction before covering it with street zone material.
- G. Backfill in street zone shall occur as follows:
1. Backfill in traveled ways and public streets shall be in accordance with the right-of-way agreement, encroachment permit or applicable regulations of the agency having jurisdiction over the traveled way. In the absence of such provisions, compact soil by approved hand-, pneumatic or mechanical-type tampers.
 2. Water consolidation will not be permitted.
 3. Construct pavement section in accordance with Contract Documents.

3.3 CLSM TRENCH CUTOFF WALLS (TRENCH PLUGS)

- A. Provide CLSM trench cutoffs (i.e. trench plugs) across the full width of the over excavation, pipe zone and trench zone. CLSM trench cutoffs shall be installed as shown on the plans and shall consist of CLSM material which extends from the bottom of trench to 2-feet below finished grade to seal the bottom and sides of the trench against water movement along the trench.
- B. Install CLSM trench plugs at the following locations:
 - 1. At stations shown on drawings, and
 - 2. At property lines, so groundwater won't cross property lines in trenches
 - 3. At both sides of road intersections.
 - 4. At least every 300 feet. Construction Manager shall approve these locations for trench plugs if they are not shown on plans.

3.4 COLD WEATHER LIMITATIONS IN PLACING FILL AND BACKFILL

- A. Unless allowed in the authorized Cold Weather Construction Plan, earth fills and backfills requiring 95 percent or higher relative compaction shall not be placed when either atmospheric temperature, or the temperature of the existing ground or the fill being placed, are below 35 degrees Fahrenheit unless both the existing ground and the fill being placed are both non-frost susceptible materials.
- B. Earth fills and backfills requiring 90 percent or lower relative compaction may be placed when temperatures are below 35 degrees Fahrenheit if the required compaction is achieved. If the required compaction is not achieved, the work shall be removed and re-compacted.
- C. Do not place any fill or backfill materials which require 95 percent, or higher, relative compaction if the excavation or subgrade contains frozen moisture (snow, ice, sleet, etc.), frozen earthen materials, or earthen materials which have been deposited in the excavation due to freezing, thawing, precipitation, or other inappropriate means.
- D. Do not place fill materials which contain frozen moisture (snow, ice, sleet, etc.) except as allowed in the paragraphs above.
- E. Work performed outside the required temperature limitations is subject to rejection, removal and replacement.

3.5 BACKFILL OF TRENCHES (AND FILLS) AND COMPACTION

- A. Unless otherwise shown in the plans or specifications, relative compaction in shall conform to ASTM D 1557 (modified proctor) and shall be as follows:

Location or Use of Fill	Relative Compaction (Unless Noted Otherwise)
Trench Zone not under structures, pavement or roads	90 percent (but do not compact for 6" below topsoils)
Trench Zone if pipes are under paved (AC or conc) or gravel roads and within 10-feet horizontally of paved or gravel roads (i.e. existing and future road shoulders), under future roads and future fills, sidewalks, curbs, beside structures and below slopes 2:1 or steeper.	95 percent or 80 percent relative density
CLSM Pipe Zone - sewer or water pipes	50 psi to 150 psi
Granular Pipe Zone (AASHTO M145 A-1-a) alternate pipe zone for water pipes	95 percent or 80 percent relative density
Trench Bottom Stabilization	85 percent, or 75 percent relative density

- B. Place bedding and backfill materials to the lines, grades, and cross sections indicated on the Plans. Place bedding and backfill materials in horizontal, uncompacted lifts not exceeding 8 inches in thickness. The difference in level on either side of a pipe shall not exceed 12 inches.
- C. Protect the pipe from damage during construction. Replace or repair broken or damaged pipe or pipe coatings. For tamping of backfill over the pipe, use tampers, vibratory rollers, and other equipment that shall not injure or disturb the pipe. Carefully place backfill around and over the pipe and do not allow it to fall directly upon the pipe to prevent coating damage. Place backfill material carefully and evenly onto the backfill previously placed in the pipe zone to prevent lateral movement of the pipe. Do not permit free fall of the material until at least 2 feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe.
- D. Backfilling of the trench above the pipe zone shall not proceed until the required strength of CLSM in pipe zone has been tested, verified, and accepted by the Construction Manager. Do not allow construction traffic over the pipe trench until the trench backfill has been compacted to a depth of over 3 feet above the top of pipe.

3.6 CLSM PLACEMENT AND SLIDE RAIL SHORING REMOVAL

- A. After surveying and setting pipe to grade, and before welding joints, do not pull up lower slide rail panels - as this causes rock refill material (under pipe zone) to flow under panels and the pipe drops and becomes out of grade.

- B. Complete pipe joint field welding and joint coating.
- C. Place a CLSM “stiff mix” saddle over (to top of pipe zone) and around pipe at intervals that leave bottom of pipe zone with no CLSM between “stiff mix” saddles. Obtain initial set of “stiff mix” saddles. This helps lock WSP into surveyed grade before placing the rest of the CLSM.
- D. Place “fluid mix” CLSM in lower part of pipe zone in a way that prevents the pipe from floating. While it is fluid, pull up lower slide rail panels to just below top of the CLSM just placed. Obtain initial set of initial “fluid mix” CLSM.
- E. Place additional CLSM “fluid mix” layers in a way that prevent the pipe from floating. While it is fluid, pull up lower slide rail panels to just below top of CLSM just placed. Obtain initial set of each CLSM layer before placing the next layer.
- F. When CLSM placement is complete to top of pipe zone, place and compact trench zone material while raising upper slide rail panels so that voids left below removed slide rail panels are filled with material compacted to trench zone requirements.
- G. As upper slide rail panels are removed, remove disturbed native earth materials (used as backfill outside slide rail shoring) at the upper sides of trench and replace them with trench zone material compacted to trench zone compaction requirements.

3.7 OTHER CLSM PLACEMENT REQUIREMENTS

- A. Do not place CLSM when ambient daytime air temperatures in trench exceed 95 degrees Fahrenheit. If daytime ambient air temperatures in trench exceed 95 degrees Fahrenheit, Contractor shall submit a written plan to the Construction Manager that identifies how Contractor will address temperature control issues when placing the CLSM.
- B. Deliver the CLSM to the trench in ready mix trucks and use pumps or chutes to place the CLSM in the trench. Do not add water after batching. Submit strength break data for both the CLSM “stiff mix” and the CLSM “fluid mix”.
- C. Maintain stability of pipe and conduit throughout CLSM placement and curing. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and the pipe placed back on line and grade. Any damage to the pipeline system caused by movement of the pipe shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to Owner. Remove all sloughed material or other debris from top of previously placed CLSM.
- D. Prior to placing pipe zone or trench zone material above CLSM the CLSM shall be allowed to cure a minimum of 24 hours and achieve enough strength such that when walking on CLSM produces no indentations. A shorter cure period will be allowed if it can be demonstrated to the Construction Manager that it will perform

its functions (to prevent pipe flotation and/or support pipe and trench zone material).

3.8 COLD WEATHER CLSM PLACEMENT AND CURING

- A. Comply with cold weather placement of CLSM submittals. CLSM placed or cured outside the temperature limitations identified herein is subject to rejection, removal and replacement.
- B. If freezing temperatures are imminent, maintain CLSM at a temperature above 40°F for seven (7) days after placement. CLSM mix and native trench soils (to 12-inches below trench face, floor and walls) must all be 40°F or greater at time of placement. Determine temperature by placing thermometer in CLSM or native soils immediately after sampling CLSM at placement site.
- C. When freezing weather appears imminent, make ready at the placement site insulation and other materials for CLSM protection which have been identified in the cold weather placement of CLSM submittal accepted by Construction Manager. Delay placement of CLSM until adequate provisions for protection against weather are made. Do not place CLSM bedding when the trench bottom or walls are frozen or contain frozen material.
- D. CLSM Curing: If during CLSM curing, temperatures are below 40 degrees, protect CLSM by insulation as allowed in the cold weather placement of CLSM submittal. Do not place CLSM if ambient temperatures are below 10 degrees F. If CLSM is kept above 40 degrees F until at least 18-inches fill or backfill is placed over the curing CLSM, no further cold weather protection is required if ambient temperatures are over 10 degrees F and no ambient forced air is circulating through pipe. The native earth temperatures typically keep both the buried pipe and the CLSM above 40 degrees F.

3.9 PLACING LOCATING (MARKING) TAPE AND (TRACER) WIRE

- A. Install marking tape over all pipelines, conduits and ducts. Install at locations shown on the plans. Unless otherwise shown, locate marking tape at the top of pipe zone and centered over the pipe.
- B. Install both marking tape and tracer wire continuously over the top (centerline) of all buried pipes unless required otherwise. Securely attach tracer wire to top of the pipe to prevent movement during backfill. Submit tracer wire splice method.
- C. At each half mile at cathodic test stations, bring tracer wire to the ground surface and attach each end of the wire to an un-used terminal on the test station board. If tracer wire test points are required more often provide them on both water and sewer pipelines.

3.10 FIELD QUALITY CONTROL

- A. Owner's Representative will provide continuous inspection of fill and will field test fill and earth backfill as placed and compacted, and inspect excavations and subgrade before concrete is placed and provide periodic inspection of open excavations, embankments, and other cuts or vertical surfaces of earth. The Owner's Representative will observe and test fills and based on laboratory results will determine whether fills have been placed in accordance with the Contract Documents.
- B. Whenever excavated material is not suitable for backfill, Contractor shall at his expense arrange for and furnish suitable imported backfill material which is capable of attaining the specified relative density. Contractor shall also arrange for removal and off-site disposal of unsuitable excavated material at his own expense.
- C. Make all necessary excavations for compaction and other soils tests as directed by the Owner's Representative.
- D. "Relative compaction" is the ratio, expressed as a percentage, of the in-place dry density to the laboratory maximum dry density.
- E. Compaction shall be deemed to comply with the Contract Documents when no more than one test of any three consecutive tests falls below the specified relative compaction. The one test shall be no more than three percentage points below the specified compaction. Contractor shall pay costs of any retesting of Work not conforming to Contract Documents.
- F. Allow sufficient time for testing and evaluation of results before material is needed. Owner's Representative will be sole and final judge of suitability of all materials.
- G. Do not use materials in question pending test results.
- H. Contractor shall remove unsatisfactory material, re-compact, adjust moisture or compaction methods, place new material, and perform other operations necessary to meet Contract requirements as directed by Owner's Representative whose decisions and directions will be considered final on these matters.
- I. Owner's Representative will not provide and is not being paid to provide directions or submittal review regarding Contractor's excavation safety procedures. Any questions or concerns of Owner's Representative will be referred to OSHA whose decisions or directions shall be considered final.

3.11 ADJUSTING AND CLEANING

- A. Make necessary arrangements for and remove and dispose of all surplus excavated material off-site, unless otherwise provided for in the Contract Documents. All costs for disposal of surplus waste material shall be borne by Contractor.

- B. Dispose of all surplus material not required for backfill or fill. Disposal shall occur outside limits of public rights-of-way and/or easements. Disposal shall comply with applicable ordinances and regulations of governmental agencies having jurisdiction and shall be done at no cost or liability to Owner.
- C. Do not deposit excavated material on private property unless written permission from property owner is secured by the Contractor. Before Owner will accept Work as being completed, Contractor shall file written release signed by all property owners with whom he has entered into agreements for disposal of surplus excavated material absolving Owner from any liability connected therewith.
- D. Do not deposit excess material in water courses or other locations where disposed material will interfere with natural drainage.
- E. After backfill is completed, dress site smooth and leave site in neat and presentable condition, free of all cleared vegetation, rubbish and other construction wastes. Haul away and legally dispose of surplus rock or other excavated material which cannot be used for backfill. Areas next to structures where blade-type equipment cannot reach shall be hand raked.

END OF SECTION

SECTION 31 23 16 – ROADWAY EXCAVATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Excavation of all material within designated areas.
- B. Rock excavation and removal.
- C. Placement of excavated material in embankment and other areas.

1.2 RELATED SECTIONS

- A. Section 01 35 43: Environmental Compliance
- B. Section 01 57 13: Temporary Erosion and Sediment Control
- C. Section 01 71 23: Survey
- D. Section 02 41 10: Preparation
- E. Section 31 23 30: Embankment, Borrow, and Backfill
- F. Section 31 32 19: Geosynthetics

1.3 REFERENCES

- A. National Fire Protection Association (NFPA) Codes and Standards
- B. OSHA Construction Standards

1.4 DEFINITIONS

- A. Rock – Material that cannot be excavated and removed without blasting, chipping, cutting, or ripping.

1.5 SUBMITTALS

- A. Proposed method of blasting, delay pattern, explosive types, and type of blasting mat cover.
- B. Copies of disposal permits, agreements, or both.

1.6 ACCEPTANCE AND PAYMENT PROCEDURES

- A. Payment is plan quantity by the cubic yard.

1. Make no adjustment to plan quantities if staked quantities differ by 5 percent or less.
- B. Notify the Engineer before beginning excavation in any area if the Contractor determines that the staked quantities differ from the plan quantities by more than 5 percent. The following procedures then apply:
 1. Provide calculations and plots according to Section 01 71 23.
 2. Evaluate the “plan quantities” to “staked quantities” by individual cuts or balances as determined by the Engineer to provide the necessary accuracy.
 3. Do not begin excavation of any cut sections that the Contractor determines to differ from plan quantities by more than 5 percent until the calculations and plots have been submitted, reviewed, and approved by the Engineer.
 - a. No payments, partial or final, will be made until submissions are provided and approved.
- C. Approved quantities become the adjusted plan quantities and are paid at the original unit bid price when the Engineer determines the staked quantities differ from plan quantities by more than 5 percent.
- D. Payment includes excavation, removal, transportation, and disposal when existing pavement is included in Roadway Excavation plan quantity.

PART 2 - PRODUCTS**2.1 MATERIALS FOR OVER-EXCAVATED AREAS**

- A. Refer to Section 31 23 33 Excavation and Backfill Operations.
- B. Geotextile Fabric – Refer to Section 31 35 00.

2.2 USE OF ON-SITE MATERIALS

- A. Refer to Section 31 23 33.

2.3 EXPLOSIVES

- A. Use explosives, delay fuses, and all blasting materials as recommended by the explosives firm. Refer to NFPA 495 – Explosive Materials Code.

PART 3 - EXECUTION**3.1 PREPARATION AND PROTECTION**

- A. Refer to Sections 01 57 13 Temporary Erosion and Sediment Control.
- B. Locate and protect utilities as necessary.

- C. Clear and grub within the designated area before starting excavation. Refer to Section 02 41 10 Site Preparation.

3.2 BLASTING MATERIAL STORAGE

- A. Store all explosives securely in compliance with Laws and Regulations. Refer to NFPA 495: Explosive Materials Code.
- B. Mark all storage places clearly.

3.3 TOPSOIL

- A. Remove topsoil according to Section 31 11 00 Clearing and Grubbing.

3.4 DEWATERING

- A. Keep excavation free from surface and ground water through all stages of construction.
 - 1. Maintain adequate drainage during all stages of construction through pumping, pipe culverts, and drainage ditches.
 - 2. Provide temporary facilities when interrupting items such as irrigation systems, sewers, and under drainages.

3.5 EXCAVATION – STANDARD PROCEDURES

- A. Finish excavation to reasonably smooth and uniform surface.
- B. Provide and maintain satisfactory access to roads, streets, and adjacent property during all phases of construction according to the Traffic Control Plan.
- C. Remove material in all cut sections to the depth shown.
 - 1. Scarify to an 8 inch depth and compact subgrade to at least 90 percent of maximum laboratory density before placing pavement section.
- D. Excavate and waste unsuitable material.
- E. Material for backfilling or finishing
 - 1. Use suitable granular material encountered in excavation to construct the top layers of embankment, finishing the roadbed, or backfill when directed by the Engineer.
 - 2. Haul the granular material directly from excavation to the final position on the roadbed when practical.

3.6 ROCK REMOVAL – NONEXPLOSIVE METHOD

- A. Excavate solid rock 6 inches to 1 ft below subgrade and backfill with acceptable material.
 - 1. Rock removed more than 1 ft below subgrade will not be measured or paid for.
 - 2. Backfilling depth greater than 1 ft below subgrade will not be measured or paid for.

3.7 ROCK REMOVAL – EXPLOSIVE METHOD

- A. Comply with OSHA Constructions Standards 1926 Subpart U - Blasting and the Use of Explosives.
- B. Comply with NFPA 495 – Explosive Materials Code.
- C. Provide a qualified explosives expert to act as an advisor and consultant during drilling and blasting operations.
- D. Do not blast beyond designated areas.

3.8 ROCK FACES

- A. Scale rock cuts of all loose rocks and fragments and leave in a neat and safe condition.

3.9 PAVEMENT

- A. Cut existing pavement on the designated lines with straight vertical edges free from irregularities when joining new construction to existing pavement.
- B. Excavate all pavement as shown.
- C. Dispose of pavement using methods acceptable to the Engineer according to all applicable rules and regulations and as follows:
 - 1. Inside the right-of-way as embankment, subject to the approval of the Engineer. Refer to Section 31 23 30.
 - 2. Outside the right-of-way subject to the approval of the Engineer. Refer to Section 01 35 43 Environmental Compliance.

END OF SECTION

SECTION 31 23 23 - COMMON FILL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Common fill material requirements.

1.2 REFERENCES

- A. AASHTO M-145: Recommended Practice for the Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.
- B. AASHTO T-27: Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

1.3 DEFINITIONS

- A. Common Fill: Backfill material which is not mechanically graded.

1.4 ACCEPTANCE

- A. Acceptance of common fill shall be determined by Engineer and based upon 1 subplot of 500 tons plus any additional sublots for each 500 tons or portion thereof over and above the first 500 tons of each common fill placed in any 1 week.
- B. The Engineer reserves the right to select and test backfill on a random basis from any location in the Work, on the site or from the backfill source.

PART 2 - PRODUCTS

2.1 GRANULAR BORROW (AASHTO TYPE A-1-a)

- A. Bank run material: free of shale, clay, slag, friable material and debris.
- B. The material must be within the following limits:

Sieve Size	Percent by Weight Passing Sieve
2 inches	99
No. 4 (4.75 mm)	30 to 70
No. 200 (75 micro m)	3 to 15

2.2 NATIVE MATERIAL

- A. Sound, earthen material with 95% passing the 4 inch sieve.
- B. Percent of material by weight passing Number 200 sieve shall not exceed 20% when tested in accordance with AASHTO T-27.

2.3 SAND

- A. Clean, coarse, natural sand.
- B. Nonplastic when tested in accordance with ASTM D 4318.
- C. 100 percent shall pass a 1/8 inch screen.
- D. No more than 20 percent shall pass a number 200 screen.

2.4 SOURCE QUALITY CONTROL

- A. Verify gradation compliance in accordance with AASHTO T-27. Select samples uniformly in time on a random basis.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Excavation and Backfill Operations: In accordance with Section 31 23 33.

END OF SECTION

SECTION 31 23 24 - SELECT FILL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Select fill material requirements.

1.2 REFERENCES

- A. AASHTO T-96: Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- B. AASHTO T-27: Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

1.3 DEFINITIONS

- A. Select Fill: Backfill material which is mechanically graded.

1.4 SUBMITTALS

- A. Material analysis of each select fill material to be used.

1.5 ACCEPTANCE

- A. Engineer reserves the right to select, reject, and test backfill on a random basis from any location in the Work or from the backfill source.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. Clean, hard, tough, durable and sound mineral aggregates that consists of 95% crushed stone, crushed gravel or crushed slag; free of deleterious and organic matter; and complies with the following:
 - 1. Aggregate Wear Under AASHTO T-96: Less than 50 percent.
 - 2. Material shall be classified as A-1 material.
- B. Aggregates - master grading band limits
 - 1. The following limits are based on fine and course aggregate having approximately the same bulk specific gravities. The limits are wider than necessary for good job control. Sieve gradations are based upon percent of aggregate passing by weight in accordance with AASHTO T-27.

2. Source quality control

- a. Verify job-mix grading band material compliance in accordance with AASHTO T-27. Select samples uniformly in time on a random basis.

2.2 DRAIN ROCK

- A. Consist of hard, durable particles of stone or gravel, screened or crushed to specified size and gradation.
- B. Free from vegetable matter, lumps or balls of clay, or other deleterious matter.
- C. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
- D. Durability Index: Percentage of wear not greater than 40 percent when tested in accordance with AASHTO T-96.
- E. Conform to size and grade within the limits as follows when tested in accordance with AASHTO T-27.

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
2 inch	100
1-1/2 inch	95-100
3/4 inch	50-100
3/8 inch	15-55
Number 4	0-25
Number 8	0-5
Number 200	0-2

2.3 GRAVEL

- A. Consist of hard, durable particles or fragments of stone or gravel, screened or crushed to specified sizes and gradations.

- B. Free from vegetable matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
- C. When sampled and tested in accordance with specified test methods, material shall comply with the following requirements:
 - 1. Durability index: Percentage of wear not greater than 40 percent after 500 revolutions when tested in accordance with AASHTO T-96.
 - 2. Plasticity Index: Not greater than 5 when tested in accordance with ASTM D 4318.
 - 3. Liquid limit: Not greater than 25 percent when tested in accordance with ASTM D 4318.
- D. Conform to sizes and grade within the limits as follows when tested in accordance with AASHTO T-27 and ASTM C 117:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
3 inch	--
1-1/2 inch	100
Number 4	30-70
Number 8	20-60
Number 30	10-40
Number 200	0-12

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Excavation and Backfill Operations: In accordance with Section 31 23 33.

END OF SECTION

SECTION 31 23 27 - SOIL COMPACTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Compaction control of native and imported backfill material.

1.2 REFERENCES

- A. AASHTO M 145: Recommended Practice for the Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.
- B. AASHTO T-99: Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb (2.49-kg) Hammer and 12-In. (305-mm) Drop.
- C. AASHTO T-180: Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using a 10-lb (4.54-kg) Hammer and an 18-In. (457-mm) Drop.
- D. AASHTO T-238: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 DEFINITIONS

- A. A-1 Soils: AASHTO M 145 describes the nature of these soils.
- B. Modified Proctor: The test method used for moisture-density relationship of soils as determined by the ASTM D 1557 test method.
- C. Percent Compaction or Percent Density: The ratio of the field dry density to the laboratory maximum dry density expressed as a percentage.
- D. Standard Proctor: The test method used for moisture-density relationship of soils as determined by the ASTM D 698 test method.

1.4 SUBMITTALS

- A. Compaction test results according to Section 01 45 00.

1.5 WARRANTY

- A. Correct deficient conditions. Replace or repair surfacing materials and damaged facilities.
- B. The method of construction repair shall be proposed in writing by Contractor for approval by Engineer prior to correcting the failed condition.

- C. Failure to detect any defective work or material does not prevent later rejection of the work nor obligate Engineer for final acceptance when such defective work or material is discovered.

PART 2 - EXECUTION

2.1 COMPACTION REQUIREMENTS

- A. The Contractor shall be responsible to perform and pay for all testing of earth materials. See Section 01 45 00.
- B. Moisten or de-water backfill material to obtain optimum moisture for compaction compliance.
- C. The material shall be deposited in horizontal layers having a compacted thickness of no more than 12 inches for roadway and 6 inches for trenches.
- D. The distribution of materials shall be such that the compacted material will be homogeneous and free from lenses, pockets, or other imperfections.
- E. The material shall have the optimum moisture content required for the purpose of compaction and the moisture content shall be uniform throughout the layer, insofar as practicable.
- F. Backfill shall be compacted by means of sheepfoot rollers, pneumatic tire rollers, vibrating rollers, or other mechanical tampers of a size and type approved by the Engineer.
- G. If the required relative density is not attained, test sections will be required to determine any adjustments in compacting equipment, thickness of layers, moisture content and compactive effort necessary to attain the specified minimum relative density.
- H. Approval of equipment, thickness of layers, moisture content and compactive effort shall not be deemed to relieve the Contractor of the responsibility for attaining the specified minimum relative densities.
- I. The Contractor in planning his work shall allow sufficient time to perform the work connected with test sections and to permit the Engineer to make tests for relative densities.

2.2 FIELD QUALITY CONTROL

- A. Optimum Soil Density: Unless indicated otherwise.
 - 1. In accordance with AASHTO T-180 Method D test (Modified Proctor).

2.3 COMPACTION UNDER ROADWAYS

- A. Fill or embankment material shall be compacted to not less than 95% of maximum dry density as measured by AASHTO T-180.
 - 1. Compaction shall extend one foot beyond edge of pavement or proposed curb line.

2.4 COMPACTION OF OTHER FILLS AND EMBANKMENTS

- A. Fill or embankment materials other than those mentioned above shall be compacted to not less than 92% of maximum dry density as measured by AASHTO T-180.

END OF SECTION

SECTION 31 23 30 – EMBANKMENT, BORROW, AND BACKFILL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Materials and placement of roadway embankments, borrow, and backfill materials.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. AASHTO M 145: Classification of Soils and Soil Aggregate Mixtures for Highway Construction Purposes
- B. AASHTO T 11: Materials Finer than 75 μ m (No. 200) Sieve in Mineral Aggregates by Washing
- C. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates
- D. AASHTO T 99: Moisture-Density Relations of Soils Using a 2.5 kg (5.5-lb) Rammer and a 305 mm (12 inch) Drop
- E. AASHTO T 180: Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 inch) Drop
- F. UDOT Materials Manual of Instruction

1.4 DEFINITIONS

- A. Well-graded material – Material having an even distribution of different particle sizes. This even distribution of particles of different sizes results in a dense mass upon compaction.

1.5 SUBMITTALS

- A. Provide the following before delivering material to the project:
 - 1. Supplier and source of materials.
 - 2. Gradation analysis. Refer to AASHTO T 27 and T 11.
 - 3. Soil classification when applicable. Refer to AASHTO M 145.
 - 4. Maximum Dry Density and Optimum Moisture Determination
 - a. Use AASHTO T 180 Method D for A-1 soils and AASHTO T 99 Method D for all other soils.
- B. Engineering proposal for alternate materials or trench configurations for drainage pipe bedding and pipe backfill as outlined in this Section, Article 2.8 C.

1.6 ACCEPTANCE

- A. Acceptance sampling and testing is according to UDOT Minimum Sampling and Testing Requirements.
- B. Engineer reserves the right to select and test material from any location at the construction site.
 - 1. Establish the limits of nonconforming material sampled non-randomly and correct.
- C. Density Requirements – Acceptance is on a lot-by-lot basis.
- D. Remove nonconforming material and replace with acceptable material.

PART 2 - PRODUCTS**2.1 GENERAL**

- A. Provide materials free of contamination from chemical or petroleum products for embankment and backfill placements. Materials may include recycled Portland Cement Concrete.
 - 1. Do not include asphalt pavement materials.

2.2 MATERIALS

- A. Borrow
 - 1. Classifications A-1-a through A-4. Refer to AASHTO M 145.
- B. Granular Borrow
 - 1. Classification A-1-a. Refer to AASHTO M 145.
 - 2. Non-plastic, well-graded, 3 inch maximum.
- C. Granular Backfill Borrow
 - 1. Classification A-1-a. Refer to AASHTO M 145.
 - 2. Well-graded, 2 inch maximum.
- D. Free-Draining Granular Backfill
 - 1. Meet the following gradation:

Table 1 – Free Draining Granular Backfill Gradation	
Sieve Size	Percent Passing
1½ inch	90-100
1 inch	20-55
¾ inch	0-15
⅜ inch	0-5

E. Embankment For Bridge

1. Classification A-1. Refer to AASHTO M 145.
2. 3 inch maximum.

2.3 EMBANKMENT

- A. Borrow or suitable roadway excavation materials excluding organic, frozen, or contaminated soils.

2.4 DRAINAGE PIPE BEDDING AND BACKFILL

A. Drainage Pipe Bedding and Drainage Pipe Backfill

1. Granular Backfill Borrow, Classification A-1. Refer to AASHTO M145.
 - a. Well-graded material.
 - b. Maximum aggregate size is 1½ inches for plastic pipe, 2 inches for all other pipes.
2. Flowable fill. Refer to Section 31 20 00 Earthwork and Dewatering.
 - a. Use only for drainage pipe backfill.

- B. Other materials or trench configurations for drainage pipe bedding and backfill may be used only upon approval of the Contractor's engineering proposal. Proposals using this option may include the use of native material or uniformly graded materials enclosed in an appropriate drainage geotextile. Any proposal must include all of the following:

1. Stamped drawings and specifications signed and sealed by a Professional Engineer licensed in the state of Utah.
2. Evaluation of site specific conditions and surrounding soils, including potential for migration of fines.
3. A structural evaluation of the pipe support system for the proposed pipe that includes the pipe structural capacity and the depth of fill.
4. Complete bedding or backfill source information including gradation, soil classification, and laboratory testing reports.

PART 3 - EXECUTION

3.1 GENERAL

- A. Complete clearing, grubbing, stripping, and stockpiling topsoil before placing material.
- B. Requirements when placing material during freezing or snowy conditions:
 - 1. Do not place embankment on frozen or snow-covered areas.
 - a. Remove snow and frozen material from embankments, foundations, and borrow areas and furnish embankment material that can be compacted to the specified density.
 - 1) Measure removed material and provide quantities to the Engineer.
 - 2) The Owner does not pay for removed material, frozen embankment replacement, or replacement material for a working platform or foundation meeting specification requirements if unfrozen.
 - 2. Do not deliver or use frozen material.
- C. Use appropriate compaction equipment adjacent to pipes, abutments, back walls, approach slabs, wing walls, retaining walls, and other structures.
 - 1. Expand the width of the trench to accommodate necessary compaction equipment.
 - 2. Compact by hand areas where compaction equipment cannot compact the soil.
- D. Over-excavate unsuitable material as directed by the Engineer.
- E. Do not use unsuitable material for embankment or backfill placement.
- F. Density Requirements
 - 1. Borrow, Granular Borrow, Granular Backfill Borrow, Embankment for Bridge, and Drainage Pipe Bedding
 - a. Meet minimum density test average of 96 percent of maximum laboratory density with no single determination lower than 92 percent.
 - 1) Use AASHTO T 180 Method D for A-1 soils and AASHTO T 99 Method D for all other soils.
 - 2) Maintain appropriate moisture for compaction during processing.
 - 2. Drainage Pipe Backfill

- a. Meet minimum density test average of 92 percent maximum laboratory density with no single determination less than 90 percent.
 - 1) Use AASHTO T 180 Method D for A-1 soils.
 - 2) Maintain appropriate moisture for compaction during processing.
- b. Meet the pavement section material density requirement for pipes that encroach into the pavement section or use flowable fill.
- 3. Meet 100 percent of the developed field density for material with more than 30 percent retained on the $\frac{3}{4}$ inch sieve.
 - a. The Engineer develops a field density compaction curve according to UDOT Materials Manual of Instruction Section 989.
- 4. Free-Draining Granular Backfill
 - a. Meet 100 percent of the developed field density.
 - 1) The Engineer develops a field density compaction curve according to UDOT Materials Manual of Instruction Section 989.

3.2 EMBANKMENT AND BORROW PLACEMENT

- A. Place roadway excavation or borrow or both in embankment section with the highest quality material in the top portion of the embankment.
- B. Scarify and compact the top 8 inches of the surface of the working platform or foundation to at least 90 percent of maximum laboratory density when the embankment height is 6 ft or less.
- C. Break and scarify all underlying concrete pavement surfaces so that pieces do not exceed 1 ft² before placing embankment over an existing concrete pavement surface that is outside the limits of removal or excavation shown.
 - 1. Remove other pavement surfaces that are not Portland Cement Concrete.
- D. Maintain Drainage
 - 1. Grade and maintain the roadway to ensure adequate drainage.
 - 2. Maintain drainage pipes and drainage ditches or provide temporary facilities when interrupting items such as irrigation systems, sewers, and under-drains.
- E. Place an initial layer to act as a working platform over soft, wet ground when approved by the Engineer.
 - 1. Density requirements do not apply to the working platform.

2. Meet density requirements for embankment placed above the working platform.
- F. Do not place initial layer of embankment until Engineer inspects and accepts the working platform or foundation.
- G. Spread embankment materials uniformly in layers not exceeding 1 ft (uncompacted depth) and compact to the density requirements.
 1. Reduce the lift thickness or modify operations if tests show unsatisfactory density.
- H. Finish subgrade surface within ± 0.2 ft of line and grade.
- I. Do not use rock or broken concrete materials over 1 ft in any dimension.
- J. Distribute larger particles so space exists for placing and compacting embankment material.
- K. Do not place rocks larger than 4 inches or broken concrete within 1 ft of the subgrade surface.
- L. Do not use compacting equipment that causes shear failure in the embankment.

3.3 GRANULAR BORROW, GRANULAR BACKFILL BORROW, AND BACKFILL PLACEMENT

- A. Finish surface within ± 0.1 ft of line and grade.
- B. Compact material in maximum 6 inch layers (uncompacted depth) to the density requirement.
- C. Backfill for structures such as bridges, foundations, box culverts, drains, and other structures.
 1. Place Embankment unless otherwise shown.

3.4 DRAINAGE PIPE FOUNDATION, BEDDING, AND BACKFILL PLACEMENT

- A. Place in 6 inch layers (uncompacted depth) and compact to the density requirement.
- B. Place uniform layers of drainage pipe backfill on both sides of the pipe and compact to the density requirement before placing successive lifts.
- C. Fully compact the haunch areas.

3.5 EMBANKMENT FOR BRIDGE PLACEMENT

- A. Construct bridge approach embankments from the existing ground up with the specified material to the limits defined in this Section and according to DD Series Standard Drawings.
 - 1. Approach Embankments
 - a. Place embankment beneath the bridge except riprap or other described materials used for MSE walls.
 - b. Place embankment from the bridge abutment centerline station to a point measured at least 150 ft away from the abutment along the approach roadway centerline and on the inside of abutments.
 - c. Use the described material throughout the length of the walls where retaining walls are located beyond this delineation.
 - 2. Intersecting Roadway Embankments
 - a. Place embankment from approximate edge of approach roadway at least 60 ft along intersecting roadway centerline.
 - 3. Adjoining Embankments
 - a. Place embankment at least 10 ft outward from edge of approach roadway pavement when adjoining embankment is not an approach embankment.
- B. Do not place initial layer of embankment until foundation or working platform is verified by the Engineer.
- C. Spread embankment materials uniformly in layers not exceeding 1 ft (uncompacted depth) and compact to the specified density requirements before placing the next layer. Reduce the lift thickness if tests show unsatisfactory density.
- D. Finish surface within ± 0.2 ft of line and grade.

3.6 FREE-DRAINING GRANULAR BACKFILL PLACEMENT

- A. Compact material in 1 ft maximum layers to the density requirement.
- B. Finish surface within ± 0.2 ft of line and grade.

END OF SECTION

SECTION 31 23 33 - EXCAVATION AND BACKFILL OPERATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements for trenching and backfilling for underground pipelines.
- B. Excavating and backfilling operations adjacent to and under structures including boxes, headwalls, or other structures as required by Engineer.
- C. Backfilling and compacting operation for construction and reconstruction of roadways, embankments, streets, parking lots, and other paved surface areas.
- D. Excavation permit requirements.

1.2 DEFINITIONS

- A. Pipe Zone: That zone in an excavation which supports, surrounds, and extends to 1 foot above the top of the pipe barrel.
- B. Bedding: Process of preparing the trench bottom to receive the pipe and the backfilling on each side of the pipe to 12 inches over the top of the pipe.
- C. Roadway: Area within the street right-of-way, including the area under the street and shoulder

1.3 SUBMITTALS

- A. Material Analysis Reports: In accordance with Sections 31 23 23 or 31 23 24 as applicable.
- B. Density Test Reports: In accordance with Section 31 23 27.
- C. Depth of backfill lift. This information shall be contingent upon type of equipment used in compaction operation. The Engineer may order lesser thickness if compaction is not achieved.

1.4 STORAGE AND HANDLING

- A. Stockpile excavated material in a manner as to cause a minimum of inconvenience to public travel and provide for emergency traffic as necessary.
- B. Maintain free access to all existing fire hydrants, water and gas valves, and meters.
- C. Maintain clearance for free flow of storm water in all bar ditches, conduits, and natural water courses.

- D. Utilize appropriate traffic signs, markers, and procedures in all product storage and handling activities.
- E. Promptly remove all other material from site.

1.5 SITE CONDITIONS

- A. Unsuitable Weather Limitations: Do not place, spread, or roll any fill material during unsuitable weather conditions. Do not resume operations until moisture content of material is satisfactory.
- B. Protection of Graded Areas: Protect graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or unsuitable weather, scarify surface, reshape, and compact to required density prior to further construction.
- D. Prior to excavation operations, photograph existing surfaces along which Work may take place in order to determine, after construction is completed, whether any damage of existing improvements occurred prior to construction operations.
- E. Grading: In compaction operations, do not vary the surface of finished aggregate base course more than 1/4" above or below grade.

PART 2 - PRODUCTS

2.1 WATER

- A. Make arrangements for source of water during construction and make arrangements for delivery of water to site. Comply with all local laws and regulations when securing water from water utility company at no additional cost to Owner.

2.2 SOIL MATERIALS

- A. Over-excavation Fill: Select Fill: in accordance with Section 31 23 24.
- B. Common Fill: in accordance with Section 31 23 23.
- C. Select Fill: in accordance with Section 31 23 24.
- D. Native Backfill:
 - 1. When approved by Engineer, native backfill material obtained from project excavations may be used as backfill, provided organic material, rubbish,

- debris, rocks larger than 8 inches, and other objectionable materials are removed.
- 2. Bituminous pavement obtained from project excavations will not be permitted as backfill except for the following:
 - a. May be mixed with road subbase if material meets section 31 23 24 gradation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify areas to be backfilled are free of debris, snow, ice, or water and ground surfaces are not frozen.
- B. Verify foundation of basement walls are braced to support surcharge forces imposed by backfilling operations.
- C. Immediately prior to suspension of construction operations for any reason, provide proper and necessary drainage of work area.

3.2 PREPARATION

- A. For pipelines, use means necessary to avoid displacement, and injury to, pipe and structures while compacting soil or operating equipment next to pipeline.
- B. Movement of construction machinery over a pipeline at any stage is solely at Contractors risk.
- C. When excavation is required in jurisdictions other than Owners, satisfy all conditions of the appropriate agencies.
- D. Identify required lines, grades, contours, and benchmarks.
- E. Notify all affected utility companies and Blue Stakes prior to commencing excavation operation.
- F. Support and protect from damage, until completion of the Work, any existing facilities and structures which exist in, pass through, or pass under the site.

3.3 CONTROL OF GROUNDWATER

- A. All trenches shall be kept free from water during excavation, fine grading, pipe laying, jointing, and embedment operations.
- B. Where the trench bottom is mucky or otherwise unstable because of the presence of groundwater, and in cases where the static groundwater elevation is above the bottom of any trench or bell holed excavation, such groundwater shall be lowered

to the extent necessary to keep the trench free from water and the trench bottom stable when the work within the trench is in progress.

3.4 SHORING

- A. Comply with Section 31 40 00 when required by field condition.

3.5 GENERAL EXCAVATION OPERATIONS

- A. If topsoil is on site, remove and store it for later use on site.
- B. Excavate site to required grade for Work. Use all means necessary to control dust on or near Work and on or near all off-site borrow and disposal areas.
- C. Notify Engineer of unexpected subsurface conditions.
- D. Underpin adjacent structure which may be damaged by excavation work, including service utilities and pipe chases.
- E. If unstable material is encountered at the bottom or face of excavation, do not perform extra excavation without Engineer's written approval. Correct unauthorized extra excavations at no cost to Owner.
- F. Provide necessary protection to excavation walls as required. If conditions permit, slope excavation side to maintain a safe and clean working area. Remove loose materials.
- G. Correct excavation beyond the specified lines and grades by filling the resulting voids with approved compacted fill. If the fill is to become the subgrade for other fill, use material approved by Engineer. Do not proceed until Engineer has approved the material and the proposed method of backfilling for over excavation errors.

3.6 EXCAVATION FOR PIPELINES

- A. Trenches shall be excavated to the depths and widths required to accommodate the construction of the pipelines, as follows:
 - 1. Except in ledge rock, cobble rock, stones or water saturated earth, mechanical excavation of trenches shall not extend below an elevation of 4 inches below the bottom of the pipe after placement in its final position.
 - 2. All additional excavation necessary for preparation of the trench bottom shall be made manually.

3. Excavation for trenches in ledge rock, cobble rock, stones, mud or other material unsatisfactory for pipe foundation, shall extend to a depth of at least 4 inches below the bottom of the pipe.
 4. A bedding of special material shall be placed and thoroughly compacted with pneumatic tampers in 4-inch lifts to provide a smooth, stable foundation.
 5. Special foundation material shall consist of suitable earth material free from roots sod or vegetable matter.
 6. Trench bottoms shall be hand shaped as specified in paragraph (2) above.
 7. The maximum width of trench, measured at the top of the pipe, shall be as narrow as possible but a minimum of 6 inches on each side of the pipe.
 8. Where ground water is encountered, trench plugs and/or filter fabric may be required at a minimum of 100 feet or as directed by the Engineer.
- B. Grade bottom of trenches to provide uniform bearing surface.
- C. If necessary, make bellholes and depressions required to complete joining of pipe or box.
- D. In public thoroughfares and regardless of trench depth, safely barricade and limit open trenches to a maximum of 200 lineal feet in the daytime, except in traveled roadways where a maximum of 80 lineal feet of open trench will be allowed.
- E. Close trenches during nighttime conditions.

3.7 GRAVEL FOUNDATION FOR PIPE

- A. Wherever the subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load; where water must be drained to maintain a dry bottom for pipe installation and at other locations as previously defined, the subgrade shall be excavated to a minimum of 12 inches and replaced with crushed rock or gravel.
- B. Gravel for pipe foundations shall conform to Drain Rock in Section 31 23 24.
- C. Drain Rock material shall be deposited over the entire trench width in 18-inch maximum layers, each layer shall be compacted by tamping, rolling, or vibrating.
- D. The material shall be graded to produce a uniform and continuous support for the installed pipe.

3.8 BACKFILLING FOR PIPELINES

- A. Backfill shall be carefully placed around and over pipes and shall not be permitted to fall directly on a pipe from such a height, or in such a manner as to cause damage.
- B. Bedding requirements are as defined in the Specifications for each specific pipe material.
- C. Trench backfilling above the level of the pipe bedding shall normally be accomplished with A-1 Native material. Excavated materials shall be free from rocks larger than 8-inches in diameter.
- D. Compaction Requirements
 - 1. Under pavements, shoulders, or other surface improvements the in-place density shall be a minimum of 95% of laboratory standard maximum dry density as determined by AASHTO T-99.
 - 2. In other areas the in-place density shall be a minimum of 92% of the maximum dry density as determined by the same laboratory method.
 - 3. All pipe bedding and all pipe zone shall be compacted to at least 95% of maximum dry density as determined by the same laboratory method.
- E. Clay cut off dikes shall be constructed as required by Engineer.

3.9 INSTALLING IMPERVIOUS BARRIERS

- A. Construct impervious barriers in the pipe and trench zones, as shown in the plans and at 100-foot intervals on slopes exceeding 30% (16.7 degrees) and within 50 feet of vertical points of inflection on slopes exceeding 30%.
- B. Construct concrete barriers such that the bottom of the collar extends at least 12 inches into the pipe base, at least 12 inches into each side of the walls of the trench, and at least 12 inches above the top of the pipe zone.

3.10 STRUCTURAL EXCAVATION

- A. Provide all required shoring, cribs, cofferdams, and caissons including all pumping, bailing, draining, sheathing, bracing, and related items.
- B. If conditions permit, slope excavation sides as excavation progress to maintain a safe and clean working area as required by OSHA.
- C. Support excavation. Do not interfere with the bearing of adjacent foundations, pipelines, etc.

- D. All unauthorized excavation below the specified structure subgrade shall be replaced with concrete, monolithic with that of the slab above or with coarse gravel thoroughly compacted into place.
- E. Subgrade soil for all concrete structures shall be firm, dense, thoroughly compacted, and consolidated.
- F. Subgrade soil shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen engaged in subgrade surfacing, laying reinforcing steel, and depositing concrete.
- G. Coarse gravel or crushed stone may be used for subsoil reinforcement if results satisfactory to the Engineer can be obtained thereby.
 - 1. Material shall be applied in lifts of 6" or less.
 - 2. Each lift shall be embedded in the subsoil by thorough tamping.
 - 3. All excess soil shall be removed to compensate for the displacement of the gravel or crushed stone and the finished elevation of any subsoil reinforced in this manner shall not be above the specified subgrade.

3.11 BACKFILLING FOR STRUCTURES

- A. Do not fill adjacent to structures until approval is obtained from Engineer.
- B. All forms shall be removed and the excavation shall be cleaned of all trash and debris.
- C. Backfill areas to contours and elevations indicated. Do not use frozen materials.
- D. Do not use compaction equipment adjacent to walls or retaining walls that may cause wall to become over stressed or moved from final alignment.
- E. Place select fill a minimum of 3 feet around the outside of structures.
- F. Place and compact select fill materials in continuous lifts not exceeding 12" loose depth.
- G. Place and compact common fill material in continuous lifts not exceeding 8" loose depth.
- H. Do not disturb or damage foundation perimeter drainage, foundation, dampproofing, foundation waterproofing and protective cover, or utilities in trenches.
- I. Backfill against foundation walls simultaneously on each side. Do not backfill against walls until concrete has obtained 7 day strength.

- J. Make smooth changes in grade. Blend slopes into level areas.
- K. Remove surplus backfill materials from site.
- L. Leave stockpile areas completely free of excess fill materials.
- M. Slope grade away from structure at a minimum of 3" in 10 feet unless otherwise indicated.
- N. Compaction: Each layer of material shall be compacted by hand or machine tampers or by other suitable equipment to a density equal to 95% of maximum dry density as measured by AASHTO T-99.
- O. Restore any damaged structure to its original strength and condition and re-backfill to specifications.

3.12 ROADWAY EXCAVATIONS

- A. In advance of setting line and grade stakes, clean subgrade area of brush, weeds, vegetation, grass, and debris. Drain all depressions or ruts which contain water.
- B. A soils classification, as determined by AASHTO T-27, shall be made on the proposed subgrade, and the following shall be required based on that classification:

Road Subgrade Preparation Schedule

Soil Classification	Requirement
A-1, A-2, or A-3	The subgrade shall be scarified to a depth of 8" and the loosened material shall be moistened and compacted to the equivalent of 95% of maximum dry density as measured by AASHTO T-99.
A-4 or A-5	The subgrade shall be over-excavated a minimum of 8" subgrade scarified and compacted, replaced with A-1 granular material, and be moistened and compacted as above.
A-6 or A-7	The subgrade shall be over-excavated a minimum of 12" subgrade scarified and compacted, replaced with A-1 granular material, and be moistened and compacted as above.

- C. No organic material, soft clay, spongy material, or other deleterious material will be permitted in the scarified or imported subgrade layer.

- D. Rough subgrades shall be shaped and graded to within a tolerance of 0.15 feet of design grade and drainage shall be maintained at all times.
- E. Moisture content of the subgrade layer shall be maintained at not less than 95% or more than 105% of optimum moisture content, during the compaction process. The entire roadbed, to one foot in back of curb, must be compacted to the specified density to a minimum depth of 8 inches.
- F. If removal of boulders, rubble, or existing improvements, found within the excavated area results in a lower excavation elevation than indicated, backfill over excavation in a manner approved by the Engineer.
- G. Remove all deposits susceptible to frost heave.
- H. Excavations through or under streets, sidewalks, street shoulders, driveways, etc. shall comply with the following requirements:
 - 1. The trench shall be filled with select fill as per Section 31 23 24.
 - 2. The trench shall be filled to the existing surface level.
 - 3. Within 10 days of the fill, sufficient fill material shall be removed and replaced with material comparable to the adjacent surface material shall meet the requirements of Section 31 23 24 of these specifications.
 - 4. The Engineer shall inspect all work.

3.13 SUBGRADE PREPARATION

- A. Compact subgrade surfaces to density specified for overlying backfills. Refer to Section 31 23 27.
- B. If areas of subgrade not readily capable of in-situ compaction, secure Engineer's authorization for extra excavation and backfill.
- C. Maintain minimum overburden cover of 2 feet over pipelines or conduits during subgrade preparation.

3.14 BACKFILLING FOR PAVEMENT

- A. Before beginning backfilling operations obtain Engineer's approval of excavation operation.
- B. Do not damage subsurface structures or service lines.
- C. Process backfill and avoid segregation. Keep base course free from pockets of coarse or fine material.

- D. Deposit base course on the roadbed in a uniform manner which will provide the required compacted thickness. Maintain moisture content.
- E. Shoulders are an integral part of the embankment. Do not build shoulders to a grade higher than that of the adjacent granular base course. Maintain efficient surface runoff at all times.
- F. Compaction: in accordance with Section 31 23 27.
- G. Proof roll prior to placing pavements.

3.15 BLASTING

- A. Blasting will not be allowed except by permission from the Engineer.
 - 1. The Contractor shall comply with all laws, ordinances, and applicable safety code requirements and regulations relative to the handling, storage, and use of explosives and protection of life and property.
 - 2. And he shall be fully responsible for all damage attributable to his blasting operations.
 - 3. Excessive blasting or overshooting will not be permitted and any material outside the authorized cross-section which may be shattered or loosened by blasting shall be removed by the Contractor.

3.16 ROCK FACES

- A. Scale rock cuts of all loose rocks and fragments and leave in a neat and safe condition.

3.17 COMPACTION OF BACKFILL

- A. In accordance with Section 31 23 27.

3.18 IMPORTED BACKFILL MATERIAL

- A. In the event the native excavated material is not satisfactory for backfilling as determined by the Engineer, the Contractor shall provide imported granular fill in accordance with Section 31 23 24.

3.19 DISPOSAL OF EXCESS MATERIALS

- A. All excess material shall be hauled away from the construction site and disposed of by the Contractor.

3.20 HISTORICAL, ARCHAEOLOGICAL, AND PALEONTOLOGICAL AREAS

- A. Protect areas per UDOT Standard Specifications Section 01 35 43
Environmental Protection - Discovery of Historic, Archaeological or Paleontological
Objects.

END OF SECTION

Section 31 23 43 – RESTORATION OF SURFACE IMPROVEMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Restoration of surface improvement requirements.

1.2 GENERAL IMPROVEMENT REQUIREMENTS

- A. The Contractor shall be responsible for the protection and the restoration or replacement of any improvements existing on public or private property at the start of work or placed there during the progress of work.
- B. Existing improvements shall include but are not limited to permanent surfacing, curbs, ditches, driveways, culverts, fences and walls. All improvements shall be reconstructed to equal or better, in all respects, to the existing improvements removed.

PART 2 – PRODUCTS

2.1 REFERENCED SECTIONS

- A. Select Fill: In accordance with Section 31 23 24.
- B. Concrete: In accordance with Section 03 30 00.

PART 3 - EXECUTION

3.1 ROAD BASE REPAIR

- A. Where trenches are excavated through gravel surfaced areas such as roads and driveways, etc., the gravel surface shall be restored and maintained as follows:
 - 1. The gravel shall be placed deep enough to provide a minimum of 6-inches of material.
 - 2. The gravel shall be placed in the trench at the time it is backfilled. The surface shall be maintained by blading, sprinkling, rolling, adding gravel, etc., to maintain a safe uniform surface satisfactory to the Engineer. Excess material shall be removed from the premises immediately.
 - 3. Material for use on gravel surfaces shall be obtained from sound tough durable gravel or rock meeting the requirements of Section 31 23 24.

3.2 BITUMINOUS SURFACE REPAIR

- A. Where trenches are excavated through bituminous surfaced roads, driveways or parking areas, the surface shall be restored and maintained as follows:
 - 1. Trenches shall be backfilled with untreated base course from the pipe bedding to 3 inches from the top of existing asphalt.
 - 2. Asphalt shall be saw cut back 12 inches from existing trench wall's and compacted as shown on standard drawing.
 - 3. Pavement restoration shall include priming of pavement edges with bituminous material and placing and rolling plant mix bituminous material to the level of the adjacent pavement surfaces.

3.3 CONCRETE REPAIR

- A. All concrete curbs, gutter, sidewalks, and driveways shall be removed and replaced to the next joint or scoring lining beyond the actually damaged or broken sections.
- B. In the event that joints or scoring lines do not exist or are three or more feet from the removed or damaged section, the damaged portions shall be saw cut, removed, and reconstructed to neat, plane faces.
- C. All new concrete shall match, as nearly as possible, the appearance of adjacent concrete improvements.
- D. Where necessary, lampblack or other pigments shall be added to the new concrete to obtain the desired results.
- E. All concrete work shall conform to the requirements of Section 03 30 00 of these Specifications.

END OF SECTION

SECTION 31 32 19 – GEOSYNTHETICS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Geosynthetics (geotextiles and geogrids) used for soil stabilization, erosion control, weed barrier, and drainage applications.

1.2 RELATED SECTIONS

- A. Section 01 57 13: Temporary Erosion and Sediment Control

1.3 REFERENCES

- A. AASHTO M 288: Geotextile Specification for Highway Applications

1.4 DEFINITIONS **Not Used** (or provide list of definitions needed for this section)

1.5 SUBMITTALS

- A. Manufacturer's product data sheet and recommended installation instructions.

1.6 PACKAGING, SHIPPING, AND STORING

- A. Protect the geosynthetic 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 manufacturer
 - b. Brand name of the product, width, length, and package weight

PART 2 - PRODUCTS

2.1 SILT FENCE GEOTEXTILE

- A. Refer to Section 01 57 13

2.2 EROSION CONTROL GEOTEXTILE

- A. Conforming to AASHTO M 288.

2.3 DRAINAGE GEOTEXTILE

- A. Class 2 nonwoven drainage geotextile according to AASHTO M 288.

2.4 SEPARATION GEOTEXTILE

- A. Class I fabric according to AASHTO M 288 with Apparent Opening Size of 0.60 mm maximum average roll value.

2.5 STABILIZATION GEOTEXTILE

- A. Class I fabric according to AASHTO M 288 with Apparent Opening Size of 0.43 mm maximum average roll value.

2.6 WEED BARRIER GEOTEXTILE

- A. Woven, needle-punched, polypropylene, 5.0 oz, weed barrier geotextile designed for commercial use.

2.7 STABILIZATION AND REINFORCEMENT GEOTEXTILE

- A. Manufacturer:

TenCate Geosynthetics Americas
365 South Holland Drive
Pendergrass, GA, USA 30567
1-800-685-9990
www.tencategeo.us
- B. Approved geotextiles: Mirafi® RS280i
- C. Substitutions shall be approved prior to use. Furnish all relevant data with comparison to the above approved product.

2.8 NONWOVEN GEOTEXTILE

- A. Pervious sheet of polyester, polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other. Nonwoven geotextile shall be composed of continuous or discontinuous (staple) fibers held together through needle-punching, pun-bonding, thermal-bonding, or resin-bonding.
- B. Geotextile Edges: Selvaged or otherwise finished to prevent outer material from pulling away from geotextile.
- C. Unseamed Sheet Width: Minimum 12 feet.
- D. Nominal Weight per Square Yard: 12 oz.

- E. Physical Properties: Conform to requirements in Table 1:

Table 1 PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE		
Property	Requirement	Test Method
Water Permittivity	1.2 sec. ⁻¹ , MinARV	ASTM D4491 (Falling Head)
Apparent Opening Size (AOS)	100 U.S. Standard Sieve Size	ASTM D4751
Grab Tensile Strength, Machine Direction	325 lb/in, MinARV	ASTM D4632
Grab Elongation, Machine Direction	50 percent, MaxARV	
Puncture Strength	150 lb, MinARV	ASTM D4833
Trapezoid Tear Strength	130 lb, MinARV	ASTM D4533
Ultraviolet Radiation Resistance	90 percent strength retention, MinARV after 500 hours	ASTM D4355

PART 3 - EXECUTION

3.1 GENERAL

- A. Place geotextile on areas that are smooth and free of projections or depressions.
- Do not drag the geotextile across the subgrade.
 - 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.
- 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.
- Use at least a 6 inch thick cover layer or twice the maximum aggregate size, whichever is thicker.
 - 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.

3.2 INSTALL SILT FENCE GEOTEXTILE

- A. Refer to Section 01 57 13

3.3 INSTALL EROSION CONTROL GEOTEXTILE

- A. Install at locations shown.
- B. Overlap the geotextile at least 2 ft 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 ft beyond the perimeter of the tear or damage.

3.4 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 ft in the down-gradient direction of flow.
- D. Overlap geotextile at least 1 ft 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 ft beyond the perimeter of the tear or damage.

3.5 INSTALL SEPARATION GEOTEXTILE

- A. Install for pavement sections or other applications at locations shown.

- B. Overlap the geotextile at least 1 ft at all longitudinal and transverse joints or sew the geotextile unless otherwise specified.
- C. Repair – Place patch over damaged area and extend 3 ft 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.

3.6 INSTALL STABILIZATION GEOTEXTILE

- A. Install stabilization geotextile at locations shown.
- B. Overlap the geotextile at least 2 ft 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 ft 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.

3.7 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 ft 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.

3.8 SEW

- A. Perform sewing as specified in AASHTO M 288, Appendix, Seaming.

3.9 INSTALL STABILIZATION AND REINFORCEMENT GEOTEXTILE

- A. Place geotextile per the manufacturer's installation requirements.
- B. Do not operate equipment directly on the fabric.
- C. Unroll the geotextile in the direction of travel so that the machine direction is parallel with traffic flow.
- D. Minimum overlap of 12 inches between adjacent rolls.
- E. End-dump or back-dump all fill material on the fabric and spread with low-pressure tracked equipment. Maintain a minimum of 12 inches of fill material between the fabric and equipment tracks.

END OF SECTION

SECTION 31 35 00 - GEOTEXTILES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Materials and procedures for installing geotextiles of the type(s) shown on the drawings, and at other locations as directed by the Engineer.

1.2 REFERENCES

- A. AASHTO M 288: Geotextile Specifications for Highway Applications.
- B. ASTM D 4791: Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.3 SUBMITTALS

- A. Submit prior to use: Manufacturer's certificate that each fabric complies with requirements of this Section.

1.4 SAMPLING AND TESTING

- A. Follow UDOT Minimum Sampling and Testing Requirements.
- B. Prior to shipment, test each individual shipment and lot of geotextile, and send testing reports with the shipment to the job site. Clearly label all rolls as being part of the same production run certified as meeting all material requirements.

1.5 PACKAGING, SHIPPING, AND STORING

- A. Protect the geotextile from direct sunlight, chemicals, mud, dirt and debris during shipment and storage. Replace at the Contractor's sole expense, any geotextile damaged or deteriorated during shipping, storage or construction.
- 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
 - c. Orange UDOT Certification sticker

1.6 ACCEPTANCE

- A. Owner rejects geotextile at installation if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transport, handling or storage.
- B. Non-compliance with UDOT Minimum Sampling and Testing Requirements will be a basis for rejection.

PART 2 - PRODUCTS

2.1 EROSION CONTROL GEOTEXTILE

- A. Furnish as specified in AASHTO M 288.

2.2 DRAINAGE GEOTEXTILE

- A. Furnish non-woven drainage geotextile as specified in AASHTO M 288 with in-situ soil designations as shown on the drawings or as indicated by the Engineer.
- B. Notify Engineer if soil conditions are different than shown on the drawings.

2.3 SEPARATION GEOTEXTILE

- A. Furnish as specified in AASHTO M 288.

2.4 STABILIZATION GEOTEXTILE

- A. Furnish as specified in AASHTO M 288.

2.5 WEED BARRIER GEOTEXTILE

- A. Woven, needle-punched, polypropylene, 5.0 oz, weed barrier geotextile designed for commercial use.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place geotextile on areas that are smooth, and free of projections or depressions. Do not drag the geotextile across the subgrade. 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. When placed for construction, cover the geotextile with indicated cover material as soon as possible. Do not leave uncovered for more than 5 days.
- D. Place cover material on the geotextile in a manner that the geotextile is not torn, punctured, or shifted. Use a minimum 6 inches thick cover layer, or twice the maximum aggregate size, whichever is thicker. 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 the lesser. Turning of vehicles on the first layer is not permitted.

3.2 INSTALLING EROSION CONTROL GEOTEXTILE

- A. Install at locations shown on the drawings.
- B. Unless otherwise specified, overlap the geotextile a minimum of 2 feet at all longitudinal and transverse joints, or sew the geotextile. For sewing requirements, refer to this Section, article, "Sewing".
- C. If overlapped, place the geotextile so that the upstream sheet overlaps the downstream sheets.
- D. For placement on slopes, overlap each sheet over the next downhill sheet.
- E. Anchor the geotextile using key trenches or aprons at the crests and toes of the slope.
- F. Pins, usually 18 inches in length may be helpful in securing the geotextile during installation.
- G. Repair: Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

3.3 INSTALLING DRAINAGE GEOTEXTILE FOR SUBSURFACE DRAINAGE

- A. Excavate trench to size and depth indicated.
- B. Cut geotextile to width required and place in trench. Prevent damage to geotextile.
- C. Overlap geotextile 12 inches or the full width of the trench, whichever is less, at the top of the trench.
- D. Overlap successive sheets of geotextile a minimum of 12 inches in the direction of flow.
- E. Place fill beginning with the sheet(s) overlapped above subsequent sheet(s), to hold geotextile in place.
- F. Repair any damage to geotextile by placing patches extending 3 feet in all directions beyond the damaged area.

3.4 INSTALLING SEPARATION GEOTEXTILE

- A. Install for pavement sections or other applications at locations shown on the drawings.
- B. Unless otherwise specified, overlap the geotextile a minimum of 1 foot at all longitudinal and transverse joints, or sew the geotextile. For sewing requirements, refer to this Section, article, "Sewing."
- 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 sheet(s) overlapped above subsequent sheet(s), to hold geotextile in place.
- E. Pins, usually 18 inches in length, may be helpful in securing the geotextile during installation.

3.5 INSTALLING STABILIZATION GEOTEXTILE

- A. Install Stabilization Geotextile at locations shown on the drawings, or as designated by the Engineer.
- B. Unless otherwise specified, overlap the geotextile a minimum of 2 feet at all longitudinal and transverse joints, or sew the geotextile. For sewing requirements, refer to this Section, article, "Sewing."
- C. For placement on slopes, overlap each sheet over the next downhill sheet.
- D. Repair: Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

- E. Place fill, beginning with the sheet(s) overlapped above subsequent sheet(s), to hold geotextile in place.
- F. Pins, usually 18 inches long, may be helpful in securing the geotextile during installation.

3.6 INSTALLING WEED BARRIER GEOTEXTILE

- A. Preparation:
 - 1. Remove sharp objects, large stones and undesirable vegetation.
 - 2. If placing geotextile over an existing bed, cut an "X" over each plant and push geotextile under plant base. If placing over a new bed, roll geotextile over soil and cut an "X" for each plant hole. Fold excess geotextile under and cover with specified landscaping materials.
- B. Surface Cover: Provide a minimum of 4 inches of cover on all areas on the geotextile unless otherwise specified by Engineer. If using large landscape rock, increase thickness of cover material over geotextile up to 3 times the diameter of the largest rock material based on Engineer=s recommendations. Do not leave any portion of geotextile exposed to direct sunlight.
- C. Repair: Repair immediately if damaged. Remove the damaged area plus an additional 3 feet and apply geotextile patch.
- D. Maintenance: Maintain surfaces and supply additional landscape materials where necessary, including areas affected by erosion.

3.7 SEWING

- A. Perform sewing (seaming) as specified in AASHTO M 288, Section A1-4.

END OF SECTION

SECTION 31 37 00 – RIPRAP

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Loose and compacted riprap.

1.2 RELATED SECTIONS

- A. Section 31 32 19: Geosynthetics

1.3 REFERENCES

- A. AASHTO T 85: Specific Gravity and Absorption of Coarse Aggregate
- B. AASHTO T 96: Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- C. AASHTO T 104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

1.4 DEFINITIONS

- A. D_{50} - The median rock diameter within a riprap mass for which 50 percent of the rocks are smaller and 50 percent are larger.
- B. Rock diameter - The equivalent diameter (average width) of a given rock.

1.5 SUBMITTALS

- A. The rock source, gradation, and laboratory values for the properties in Table 1, for information.

PART 2 - PRODUCTS

2.1 RIPRAP

- A. Rock
 - 1. Angular, hard, durable, resistant to weathering and free from seams, cracks and other structural defects.
 - a. Do not use shale, mudstone, or other rock that may break into smaller pieces in the process of handling and placing.
 - b. Do not use concrete or asphalt rubble.
 - 2. Meet the properties listed in Table 1.

Table 1 - Physical Properties		
Property	Value	Test Method
Specific Gravity	2.5 min	AASHTO T 85
Absorption	2% max	AASHTO T 85
Soundness of Aggregate using Sodium Sulfate or Magnesium Sulfate	12% max or 17.5% max	AASHTO T 104
Resistance to Degradation	40% max	AASHTO T 96

3. Well graded rock throughout the riprap layer to produce a dense mass. Refer to Table 2 for riprap gradation limits.
 - a. Control gradation by sample measurement or by visual inspection, as determined by the Engineer.

Table 2 - Riprap Gradation Limits	
Rock Diameter Range (ft)	Percent of Gradation Smaller Than
$1.5D_{50}$ to $1.7D_{50}$	100
$1.2D_{50}$ to $1.4D_{50}$	85
$1.0D_{50}$ to $1.15D_{50}$	50
$0.4D_{50}$ to $0.6D_{50}$	15
$0.1D_{50}$	10

2.2 EROSION CONTROL GEOTEXTILE

- A. Refer to Section 31 32 19, except use a nonwoven 12 oz/yd² maximum average roll value.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Excavate and grade to provide a firm and uniform bearing surface.
- B. Install erosion control geotextile as shown.

3.2 LOOSE RIPRAP

- A. Place rocks to provide a secure unsegregated dense mass.

1. Distribute and manipulate the rocks so that the larger rocks are uniformly distributed and the smaller rocks serve to fill the spaces between the larger rocks.

3.3 COMPACTED RIPRAP

- A. Place rocks conforming to this Section, Article 3.2.
- B. Compact riprap to remove irregular surface protrusions larger than 3 inches.

END OF SECTION

SECTION 31 40 00 - SHORING AND UNDERPINNING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Shoring for open excavations requiring a protective system.

1.2 REFERENCES

- A. OSHA Construction Standards Chapter P: Excavations, Trenching, and Shoring.

1.3 RESPONSIBILITY

- A. Contractor is solely responsible for safety. It is the Contractor's responsibility to adhere to all of OSHA's current regulations.

1.4 DEFINITIONS

- A. Accepted Engineering Practices: Those requirements or practices which are compatible with standards required by a duly licensed or recognized authority.
- B. Benching: A method of protecting persons and property against cave-ins by excavation the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.
- C. Excavation: Any man-made cut, cavity, or depression in an earth surface, including trenches, formed by earth removal and producing unsupported earth conditions (sides). If installed forms or similar structures reduce the depth-to-width relationship, and excavation may become a trench.
- D. Failure: The permanent deformation or breakage of a structural member or connection; or the collapse of all or part of an excavation.
- E. Protective System: Any recognized method of protecting persons and property against cave-ins, the collapse of adjacent structures, or material that may fall or roll from an excavation side or into an excavation. Protective systems include support systems, sloping and benching systems and shield systems.
- F. Shield/Trenchbox: A structure that is able to withstand the forces imposed on it by a cave-in and thereby protect persons and property within the structure without preventing a cave-in. Shields may be permanent structures or may be designed to be portable and moved along as work progresses. Portable shields used in trenches are usually referred to as "trench boxes" or "trench shields".
- G. Shoring: A structure that supports the sides of an excavation and thereby protects persons and property by preventing cave-ins.

- H. Sides: A vertical or inclined earth surfaces formed at the outer edges of an excavation.
- I. Sloping: A method of protecting persons and property against cave-ins by excavation to form sides that are inclined away from the excavation, the angle on incline being of such a degree for the conditions of exposure that a cave-in will not occur.
- J. Support System: A structure which protects persons and property by providing support to an adjacent structure, underground installation, or the sides of an excavation.
- K. Trench: A narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet.

1.5 DESIGN OF PROTECTIVE SYSTEMS

- A. Use professional engineer to design support systems, shield systems, and the structural components of these systems, and sloping and benching systems to resist without failure all loads that are intended to be imposed or transmitted to them.
- B. Fully compensate in design procedures for hydrostatic pressure in the excavation sides.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials shall be as per 1.05 of this section

PART 3 - EXECUTION

3.1 STABILITY OF ADJACENT STRUCTURES

- A. Use support systems such as shoring, bracing, or underpinning where stability of adjoining buildings, walls, sidewalks, pavements, or other structures is endangered by excavation operations.

3.2 INSPECTIONS

- A. Contractor/Developer shall employ and have on site at all times a competent person, as defined by OSHA, who is responsible for excavation inspection.
- B. Inspect excavations daily for evidence of possible cave-ins, indications of failure of protective systems, or other hazardous conditions.

- C. Upon discovery of hazardous conditions, cease all work in the excavations until additional precautions have been taken to ensure persons and property safety.

3.3 ADDITIONAL REQUIREMENT FOR TRENCH EXCAVATION

- A. Do not excavate material to a level greater than 2 feet below the bottom of the members of a support system if the system is designed to resist the forces calculated for the full depth of the trench, and indications of a possible cave-in below the bottom of the support system are not evident while the trench is open.

END OF SECTION

SECTION 31 71 00- TUNNEL EXCAVATION AND INITIAL SUPPORT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section presents requirements for tunnel excavation and the installation of the Initial Support associated with the work, including furnishing all labor, equipment, and materials for tunnels in the Contract.
- B. Section 1.06 specifies allowable tunnel construction methods for each tunnel.

1.02 RELATED WORK

- A. Related documents and Specification Sections include but are not necessarily limited to:
 - 1. 31 09 13 – Geotechnical Instrumentation and Monitoring
 - 2. 31 73 00 – Contact Grout
 - 3. 31 74 23 – Carrier Pipe Installation and Backfill
 - 4. 31 75 00 – Construction Shafts
 - 5. Geotechnical Baseline Report (GBR), Lithos Engineering/GEI Consultants
 - 6. Geotechnical Investigation Report (GIR), RB&G Engineering

1.03 DEFINITIONS

- A. CASING PIPE: Pipe installed along the designed tunnel alignment that also serves as the Initial Support.
- B. CARRIER PIPE: Pipe that carries the product fluid.
- C. CUTTERHEAD: The leading face of a rotary tunnel excavation system that is responsible for excavation of the ground.
- D. CUTTING SHOE: Reinforcement provided at the leading edge of the casing pipe string, which provides support, rock breaking capabilities and directs spoils into the casing pipe during ramming.
- E. GOVERNING AGENCY: Agency which owns and/or operates the property in which the tunnel work will be conducted.
- F. GUIDANCE SYSTEM: A system that is utilized to guide the tunnel excavation along the design line and grade within specified tolerances.

- G. GUIDED AUGER BORING: The trenchless installation of a Casing Pipe by Jacking and rotary excavation using a Cutterhead and attached auger string. Line and grade are maintained through the use of a Guidance System. Capable of accurate steering in both line and grade directions.
- H. HAND EXCAVATION: A tunnel excavation technique in which the ground is removed using hand tools either powered or unpowered. Also known as hand mining.
- I. INITIAL SUPPORT: Temporary ground support installed concurrent with tunnel excavation to maintain tunnel stability prior to installation of the Carrier Pipe. Includes Casing Pipe.
- J. INTERMEDIATE JACKING STATION (IJS): A Series of hydraulic jacks temporarily installed between two Casing Pipe segments that provide additional Jacking force.
- K. JACKING: The process of installing a Casing Pipe into the ground using hydraulic jacks to push from the launch shaft while excavating muck at the face with mechanized equipment.
- L. LAUNCH SEAL: A seal that is fitted on the shaft wall and through which the boring machine and casing pipe passes to avoid inflow of groundwater and ground into the tunnel shaft.
- M. OBSTRUCTION: Objects or portions of objects located within the cross-sectional area of the tunnel excavation face. An Obstruction shall be defined as:
 - 1. Makes further advancement of the tunnel impossible using techniques typically used for the current tunnel excavation method; and
 - 2. Has an unconfined compressive strength greater than 25,000 psi, or consists of steel, concrete, brick, timber, rock, rubble, or other artificial material.
- N. OVERCUT: The difference between the radius of the excavation created by the boring machine or cutting shoe as appropriate, and the outside radius of the Initial Support.
- O. OVERCUT BAND: A thin band attached to the front of the first Casing Pipe segment or cutting head used to create an Overcut and lessen skin friction and decrease required installation forces.
- P. SHIELD MINING: A tunnel excavation technique using a Tunnel Shield in which the ground is removed using a hydraulic digger or Hand Excavation.
- Q. TUNNEL BORING MACHINE (TBM): A non-pressurized, rotary method of tunnel excavation operated from inside the tunnel, capable of accurate steering in both line and grade directions.

- R. TUNNEL SHIELD: A steel cylinder that provides ground support at the tunnel face and the leading edge of the Initial Support and is advanced through the ground with the Casing Pipe. Capable of accurate steering in both line and grade directions.
- S. TWO-PASS TUNNELING SYSTEM: A method of tunneling in which Initial Support is installed prior to installation of the Carrier Pipe.

1.04 REFERENCE STANDARDS

- A. ANSI/AWS D1.1 Structural Welding Code
- B. ASTM A36 / A36M-19 - Standard Specification for Carbon Structural Steel
- C. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- D. ASTM A252 – Standard Specification for Welded and Seamless Steel Pipe Piles
- E. ASTM 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.

1.05 GENERAL REQUIREMENTS

- A. Be responsible for design and construction of Initial Support, and performance of the tunnel excavation.
- B. Minimum design requirements are presented herein. Be responsible for developing and implementing the design to fulfill the specified design requirements provided by the Engineer which are necessary for completion of the work.
- C. Perform tunnel excavation in accordance with all Governing Agencies, applicable permits and requirements, and all applicable laws and regulations.
- D. Construct and install tunnel Initial Support concurrently with the tunnel excavation. Exposed, unsupported ground will not be allowed.
- E. Provide means to control the face of the tunnel in the case of loss of ground integrity. Face control can include but is not limited to: slurry, the cutterhead, competent soil plugs, ground improvement, sand bags, breasting boards/plates, shotcrete, or other means subject to approval of the Engineer.

- F. The Contractor will select Initial Support while adhering to requirements specified herein.
 - 1. Safely withstand all installation and long-term loads, and specifically: ground and highway surcharge; and construction and machine loads including non-uniform loading, and stress concentrations.
 - 2. Include all loads and stresses caused by fabrication, transportation, and construction operations including handling, erecting, and grouting pressures.
 - 3. Minimum Casing Pipe thickness is specified herein. Increase Casing Pipe thickness as necessary to correspond with Contractor equipment, safely resist applied loads, and to control ground movement.

1.06 ALLOWABLE TUNNELING METHODS

- A. Allowable tunnel excavation methods include:
 - 1. Tunnel Boring Machine
 - 2. Shield Mining
 - 3. Guided Auger Boring
- B. All techniques require steel Casing Pipe as Initial Support.
- C. Allowable methods have been selected based on anticipated ground conditions and ground behavior as described in the GBR and in conjunction with the dimensions of the tunnel. The Contractor may propose to use an alternative system for tunnel excavation and support. Any alternative methods are subject to approval by the Owner, Engineer, and Governing Agencies. Note that approval of specified methods has been obtained by the Governing Agencies prior to bid and approval of alternative methods may result in substantial time delays and will be the sole responsibility of the Contractor.

1.07 GROUND CONDITIONS:

- A. Information regarding the ground conditions to be anticipated can be found in the GBR and GIR.

1.08 GASSY CONDITIONS

- A. Adhere to OSHA 29 CFR 1926 Subpart S (1926.800) and all other applicable regulations regarding working where naturally occurring gasses may be present.
- B. Tunnels are classified as Potentially Gassy.

1.09 QUALIFICATIONS

- A. Tunnel contractors will substantially perform all tunnel construction work. Subcontracting of major aspects of the tunnel work will not be allowed. Ancillary work may be subcontracted; for example, trucking and grout supply/mixing.
- B. The Contractor directly engaged in tunnel excavation and support work will have completed at least three tunnel projects during the past two years using similar methods as allowed and selected for use under Section 1.06 and similar scope as proposed for this project. This experience will cover the full range of tunnel excavation components and work items including but not limited to the excavation of the tunnel, disposal of muck, and control of the encountered conditions. These jobs must be completed at the time of bidding to count as relevant experience for this project.
- C. The onsite foreman for tunnel construction shall have:
 - 1. At least five years of construction experience with excavation and support of tunnels
 - 2. Successfully completed at least two similar jobs within the last three years using excavation and support methods similar to those proposed by the Contractor.
- D. All personnel employed by the Contractor in the work will be experienced and competent in their respective tasks and will work only under the direct control of a suitably experienced foreman or superintendent.
- E. Design of engineered structures as defined herein will be signed and sealed by a Registered Professional Engineer in the State of Utah who has completed a minimum of two tunnel projects of similar scope in the past five years. These jobs must be completed at the time of bidding to count as relevant experience for this project.

1.10 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two weeks before the scheduled start of the applicable activity. Each number submittal below is to be submitted as a single package, i.e. submit all portions of the 2. Tunnel Work Plan as a single submittal package.
 - 1. Submit qualifications as stated in 1.09.
 - 2. Tunnel Work Plan. Submit a detailed work plan of all proposed tunnel construction operations and Initial Support provisions. Include a description and drawings of proposed methods and procedures for:
 - a. Working drawings including the launch and retrieval shaft layouts, ancillary equipment, thrust block and/or rail system configuration, and limits of construction during tunneling;

- b. Tunnel excavation equipment to be used including manufacturer literature, drawings, as-built and modified dimensions, and capacities;
 - c. Line and grade surveying methods during installation;
 - d. Excavating the tunnel including description of activities involved in a single cycle of excavation and Initial Support Installation;
 - e. Addressing and handling excavating the tunnel in mixed face conditions where shown in the GBR
 - f. Procedures for measuring excavated muck quantities versus the installed length or progress during tunneling operations;
 - g. Description and location of IJS's as required herein.
 - h. Lubrication system and lubricants;
 - i. As necessary, Casing Pipe coupling methods to maintain pipe segment alignment during installation;
 - j. Hauling and disposal of excavated muck, including disposal site details;
 - k. Detailed contingency plans for the following:
 - 1) Obstructions (as defined herein) encountered during tunnel construction;
 - 2) Settlement and/or heave;
 - 3) Loss of line and grade during tunnel construction.
3. For the tunnel installation method selected, submit a plan to maintain stability of the face and prevent ground loss at the beginning of the drive. This may include but is not limited to: ground modification outside the shaft and machine design.
4. If Initial Support selected by the Contractor differs from as provided in Part 2, Initial Support design calculations including loads, methods, assumptions, results, and safety factors.
 - a. Include as a minimum, evaluation of axial, flexural and shear of the Initial Support in uniform and non-uniform loading and support conditions as dictated by the proposed installation techniques and long-term loading. A safety factor appropriate for the level of uncertainty and the nature of the construction shall be applied.
 - b. Calculations shall be signed and stamped by a Professional Engineer Registered in the State of Utah with minimum qualifications as stated in Section 1.09.
5. The Contractor will submit dewatering plans, if required, for approval in locations where Shaft or Tunnel excavations extend beneath baselined groundwater elevations as indicated in the GBR. The Contractor shall develop and submit groundwater related contingency plans including:
 - a. Contingency plan to handle excess water encountered in the tunnel.
 - b. Contingency plan to address unstable ground encountered in the tunnel due to incomplete dewatering.
6. Schedule. A critical path schedule of tunneling-related activities and activities for project components interfacing with the tunnel. The schedule will include at a minimum:

-
- a. Duration for launch and receiving shaft or pit excavation;
 - b. Launch pit set up; and
 - c. Anticipated daily production rate for tunnel excavation and initial support installation;
 - d. Contact Grouting;
 - e. Carrier Pipe Installation; and
 - f. Backfill Grouting, as applicable.
 7. Submit Manufacturer's written certifications that Initial Support materials meet or exceed the specified requirements as stated herein.
 8. Contractor's safety plan for personnel conducting tunneling operations including, but not necessarily limited to, provisions for ventilation, temperature control, lighting, electrical safeguards, safety of the public, monitoring, and warning systems, submittal will be for information only and not approved or disapproved by Engineer;
 9. Certifications of qualified welders where welding is required.
 - B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
 1. Provide Written Daily Logs including: a summary of encountered ground conditions and ground behavior; the length of excavated and supported tunnel; an estimate of estimated muck quantity; and a general summary of daily tunneling activities. Written Daily Logs are to be recorded by the Contractor's onsite personnel and signed by the Contractor's Tunneling Superintendent for each shift and will be submitted to the Engineer within two working days of the date of the log.
 2. Instrumentation monitoring results as required herein and in Section 31 09 13 – Geotechnical Instrumentation and Monitoring.
 - C. Provide copies of reports as detailed in this specification and as required by public authorities to the Engineer within 24 hours following preparation and submittal to third party authority. These reports are for record purposes only.
 - D. Postconstruction Submittals:
 1. Record Drawings as detailed in Section 3.16.

PART 2 EQUIPMENT, PRODUCTS AND MATERIALS

2.01 EQUIPMENT

- A. The Contractor will determine and provide the equipment necessary for excavation and Initial Support of the tunnel and to complete all work associated with this Section within the ground conditions stated in the GBR, without impacts to overlying infrastructure, and without showing evidence of undue stress or failure. Backup equipment shall be required in the event of an equipment breakdown and where the condition of the equipment to be used indicates that routine component replacement or repair will likely be necessary during the work.
- B. Tunnel excavation equipment will have the following minimum attributes:
 - 1. Be capable of controlling the ground during excavation and shutdown.
 - 2. If applicable, have a system to minimize roll of the boring machine and Initial Support during installation and/or allow for rotation to correct roll.
 - 3. Be capable of being operated in a manner that will prevent loss of ground during excavation and be steerable and capable of controlling the advance of the heading to maintain line and grade within the tolerances specified.
 - 4. The excavation and installation equipment will be capable of handling and removing all anticipated material documented in the GBR.
 - 5. Have the minimum thrust capacity required to install the Casing Pipe.
- C. Guidance System
 - 1. For Guided Auger Boring:
 - a. Steerable at the machine head by means of hydraulically actuated panels, e.g. On-Target Steering System as manufactured by McLaughlin or approved equivalent.

2.02 PRODUCTS AND MATERIALS

- A. Minimum Initial Support diameters are listed on the Drawings. The Contractor may, at its discretion use a larger Initial Support diameter subject to approval by the Engineer and with supporting calculations.
- B. Casing Pipe:
 - 1. A Casing Pipe will be used for all roadway and/or highway crossings.
 - 2. The minimum casing pipe thickness for the minimum Casing Pipe diameter stated below is 0.625 inches or as required by the Governing Agency granting the utility permit; whichever results in a greater thickness. Casing Pipe thickness may be increased by the Contractor at its discretion.
 - 3. At a minimum the Casing Pipe will conform to ASTM A 252 Grade 2 steel and be manufactured specifically for jacking.

4. The pipe will be utilized in accordance with the pipe manufacturer's specifications, guidelines for tunnel installation, and recommendations of the equipment manufacturer.
 5. The contractor will adhere to pipe manufacturer's installation guidelines for:
 - a. Handling;
 - b. Launch shaft preparations;
 - c. End preparations, mating procedures; and
 - d. Installation.
 6. The Casing Pipe will be round. Casing Pipe are required to have a roundness tolerance so that the difference between the major and minor outside diameters are not exceed to lesser of 1% of the specified nominal outside diameter or 0.25-inches.
- C. Pipe Joints:
1. Jacked Casing – Either of:
 - a. Welded with a full penetration butt weld in accordance with ANSI/AWS D1.1.
 - b. T5 as manufactured by Permalok, Tri-Loc as manufactured by Trinity Products, or equivalent.
 2. The joints are to be in accordance with the pipe manufacturer's specifications and guidelines for jacked or rammed pipe.
- D. Grout Ports: Install grout ports as shown on the Contract Drawings and as specified in specification Section 31 73 00 – Contact Grout. Grout Ports are to be installed prior to Initial Support installation if Casing Pipe is used.
- E. Lubricant:
1. Lubricant used to reduce friction can consist of a mixture of polymer, water, and additives, and is the responsibility of the Contractor.
 2. Lubricant will be non-toxic, and not release environmental contaminants into the groundwater either directly or from degradation and shall comply with NSF/ANSI Standard 060

PART 3 EXECUTION

3.01 TUNNEL REQUIREMENTS - GENERAL

- A. Do not begin tunneling until:
1. Required preconstruction submittals have been made and the Engineer has reviewed and accepted submittals in writing.
 2. All required permits are in place and the Governing Agency has been satisfactorily notified of the schedule and work.
 3. Shaft excavations, stabilization and shoring have been satisfactorily completed in accordance with Section 31 75 00 – Construction Shafts.

4. The locations of all monitoring and instrumentation points have been established and initial baseline measurements have been obtained in accordance with Section 31 09 13 – Geotechnical Instrumentation and Monitoring.
 5. For each tunnel, a pre-job activity and safety meeting has been conducted with the Contractor and Engineer. Arrange this conference and inform the Engineer of the time and place of the conference at least seven days in advance of tunneling.
 6. Existing utilities near the proposed alignment have been identified both horizontally and vertically.
- B. Perform tunneling operations in a manner that will minimize loss of ground and minimize settlement or heave of the ground surface, structures, utilities and other facilities above and adjacent to the tunnel.
- C. Maintain clean working conditions at all times inside and around the tunnel and shafts. All excavated muck, and any other material not required for tunneling are to be removed from the excavation in a timely manner.
- D. Design, install and operate tunneling support utilities as necessary for support of construction and the safety of workers in accordance with project requirements and all Federal, State, and local laws, regulations, and codes. Utilities including but not be limited to electrical, lighting, water, and ventilation.

3.02 TUNNEL EXCAVATION - GENERAL

- A. Maximum radial Overcut is to be compatible with the subsurface conditions, stiffness characteristics of selected pipe, and joint system, tunnel diameter, and excavation method at the designed maximum installation loads. Overcut may not exceed 0.75-inches unless approved otherwise by the Engineer.
- B. Monitor and control the volume of muck removed. Compare theoretical and actual volumes of spoil removed as excavation progresses. Investigate potential voids created by over excavation and fill them with grout to avoid surface settlement or structure damage.
- C. During shutdowns and other interruptions in tunnel excavation work, provide means to maintain the integrity of the ground at the face of the tunnel.
- D. Avoid damage to pipe sections, joints, and overall Initial Support during tunnel construction. In the event of damage to a pipe section or pipe joint during Tunneling, the Contractor must notify the Engineer within the day of observation of the damage.
1. If a damaged Casing Pipe cannot be repaired, jack all damaged pipe sections completely through the tunnel following completion of tunnel excavation.

- E. Limit the jacking force to stay at or below safe working limit of the Initial Support.
- F. Continuously monitor and record the jacking loads at the jacking frame or boring machine as applicable.

3.03 INTERMEDIATE JACKING STATION

- A. Use of an IJS should be considered by the Contractor but is not required.
- B. If utilized, install an IJS or multiple IJS's in tunnel as necessary to maintain Jacking loads below the safe working limit of the Initial Support.

3.04 TUNNEL BORING MACHINE

- A. Requirements presented in Sections 3.01 and Section 3.02 of this Specification apply to this Section unless modified herein.
- B. The TBM Guidance System shall consist of an optical theodolite or laser-based system capable of continuously monitoring the location of the TBM head's position.
- C. Employ use of a cradle upon initial setup to properly align the TBM with the design line and grade.
- D. Operate the TBM in a manner to minimize movement of the ground in front of and surrounding the tunnel and to minimize loss of ground, surface settlement, and heave of the ground surface. Control the advance rate, volume of material excavated, and pressure applied to the tunnel face to avoid over-excavation, loss of ground, and heave of the ground surface.
- E. Maintain cutterhead pressure against the excavation face at all times, including during work shutdown periods.
- F. Steering corrections made to the alignment are to be carried out in such a manner that the joint angle of any two adjacent pipes or Initial Support segments does not exceed allowable limits.
- G. Record, at a minimum, the following data which will be made available to the Engineer:
 - 1. Maximum jacking load encountered during each segment advance;
 - 2. Cutter head torque;
 - 3. Steering pressures utilized to maintain or return to design line and grade;
 - 4. Cutter head RPM; and
 - 5. Line and grade.

3.05 SHIELD MINING

- A. Requirements presented in Sections 3.01 and Section 3.02 of this Specification apply to this Section unless modified herein.
- B. The Shield guidance system is to include an optical theodolite or laser-based system as capable of continuously monitoring the location of the Shield line and grade.
- C. Support the ground to provide safety, prevent loss of ground, and to keep the perimeter and face of the tunnel excavation stable. Maintain the ability to install breasting boards or other mechanical barriers across the entire the excavation face completely at all times.
- D. If the excavation is outside of firm, stable ground as outlined in the project GBR, equip the Shield with the ability to install sand shelves and breasting boards. Have sand shelves and breasting boards necessary to control the ground conditions outlined the project GBR onsite and readily available. Provide sand shelves wide enough to control the ground at its angle of repose and permit installation of breasting boards. Space sand shelves as necessary suitable for the ground conditions.
- E. Equip the shield with stabilizers and/or extendable fins that allow the equipment to maintain a level orientation and correct a condition in which the shield begins to roll.
- F. Control the advance rate, volume of material excavated, and pressure applied to the tunnel face to keep the tunnel excavation stable.
- G. Record, at a minimum, the following data which will be made available to the Engineer:
 - 1. Maximum jacking load encountered during each segment advance;
 - 2. Shield rotation angle;
 - 3. Steering pressures utilized to maintain or return to design line and grade;
 - 4. Line and grade; and
 - 5. General description of materials encountered at the excavation face.

3.06 GUIDED AUGER BORING

- A. Requirements presented in Sections 3.01 and 3.02 of this Specification apply to this Section unless specifically noted herein.
- B. Utilize a Guidance System to install the Casing Pipe.
- C. In Running or Raveling ground, maintain a minimum 5-foot Soil Plug to reduce inflow of material.

- D. Control the advance, volume of material excavated, and size of the Soil Plug to result in stable ground at the leading edge of the pipe and to prevent the loss of ground and heave.
- E. Prevent the soil within the plug from running or flowing and exposing the ground at the leading edge of the pipe.
- F. Record, at a minimum, the following data which will be made available to the Engineer:
 - 1. Maximum jacking load encountered during each Casing Pipe segment advance;
 - 2. Cutter head torque;
 - 3. Steering pressures utilized to maintain or return to design line and grade;
 - 4. Cutter head RPM; and
 - 5. Line and grade.

3.07 LUBRICATION OF CASING PIPE

- A. For Initial Support methods using Casing Pipe, provide the means to inject lubrication into the overcut annulus.
- B. Provide adequate protection for the lubrication system to withstand all anticipated ground conditions as described in the GBR.
 - 1. Breakage or failure of the lubrication system shall not relieve the Contractor of its responsibility to install the Casing Pipe as required or for excessive settlement of the ground surface or other underground structures.
- C. Maintain the overcut annulus full of lubrication at all times from the start of jacking or ramming until the installation of Casing Pipe is complete.

3.08 ERECTED SUPPORT

- A. Erected support is not allowed. Initial support will consist of jacked steel casing pipe.

3.09 OBSTRUCTION DURING TUNNELING

- A. Remove, clear, or otherwise make it possible for the tunneling equipment and Initial Support to progress past, or through an Obstruction in accordance with the Contractor's submitted contingency plan.
- B. Additional payment for Obstruction removal will be made if the object is found to meet the definition of an Obstruction and subject to the following requirements:

1. Notify the Owner in writing on the same calendar day as encountering the Obstruction.
 2. Notify and obtain approval from affected Governing Agencies of the intent to excavate to remove the Obstruction if excavation is necessary within the right-of-way limits of affected Governing Agencies.
 3. Submit a complete plan for removal of the Obstruction including estimated time and costs to the Owner prior to starting Work to remove the Obstruction.
 4. Upon written authorization by the Owner, proceed with removal of the Obstruction by means of the approved removal procedure.
 5. No excavation to remove the Obstruction will be allowed without the Owner being present.
- C. If the Obstruction is such that the tunnel is at risk of endangering life and/or property, the Contractor is directed to work 24-hours/7-days per week as necessary to create a stable and safe condition. Requirements in Section 3.09.B apply thereafter.

3.10 QUALITY CONTROL

- A. Perform all Tunnel Excavation and Initial Support work in the presence of the Engineer, unless the Engineer has granted prior approval in writing to perform such work in their absence.
- B. Perform all work in accordance with all current applicable regulations and codes of federal, state, and local agencies. In the event of conflict, comply with the most restrictive applicable requirements.

3.11 TUNNEL LINE AND GRADE TOLERANCES

- A. At a minimum, the tunnel is to be within eight inches of the design line and eight inches of the design grade, or sufficiently true and accurate to the design alignment and profile to allow for accurate placement of the Carrier Pipe, whichever is more stringent. Installed Initial Support not meeting the tolerances indicated will be reconstructed or replaced at the Contractor's cost.
- B. The Initial Support will allow for a clearance of at least three inches between the outside of the Carrier Pipe and the closest point of the Initial Support in all directions.
- C. Changes in Initial Support alignment and grade during installation are to be made gradually such that joints are mated within the pipe manufacturer's specifications, fully functional, and not compromised in any way.
- D. If the Initial Support is off line and/or grade by more than the specified tolerances, make adjustments, repairs and changes as necessary to achieve the specified tolerances.

- E. If the tunnel is sufficiently far off line and/or grade to require redesign of structures, acquisition of easements, or backfilling and re-excavation, be responsible for doing all necessary additional work as determined by the Engineer and all associated costs. If the Initial Support is off line and/or grade by an amount that requires, in the opinion of the Engineer, re-design of any structure, the Contractor is responsible for all redesign costs.
- F. The Contractor is responsible for setting control points and controlling the line and grade of the tunnel as necessary to achieve the specified line, grade and tolerances for the Initial Support.

3.12 SAFETY REQUIREMENTS

- A. Designate a site or project Safety Officer. The Safety Officer will administer an accident prevention program and prepare a code of safe practices and an emergency plan. Provide the Engineer with a copy of each prior to starting tunnel excavation. Hold safety meetings and provide safety instruction for new employees and site visitors.
- B. Lighting Work Areas: Provide all work areas with sufficient lighting to facilitate proper performance and inspection of work, provide safe passage between the installation Shaft and Tunnel heading, and be in accordance with applicable federal, state and local laws, safety codes, regulations, and ordinances.

3.13 TUNNEL ACCESS

- A. Provide safe access for the Owner and Engineer during active tunnel work. Access will be for, but not be limited to, the following: to inspect and observe the work; to perform independent line and grade surveys; for geologic mapping, for monitoring of instrumentation; and for installation of additional instrumentation.

3.14 EXCAVATED MATERIAL

- A. Transport and dispose of all excess excavated materials and muck properly away from the construction site in such a fashion that trucks and other vehicles do not create a dirt nuisance on roads and pathways.
- B. Secure the required permits and promptly remove and dispose of any spillage and excess muck as required.

3.15 CLEANUP AND RESTORATION

- A. Remove all equipment, unused materials, and debris from the site once the required work has been completed. Restoration will follow construction as the work progresses and be completed as soon as possible. Restore and repair any damage resulting from surface settlement or heave caused by the work immediately. Any property or improvements damaged or destroyed, will be restored to a condition equal to or better than existing prior to construction at no additional cost to the Owner. Restoration will be completed immediately, if a third party or the Owner are inconvenienced by the damage, and in no case later than 30 days after the damage is discovered. This provision for restoration includes all property which was affected by the construction operations.

3.16 CONSTRUCTION RECORDS

- A. Maintain Written Daily Logs for all components and phases of tunnel construction. Submit Daily Logs weekly to the Owner or Engineer. The Daily Logs are to be signed by the site Superintendent or shift foreman and contain the following:
 - 1. Subcontractors onsite with their personnel and equipment, and the work performed. The reports are to be broken down into work time and down/standby time for each Subcontractor;
 - 2. Work crews and equipment onsite, and the work performed. The reports are to be broken down into work time and down/standby time for each crew and piece of equipment;
 - 3. Progress made for each construction stage;
 - 4. Survey results – line and grade;
 - 5. Problems or unusual conditions encountered and actions taken to address these situations;
 - 6. Record of safety meetings conducted; and,
 - 7. List of visitors to construction site.
- B. Maintain records of all surveys.
- C. Maintain records of the tunnel excavation including but not limited to the following:
 - 1. The station of the face of the excavation and advance distance;
 - 2. The position of the tunneling face or machine in relation to the design line and grade;
 - 3. The maximum jacking or ramming load encountered during each Initial Support segment advancement.
 - 4. The date, starting time, and finish time;
 - 5. Any unusual conditions, breakdowns, and delays; and
 - 6. Excavated muck quantity.
- D. Maintain records of all monitoring of the during construction including but not limited to the following:

1. Description and position of complete and partially complete Initial Support installed;
 2. Description of ground type and conditions, and ground behavior; and
 3. Inconsistencies such as unusual spacings, deformations, and unusual performance.
- E. Construction Record Drawings. Keep and maintain at the construction site a complete set of final design drawings for recording as-built conditions. It will have been marked or noted thereon all field information, properly dated, recording as-built conditions. This set of field drawings will be kept up-to-date during construction. The record drawings will be updated at least once every week to current conditions. The record drawings will contain the following as a minimum:
1. Locations (line and grade) of the installed Initial Support as required herein.
- F. As-built drawings shall be submitted and accepted by the Engineer prior to recommending final payment.

3.17 PROGRESS MEETINGS.

- A. Contractor's onsite foreman to attend the periodic hour-long (weekly or bi-weekly) construction meetings in person during a time frame of two weeks before the active tunneling operations to two weeks after the active tunneling operations for each tunnel.

END OF SECTION

SECTION 31 73 00 - CONTACT GROUT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Section includes requirements for conducting Contact Grouting of overcut and voids outside the Initial Support.

1.02 RELATED WORK:

- A. Related documents and Specification Sections include but are not necessarily limited to:
 - 1. 31 09 13 – Geotechnical Instrumentation and Monitoring
 - 2. 31 71 00 – Tunnel Excavation and Initial Support
 - 3. 31 74 23 – Carrier Pipe Installation and Backfill
 - 4. 31 75 00 – Construction Shafts
 - 5. Geotechnical Baseline Report (GBR), Lithos Engineering
 - 6. Geotechnical Investigation Report (GIR), RB&G Engineering

1.03 DEFINITIONS

- A. CONTACT GROUT: An approved mixture of Portland cement and water used to fill the annular overcut space created during tunneling.
- B. CONTACT GROUTING: The filling of the overcut and voids in the ground or between the ground and Initial Support.
- C. GROUT PORTS: Location along the tunnel Initial Support where grout is injected in the overcut and void space.
- D. See Section 31 71 00 – Tunnel Excavation and Initial Support for additional definitions.

1.04 REFERENCE STANDARDS:

- A. ASTM C150 – Standard Specification for Portland Cement.
- B. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
- C. ASTM C942 – Test Method for Compressive Strength of Grout for Pre-placed Aggregate Concrete in the Laboratory.

1.05 GENERAL REQUIREMENTS

- A. Be responsible for construction and performance of the Contact Grouting on this project.
- B. Be responsible for developing and implementing Contact Grouting to fulfill the specified requirements necessary for completion of the work.
- C. Provide testing of materials and verification of material properties.
- D. Provide the Engineer with a schedule of Contact Grouting activities at least two (2) weeks before beginning grouting and update weekly. Notify the Engineer at least one working day in advance of schedule changes.

1.06 QUALIFICATIONS:

- A. Be experienced in grouting tunnels and underground projects using methods, materials, and equipment comparable to this project. Demonstrate successful completion of at least two grouting jobs in the last five years with similar scope to the proposed Contact Grouting plan.

1.07 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two weeks before the scheduled start of the applicable activity.
 - 1. Contractor Contact Grouting qualifications.
 - 2. Descriptions and shop drawings describing and illustrating methods and equipment proposed for grouting. Include at a minimum the method(s) of transporting/delivery, sequence and stages of Contact Grouting, injection locations, and verification of grouting.
 - 3. Provide the maximum anticipated Contact Grout pressure. This pressure is to be verified in the field and will not be exceeded without prior approval from the Engineer. The maximum anticipated Contract Grout Pressure is not to cause heave or distress the ground surrounding the Initial Support and will not damage the Initial Support.
 - 4. Mix design for the grout including proportions of all constituents, properties of the test results of the wet mix, and test results of the cured backfill.
 - a. Submittal shall fulfill all the QA/QC requirements specified herein.
 - b. Submit test results from samples made using the same materials, including water and cement that will be used on the Project. Use of potable water will exclude submitting test results with the same water.
 - 5. Description of equipment and methods proposed to mix Contact Grout including mixing equipment, quantity controls and instrumentation.
 - a. Description of trial batches, trial batch testing and proof of acceptable delivery and placement of grout.

6. Injection methods for grout including pumping equipment, mixer, agitator, hoses, boosters, pumping distances, return flow lines, flow rates, and pressures.
 - a. Include methods and description of instrumentation to monitor and control placement of the grout, and procedures to be used to verify complete placement and check for voids.
 7. Drawings and description of grout ports, plugs, and valves for the ports, and materials used to plug and permanently seal the grout ports following Contact Grouting.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
1. Test results. Include results of all Contact Grout tests specified herein for the grout including but not limited to field tests and laboratory tests.
 2. Instrumentation and monitoring collected data during contact grouting as specified in Section 31 09 13 – Geotechnical Instrumentation and Monitoring.
 3. Daily Logs as specified herein. Submit logs daily for the previous day's work within one day.

PART 2 EQUIPMENT, PRODUCTS, AND MATERIALS

2.01 GROUTING EQUIPMENT

- A. If Contact Grout is batched onsite, the Contractor's grouting equipment is to consist, at a minimum, of:
1. Water meter in gallons;
 2. High speed shear mixer;
 3. Paddle type agitator;
 4. Grout pump; and
 5. Grouting header assembly.
- B. Provide grouting equipment with the ability to grout to the maximum grout pressure, controllable to within 0.5 pounds per square inch (psi), and controllable to within 0.5 gallons per minute (gpm).
- C. Provide controls on the proportioning and mixing of the grout sufficient to assure the designed mix is achieved.
- D. Provide a pressure gauge at the injection point with a range suitable for the expected pressures and reading to an accuracy of 0.1 psi or better.
- E. Provide a flow meter with a range suitable for the expected grout flows and measuring the rate of flow to an accuracy of 0.2 gpm or better.

- F. Provide a total flow indicator capable of measuring the grout injected at each port to an accuracy of one gallon or better.
- G. Provide piping with a spigot and valve at the injection point for collecting grout samples.

2.02 COMMUNICATIONS EQUIPMENT

- A. Provide equipment to communicate between workers in the tunnel at the grout injection points with workers outside the tunnel.

2.03 MATERIALS

- A. Contact Grout.
 - 1. A mixture of Portland cement and water.
 - a. Maximum water/cement ratio of 1:1 by volume.
 - b. 28-day strength of at least 300 psi.
 - c. No shrinkage when tested per ASTM C827.
 - 2. Cement will be Type I/II.
 - 3. Sand may be added only with approval of the Engineer.
 - 4. Tested for compressive strength per ASTM C942.
 - 5. Use only potable water. Alternative water sources may be utilized with the approval of the Engineer.
 - a. If an alternative water source is desired, prior to use on the project, provide test data using the proposed water source showing grout meets all quality requirements herein.
- B. Ports and Port Patches in Initial Support.
 - 1. Ports and Port Patches in the Initial Support as shown on the Contract Drawings. The holes or ports are to be compatible with a minimum 1-inch diameter pipe nipple.
 - 2. Ports are to be pre-fabricated in Casing Pipe.

PART 3 EXECUTION

3.01 CONTACT GROUTING

- A. Contact Grout using methods and procedures that track the movement of grout and verify presence of grout throughout the tunnel by injecting grout at one port and using nearby ports to detect the presence of grout. Sequentially close off and move injection points to ensure full grout coverage of voids outside of the casing pipe.
- B. Construct a bulkhead or otherwise seal the ends of the tunnel to prevent leakage of Contact Grout into the shaft or portal and allow for buildup of grout pressure.

- C. The grout pressure is to be sufficient for the grout to fill voids and displace fluids surrounding the pipe. Maximum allowable grouting pressure is to be maintained from the start of grout injection of each hole to refusal of the hole.
- D. The maximum grout pressure at all locations is to be less than the pressure that would cause ground surface heave and/or cause hydraulic fracturing and/or cause damage to the Initial Support.
- E. Maximum Contact Grout injection port spacing as shown on the Contract Drawings. Contact Grout through any injection port will be considered complete when maximum grout pressure is held for a minimum of two minutes, or when grout delivery causes rapid increases in the grout injection pressure beyond the maximum grout injection pressure.
- F. After completion of Contact Grout, replace plug, and fill or patch in accordance with Initial Support manufacturers' specifications and recommendations.

3.02 QUALITY CONTROL

- A. Monitor and record as a minimum all data necessary to complete the required Submittals.
- B. Pressure gauges of appropriate diameters and ranges for monitoring the Contact Grout injection pressures are to be located as close as possible to the point of injection in the line transporting the Contact Grout. Contact Grouting is not permitted without pressure gauges in good working condition.
- C. The volume of grout injected is to be measured, recorded, and compared with the anticipated volume per foot of grout expected. The advance of the grout will be monitored using grout injection ports.
- D. Perform all monitoring and testing as specified and as necessary to complete all submittals.
- E. Ground Movement
 - 1. Be solely responsible for damage caused by grouting operations. Determine the amount of movement allowed and control movements within those limits. The Contractor at its expense, will be required to repair any damage caused by grouting.
 - 2. Surface survey points as designated in Section 31 09 13 – Tunnel Instrumentation and Monitoring are to be monitored and measured during Contact Grout pumping. If surface heave is measured during Contact Grouting, cease grouting at that specific Port immediately and move on to the next port in series.

3.03 TESTING

- A. Test the Contact Grout. Obtain samples of Contact Grout at the point of discharge or alternatively at a simulated point of discharge through the same or greater pumping distance.
- B. Compression and Shrinkage Testing of Grout: Make a minimum of one set of five 3-inch diameter by 6-inch high cylinders for each 400 LF of contiguous tunnel. Make at least one set of test samples from each 75 cubic feet, or major fraction thereof, of Contact Grout placed in any one day. Test grout compressive strength at seven days and 28 days.
- C. Provide testing results to the Engineer as they become available from the Contractor-employed testing agency.

3.04 DAILY LOGS

- A. Maintain Daily Logs of the work. As a minimum, the Daily Logs shall contain the following:
 - 1. Work hours, equipment and crews in use with persons and craft designations;
 - 2. Stations of grouting;
 - 3. Volume and pressures injected at each location and grout sequence with take at each port and observations of return from nearby holes;
 - 4. Record of holes grouted with locations, quantities, pressures, injection times, and verifications used; and
 - 5. Problems or unusual conditions encountered, and actions taken to address these situations.

END OF SECTION

SECTION 31 74 23 - CARRIER PIPE INSTALLATION AND BACKFILL

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Section covers requirements for installation of the Carrier Pipe in the tunnel and backfilling the annulus between the Carrier Pipe and Initial Support with Backfill Grout.

1.2 RELATED WORK

- A. Related Documents and Specification Sections include but are not necessarily limited to:
 - 1. 31 09 13 – Geotechnical Instrumentation and Monitoring
 - 2. 31 71 00 – Tunnel Excavation and Initial Support
 - 3. 31 73 00 – Contract Grout
 - 4. 31 75 00 – Construction Shafts
 - 5. Geotechnical Baseline Report (GBR) – Lithos Engineering
 - 6. Geotechnical Investigation Report (GIR) – RB&G Engineering

1.3 DEFINITIONS

- A. Definitions are as defined in Section 31 71 00 – Tunnel Excavation and Initial Support.
- B. BULKHEAD: Material placed between the Carrier Pipe and the Initial Support to contain Backfill Grout. Bulkheads are typically required at both ends of a tunnel and may also be located at intermediate locations within a tunnel to contain the Backfill Grout in the annular space between the Carrier Pipe and Initial Support.
- C. BACKFILL: Filling of the annular space between the Carrier Pipe and Initial Support.
- D. BACKFILL GROUT: flowable material to be used in the Backfill operations; can be Cellular Grout or Flyash Grout.
- E. CELLULAR GROUT: A low density, lightweight, cementitious material that contains stable air or gas cells as preformed foam uniformly distributed throughout the mixture.
- F. FLYASH GROUT: A self-leveling and self-compacting, cementitious material using pozzolanic flyash as the primary cementitious material.

CARRIER PIPE INSTALLATION AND BACKFILL

31 74 23 - 1

1.4 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. C495 – Standard Test Method for compressive strength of lightweight insulating concrete.
2. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
3. C796 – Standard Test Method for foaming agents for use in producing Cellular Grout using preformed foam.
4. C869 – Standard Specification for foaming agents used in making preformed foam for Cellular Grout.
5. C939 – Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
6. D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material Test Cylinders
7. D5971 – Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material
8. D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material
9. D6103 - Standard Test Method for Flow Consistency of Controlled Low Strength Material

1.5 GENERAL REQUIREMENTS

- A. Perform design, construction, and execution of the pipe installation and pipe backfill.
- B. Minimum design requirements are presented herein. It is the Contractor's responsibility to develop and implement the design to fulfill the specified design requirements determined by the Contractor which are necessary for completion of the work.
- C. Requirements
1. Install Carrier Pipe without damage and to the grades shown and specified.
 2. Backfill annulus outside Carrier Pipe fully with Backfill Grout.
 3. Restrain Carrier Pipe from movement due to buoyant and other forces during Backfill Grouting.
 4. Introduce Backfill Grout into the annulus outside the Carrier Pipe using grout lines (slick lines) secured to the Carrier Pipe or Initial Support or directly from the shafts. Grout ports through the Carrier Pipe are not allowed.
 5. Introduce Backfill Grout in tunnels at a spacing of not greater than every 200 feet through the use of slicklines, or other approved method.

CARRIER PIPE INSTALLATION AND BACKFILL

31 74 23 - 2

THE POINT REDEVELOPMENT

03 Transmission Line

Draper, UT

Construction Drawings
August to
May 2025

-
6. Provide testing of materials and verification of material properties as required herein.
 7. Notification.
 - a. Provide the Owner's Representative with a schedule of Carrier Pipe installation and Backfill Grouting activities at least three (3) weeks before beginning pipe installation, and update weekly.
 - b. Notify the Owner's Representative at least one working day in advance of schedule changes.
- D. Pipe Installation Methods
1. Install Carrier Pipe in the tunnel either incrementally or by jacking or pulling a pre-assembled pipe string as determined by the Contractor.
 2. Utilize casing spacers or other approved blocking method on the Carrier Pipe to prevent pipe movement.
 3. Utilize joint restraint methods or devices to prevent pull-out or over-assembling of Carrier Pipe joints.

1.6 QUALIFICATIONS

- A. The Contractor shall be experienced in the installation of pipe in tunnels and backfilling annular spaces using methods, materials, and equipment comparable to this project.
- B. Designate Installation and Backfill Grouting Experts. The Installation and Backfill Grouting Experts may be the same person. The Experts shall:
 1. Be thoroughly knowledgeable about the transportation, placement, and securement of prefabricated pipe in tunnels.
 2. Successfully have completed at least two (2) similar projects in which the pipe was placed in the Initial Support using the same methods as proposed for this project.
 3. Successfully have completed at least two (2) similar projects in which the pipe annulus in a tunnel was backfilled with Flyash Grout or Cellular Grout as applicable, and
 4. Be thoroughly knowledgeable about mixing, pumping and placement of Backfill Grout, including Flyash Grout or Cellular Grout as applicable, in tunnels.

1.7 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity.
 1. Qualifications of pipe Installation and Backfill Grouting Experts (may be the same person).
 2. Descriptions and shop drawings describing and illustrating methods and equipment proposed for installation of the Carrier Pipe in the tunnel. The submittal shall address, as a minimum, pipe:

CARRIER PIPE INSTALLATION AND BACKFILL

31 74 23 - 3

THE POINT REDEVELOPMENT

03 Transmission Line

Draper, UT

Construction Drawings
August to
May 2025

-
- a. Transportation,
 - b. Section joining,
 - c. Line and grade surveying, and
 - d. Line and grade control.
 3. Methods, procedures, and equipment for monitoring, controlling, and adjusting the alignment of the Carrier Pipe in the tunnel both during installation and after installation but prior to Backfill Grouting.
 4. Descriptions, Shop Drawings, and calculations for securing the pipe during Backfill Grouting. Submit calculations which evaluate:
 - a. Theoretical annulus volume for actual Initial Support ID and Carrier Pipe OD with adjustments for bells and spacers.
 - b. Buoyant force(s) generated during backfilling of each stage.
 - c. Loads and deflection of tiedowns, bracing, and spacers.
 - d. Bearing stresses on the pipe and the tunnel walls from the tiedowns or braces.
 - e. Bending stresses on the pipe between tiedowns or braces.
 - f. Maximum allowable backfill injection and head pressure (if a pump is used)
 - g. The calculations shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado experienced in comparable tunneling and pipeline work.
 5. Description of equipment and methods proposed to mix Backfill Grout including:
 - a. Mix design and results of preconstruction tests for the Backfill Grout. Results of tests on trial batches conducted as part of grout mix design and pre-grouting verification testing.
 - b. Mixing equipment
 - c. Quantity controls
 - d. Instrumentation
 - e. Description of trial batches, trial batch testing and proof of acceptable delivery and placement of Backfill Grout in the tunnel.
 6. Description of injection methods for Backfill Grout including:
 - a. Pumping equipment
 - b. Delivery equipment (hoses, valves)
 - c. Pumping distances and delivery points
 - d. Flow rates
 - e. Pressures
 - f. Bulkhead details
 - g. Proposed orientation of all grout and ventilation pipes.
 - h. Methods and description of instrumentation to monitor and control placement of the backfill, and procedures to be used to verify backfill volumes.
 - i. Method and procedures to handle excessive flowing water if criteria in Section 3.7.L herein, are met.
 7. Pipe manufacturer certification letter stating that the proposed backfill materials and methods are acceptable for the carrier pipe type.
-

CARRIER PIPE INSTALLATION AND BACKFILL

31 74 23 - 4

THE POINT REDEVELOPMENT
03 Transmission Line

Draper, UT

Construction Drawings
August to
May 2025

-
8. Trial batch results demonstrating the same mix design that includes:
 - a. Date of mix performed and reported
 - b. Mix number
 - c. Materials
 - d. Sources
 - e. Physical properties
 - f. Compressive strength results
 - B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
 1. Survey results. Surveys shall be conducted and submitted as specified herein.
 2. Daily Field Reports.
 3. Field installation logs having as a minimum, stations and length of Carrier Pipe installed and volume of Backfill Grout delivered; Submit logs daily. Provide copies of reports as required by public authorities to the Engineer within 24 hours following preparation and submittal to third party authority. These reports are for record purposes only.
 - C. Postconstruction Submittals:
 1. Survey of the line and grade of the Carrier Pipe in the tunnel.

PART 2 - EQUIPMENT, PRODUCTS AND MATERIALS

2.1 MATERIALS

- A. Carrier Pipe: as shown on the Contract Drawings and as specified in the Contract Documents.
- B. Backfill Grout shall have the following properties:
 1. Flowable through delivery lines in tunnel annulus
 2. Have a heat of hydration that will not weaken or otherwise harm pipe materials
 3. Viscosity shall be low enough to allow grout to completely fill all voids in the annulus between the Carrier Pipe and the ground.
 - a. Efflux time through a Flow Cone per ASTM C 939 shall be no greater than 22 seconds.
 4. Minimum 28-day compressive strength of 200 psi
 - a. Test in accordance with ASTM C 495.
 - b. Minimum wet density of 45 pcf unless water is present in the tunnel at which point a minimum wet density of 65 pcf is required, or per the direction of the Engineer.
 5. Additives may be used only with review per approval of the Engineer.
 6. Non-shrink mix.

CARRIER PIPE INSTALLATION AND BACKFILL

31 74 23 - 5

THE POINT REDEVELOPMENT

03 Transmission Line

Draper, UT

Construction Date August to
May 2025

-
7. Grout shall be a mix of water and cement and/or flyash or foamed Cellular Grout. No aggregates are allowed.
 - a. Cellular Grout:
 - 1) Cement: Portland Type I/II.
 - 2) Foaming agent for Cellular Grout: in accordance with ASTM C 869.
 - a) Test in accordance with ASTM C 796.
 - b. Flyash Grout:
 - 1) Flyash Grout shall be composed of:
 - a) Type C Flyash, water, and a set retarder, or
 - b) Type F Flyash, cement, water, and a set retarder. Cement to Flyash ratio shall not be greater than 0.25:1 by weight.
 - C. Pipe Securement: secure pipe using prefabricated spacers or other approved bracing.
 1. Spacers:
 - a. Specifically designed for placing Carrier Pipe in tunnels and as skids for the pipe to ride on during installation.
 - b. Variable in size or adjustable to place the position of the Carrier Pipe taking into account variations of the tunnel and Initial Support.
 - c. Design to have sufficient contact points with the Carrier Pipe and the tunnel Initial Support to resist damage/deformation to carrier from buoyancy caused by Backfill Grouting.
 2. Bracing: wood, steel, or other system that is rigid under the imposed loads and does not damage the Carrier Pipe.
 - D. Bulkhead Closure:
 1. Provide Bulkheads at the ends of the pipe to prevent spillout of the Backfill Grout and not damage or degrade the Initial Support or Carrier Pipe during installation or over the life of the structure.
 2. Provide venting at the crown of the annulus between Carrier Pipe and Initial Support at the highest elevation to ensure the tunnel is fully evacuated of water/air and filled with grout.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Carrier Pipe shall have internal bracing, if necessary, to protect the pipe and control deflections including out-of-round distortions during transportation, handling, and installation.
- B. Pipe installation and Backfill Grouting shall be conducted under the direct supervision of the Installation and Backfill Grouting Expert(s).

CARRIER PIPE INSTALLATION AND BACKFILL

31 74 23 - 6

THE POINT REDEVELOPMENT
03 Transmission Line

Draper, UT

Construction Drawings
August to
May 2025

3.2 PREPARATION

- A. Do not commence with pipe installation until the tunnel is prepared for pipe installation in accordance with the following requirements:
 - 1. The tunnel excavation has been stabilized.
 - 2. The alignment of the tunnel has been surveyed and has been verified to allow for installation of the Carrier Pipe to the specified tolerances and clearances.
 - 3. The tunnel has been cleaned as specified herein.

3.3 SURVEYS

- A. Surveys shall be at intervals not exceeding 20 ft and shall be for both line and grade to an accuracy of 0.01 ft or better.
- B. Conduct the following surveys:
 - 1. Completed tunnel Initial Support prior to installation of the Carrier Pipe.
 - 2. Carrier Pipe invert prior to Backfill Grouting.
 - 3. Carrier Pipe invert after Backfill Grouting.

3.4 QUALITY CONTROL

- A. Test methods shall be in accordance with ASTM C 495.
 - 1. Cast the specimens into cylinders at least 3 inches in diameter and 6 inches tall.
 - 2. Separate and remove the specimens for testing by cutting and trimming the forming material surrounding the cylinders.
- B. Backfill Grout Mix Design:
 - 1. Two sets of compression test specimens shall be made.
 - 2. Test one set of specimens at an age of 7 days and the other set at an age of 28 days.
 - 3. Test mix for unit weight at the time of cylinder casting.
- C. Index Testing of Backfill Grout:
 - 1. Conduct set of index tests from the first batch of Backfill Grout mixed each day, after a change in mix design, and from each batch of Backfill Grout from which compression test specimens are made.
 - 2. Conduct index tests a maximum of every two hours from each batch to verify the grout properties.
 - 3. Include as a minimum the following index tests at the time of placement:
 - a. Wet unit weight (wet density)
 - b. Ambient temperature
 - c. Grout temperature
 - d. Efflux time through Flow Cone
- D. Compression Testing of Backfill Grout:

CARRIER PIPE INSTALLATION AND BACKFILL

31 74 23 - 7

THE POINT REDEVELOPMENT

03 Transmission Line

Draper, UT

Construction Drawings
August to
May 2025

-
1. Make a minimum of one set of 5 specimens each day when up to 25 cubic yards of Backfill Grout is placed.
 2. Test two specimens at an age of 7 days and 2 specimens at an age of 28 days.
 - a. Hold one specimen in storage.

3.5 TOLERANCES AND CLEARANCES

- A. The Carrier Pipe shall be installed to the line and grade specified in the Technical Specifications and Drawings.
- B. The Carrier Pipe shall have a clearance of at least 3 inches between the outside of the pipe and the closest point of the Initial Support system in all directions.
- C. Changes in Carrier Pipe alignment and grade shall be made gradually such that pipe joints are mated within the pipe manufacturer's specifications, fully functional, and not compromised in any way.
- D. Reverse grades will not be allowed.
- E. If the Carrier Pipe is off line and/or grade by more than the specified tolerances, the Contractor shall make adjustments, repairs and changes as necessary to achieve the specified tolerances.
- F. If the Carrier Pipe is off line and/or grade by an amount that requires, in the opinion of the Engineer, re-design of any structure, the Contractor shall be responsible for all redesign costs.

3.6 INSTALLATION METHODS

- A. Install the pipe into the tunnels by sliding an assembled pipe string into the tunnels by jacking or pulling, or both. Alternatively, individual sections of pipe may be carried into the tunnel and mated in place.
- B. Complete each joint by mating per the manufacturer's requirements and the Contract Documents.
- C. Adjust the position of the Carrier Pipe within the spacers as necessary to achieve proper line and grade when the pipe is at the final position.
- D. Securing: Ensure that the pipe and each pipe segment is firmly secured to prevent flotation, settlement, lateral and axial movement, and pipe deflection during Backfill Grouting.

CARRIER PIPE INSTALLATION AND BACKFILL

31 74 23 - 8

3.7 BACKFILLING METHODS

- A. Before placement of Backfill Grout in the tunnel, demonstrate, using trial mixes of the same design as those proposed for use and the same equipment proposed for placement, the ability to produce Backfill Grout of the required density and strength. Demonstrate the ability to pump the Backfill Grout mix the distances proposed without loss of Backfill Grout quality; may be based on previous projects.
- B. Completely backfill the annulus between the Carrier Pipe and the Initial Support with Backfill Grout. Placement methods shall completely fill the spaces below the Carrier Pipe and around the Carrier Pipe support system components.
- C. Place Backfill Grout in multiple lifts to prevent pipe flotation unless stiffeners or pipe supports and closely spaced blocking of sufficient structural rigidity are provided to prevent pipe flotation, movement, or damage to the pipe. Lift thickness required to prevent flotation and damage to the pipe shall be determined by the Contractor.
- D. Backfill grout shall not be subject to free fall greater than 10 feet.
- E. The pressure of the backfill against the Carrier Pipe shall not exceed manufacturer limitations at any time and at any location.
- F. If Cellular Grout is used, the grout shall be pumped using a progressive cavity, positive placement pump such as a Moyno pump. Piston or plunger pumps shall not be used.
- G. The Contractor may elect to inject Backfill Grout into the tunnel at the shaft(s) or from within the tunnel depending on the pipe installation method. Spacing of discharge points shall be as specified in Section 1.5 to assure continuity between discharge points.
- H. Backfill grout shall be injected from the top of the shafts or pumped from the base of the shaft.
- I. If the complete filling of the annulus and voids is not verified during backfilling, conduct a secondary grouting program to fill the remaining annulus and voids.
- J. Maintain a supply of swabs and compressed air at the tunnel at the location of the backfilling operations or the bulkhead as appropriate to facilitate cleaning of injection lines or outlets as necessary.
- K. To prevent contamination of the Backfill Grout, do not introduce water into the tunnel through injection lines.

CARRIER PIPE INSTALLATION AND BACKFILL

31 74 23 - 9

THE POINT REDEVELOPMENT

03 Transmission Line

Draper, UT

Construction Drawings
August to
May 2025

L. Flowing Water

1. If water is inflowing from the ground into the tunnel at a rate greater than one gallon per minute at any location, it must be directed to the invert at that location prior to backfill grouting to prevent washout.
2. Develop a plan to direct water using panning, drain pipes, drain rock, etc. prior to grouting.
3. Fill drain pipes, drain rock, etc with grout once the primary annulus backfill grouting is complete.

3.8 CONSTRUCTION RECORDS

- A. The Contractor shall maintain Daily Field Reports for pipe installation and annular sealing. The Field Reports shall be signed by the site superintendent or shift foreman and shall contain the following:
1. Crews and subcontractors onsite with their personnel and equipment, and the work performed. The reports shall be broken down into work time and down/standby time for each crew and subcontractor;
 2. Record of pipe installed;
 3. Pipe joining reports;
 4. Record of annular sealing materials, and configuration of the seals;
 5. Problems or unusual conditions encountered and actions taken to address these situations.

END OF SECTION

CARRIER PIPE INSTALLATION AND BACKFILL

31 74 23 - 10

**THE POINT REDEVELOPMENT
DFCM PROJECT NO. 25406300**

SECTION 31 75 00 - CONSTRUCTION SHAFTS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Section includes Requirements for construction of shafts, pits, portals and all excavations to access tunnel work including requirements for excavation, ground support, and abandonment.

1.02 RELATED WORK

- A. Related documents and Specification Sections include but are not necessarily limited to:
 - 1. 31 09 13 – Geotechnical Instrumentation and Monitoring
 - 2. 31 71 00 – Tunnel Excavation and Initial Support
 - 3. 31 73 00 – Contact Grout
 - 4. 31 74 23 – Carrier Pipe Installation and Backfill
 - 5. Geotechnical Baseline Report (GBR), Lithos Engineering
 - 6. Geotechnical Investigation Report (GIR), RB&G Engineering

1.03 DEFINITIONS

- A. **SHAFTS:** The launch or retrieval locations of the tunnel installation, typically situated adjacent to the excavation, the Initial Support is installed under or at tie-in locations to the larger pipe system(s). In shallow tunneling scenarios, can also be pits or portals, excavated in a sloped manner up and away from tunneling equipment.
- B. **SHAFT SUPPORT SYSTEM:** Temporary erected support within the excavated Shafts to create a safe location for launch and retrieval of the tunnel installation. Shaft Support Systems commonly include but are not limited to trench boxes, slide rails, sheet piles, ring beams and liner plate, or soldier pile and lagging.
- C. See Section 31 71 00 – Tunnel Excavation and Initial Support for additional definitions.

1.04 REFERENCE STANDARDS

- A. Occupational Safety and Health Administration (OSHA) Regulation 1926 Subpart P, Excavations.

1.05 GENERAL

- A. Be fully responsible for the construction pits, shafts, or shaft support systems.

1.06 REQUIREMENTS

- A. Determine the shaft footprint size, methods of excavation, ground control, ground support type, and allowable excavation slopes needed to perform the work and provide access for tunnel construction subject to the limitations specified herein and elsewhere in the Contract Documents.
- B. Ground support for shafts and excavations shall stay within established easements unless the Contractor obtains additional easements, permits and approvals from affected property owners.
- C. Where excavations are undertaken near any structure or facility including but not limited to buildings, highways, streets, or utilities; do not alter, damage, impair, or interfere with the operation of the structure or facility.

1.07 GROUND CONDITIONS:

- A. Information regarding the ground conditions can be found in the GIR and GBR.

1.08 QUALIFICATIONS

- A. The onsite Foreman or Superintendent for shaft construction shall have successfully completed at least two similar jobs within the last five years using excavation and support methods similar to those proposed by the Contractor. These jobs must be completed at the time of bidding to count as relevant experience for this project.
- B. The Shaft Support Designer shall have successfully designed at least two similar jobs within the last five years using excavation and support methods similar to those proposed by the Contractor. These jobs must be completed at the time of bidding to count as relevant experience for this project.
- C. All personnel employed by the Contractor in the work shall be experienced and competent in their respective tasks and shall work only under the direct control of a suitably experienced supervisor.
- D. Design of engineered structures as defined herein will be signed and sealed by a Registered Professional Engineer in the State of Utah who has completed a minimum of two tunneling shaft projects of similar scope in the past five years. These jobs must be completed at the time of bidding to count as relevant experience for this project.

1.09 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two weeks before the scheduled start of the applicable activity.
 - 1. Shaft Work Plan including:
 - a. Description and shop drawings of the shafts, components of the shaft, and shaft excavation.
 - b. Details of proposed methods and procedures for excavating shafts.
 - c. Proposed shaft size and shape.
 - d. Layout and proposed location(s) of shaft and tunnel support equipment.
 - 2. Shaft Support including:
 - a. Descriptions and shop drawings describing and illustrating the type of Shaft Support System proposed, methods of installation, and equipment proposed to install the support.
 - 3. For Shafts greater than 20 feet in depth, provide Shaft support design calculations including loads, methods, assumptions, results, and safety factors. Shaft support shall consider support around the openings where the tunnel will exit the launch shaft and enter the receiving shaft. Calculations shall be signed and stamped by the Shaft Support Designer.
 - a. Shaft Support Designer shall be a Registered Utah Professional Engineer with qualifications as listed under Section 1.08.
 - 4. As necessary, Thrust Block design as part of the shaft to withstand applied Casing Pipe installation loads. The design shall include loads, methods, assumptions, results, and safety factors.
 - a. Thrust Block designer shall be a Registered Utah Professional Engineer with at least five years of experience with the design of tunnels and shafts.
 - 5. For Watertight shafts, required at the Tunnel Name, include within the submittal the methods to be utilized in order to construct the shafts in a manner which eliminates groundwater inflow per Section **Error! Reference source not found.** of this Specification Section.
- B. Construction: Submit the following to the Engineer during construction on a daily basis:
 - 1. Written Daily Logs. The Daily Logs shall have field logs submitted to the Engineer. As a minimum, the logs shall include:
 - a. The depth of excavation at each shaft.
 - b. The number of people on the crew.
 - c. Method of excavation.
 - d. Shaft support installed.
 - e. Description of the soils encountered, position of different soils layers, estimated groundwater inflow rates and depths, and description of ground behavior.
 - f. Any unusual conditions, breakdowns, and delays.
- C. Postconstruction Submittals:

-
1. Record of what shaft support elements remain in the ground with location and top elevation.
 2. Written Daily Logs shall be package and provided for Shafts prior to initiating tunnel construction.

PART 2 EQUIPMENT, PRODUCTS, AND MATERIALS

2.01 EQUIPMENT

- A. Excavation Equipment. Determine the equipment used to excavate the shafts.
- B. Ancillary Equipment. Determine the equipment used for all ancillary work including but not limited to spoil removal, materials transfer, and tunneling utilities.

2.02 MATERIALS

- A. Determine the type and design the shaft temporary support.

PART 3 EXECUTION

3.01 GENERAL EXECUTION

- A. Determine the shaft and excavation sizes and shapes subject to easement and property limitations.
- B. Perform excavations in a manner that will limit loss of ground and limit settlement of the ground surface, structures, and utilities above and adjacent to the shafts.
- C. Designate an OSHA Competent Person and identify and adhere to all relevant OSHA regulations.

3.02 EXCAVATION SUPPORT SYSTEMS

- A. Design and construct shafts to withstand all imposed loads, including at a minimum, ground conditions identified in the GBR, dynamic loads from equipment, applicable live loading conditions, and surcharge loads from materials.
- B. Grade ground surface in the vicinity of shafts to prevent surface water from entering the excavation.

3.03 RESTORATION

- A. All structures and utilities modified or moved shall be restored to the original condition or as determined by the Engineer.

3.04 ABANDONMENT

- A. Backfill shafts and excavations with specified and approved materials and methods in accordance with Project Specifications.
- B. Remove all structural elements within five feet of the ground surface that are used for support of shafts and excavations. Any materials left in the ground shall be approved by the Engineer and surveyed and documented on the Record Drawings.

END OF SECTION

SECTION 32 01 05 – INFORMATIONAL, REGULATORY, AND WARNING SIGNS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Information, regulatory, street name and warning signs but not construction signs.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. ASTM Standards:
 - 1. ASTM B 209: Standard Specification for Aluminum and Aluminum - Alloy Sheet and Plate.
- B. Federal Specification (General Services Administration).
 - 1. FS L-P 380: Plastic Molding Material Methacrylate.
 - 2. FS L-S-300: Sheeting and Tape, Reflective: Nonexposed Lens.
- C. National Bureau of Standards:
 - 1. PS 1: Construction and Industrial Plywood.
- D. MUTCD: Manual on Uniform Traffic Control Devices for Streets and Highways.
- E. Draper City Standard Details
- F. American Public Works Association (APWA), Manual of Standard Specifications

1.4 DEFINITIONS

- A. For definition purposes, the various types of signs are identified by a combination of letter and number. The letter represents the type of sign panel construction and the number represents the type of lettering and symbols to be used as follows:
 - 1. Panel Type:
 - a. Type A: Reflectorized sheeting on sheet aluminum.
 - b. Type B: Reflectorized sheeting on plywood.
 - 2. Letter Type:
 - a. Type 1: Reflectorized demountable cutout letters, symbols, and borders with prismatic reflectors.

- b. Type 2: Opaque legend and borders.
- c. Type 3: Reflectorized permanently attached cutout letters, symbols, and borders or reflectorized screen processed letters, symbols, and borders.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide signage that is the product of one manufacturer, who has provided signage as specified for a minimum of three (3) years. Submit manufacturer's qualifications.

1.6 SUBMITTALS

- A. Submit in accordance with Section 01 33 00, Shop Drawings, Product Data, and Samples.
 - 1. Exterior Sign Samples: 152 x 152 mm (6 x 6 inches) samples of each color and material.
 - 2. Submit sample of each color of reflective sheeting including manufacturer's name and product number.
- B. Manufacturer's Literature:
 - 1. Showing the methods and procedures proposed for the anchorage of the signage system to each surface type.
 - 2. Manufacturer's printed specifications and maintenance instructions.
- C. Sign Location Plan, showing location, type and total number of signs required.
- D. Shop Drawings: Scaled for manufacture and fabrication of sign types. Identify materials, show joints, welds, anchorage, accessory items, mounting and finishes.
- E. Full size layout patterns for dimensional letters.
- F. Manufacturer's qualifications.
- G. Installer's qualifications.

1.7 WARRANTY

- A. Product must perform for at least 7 years.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Sign Blank:

1. Aluminum Sheet:
 - a. 0.08 inch thick ASTM B209 alloy 6061-T6 or 5052-H38. Uniform thickness throughout entire sign blank.
 - b. Aluminum shall be free of corrosion, white rust, and dirt and be degreased by vapor degreasing or alkaline degreasing.
 - c. Blanks shall be etched by acid etching or alkaline etching.
 - d. Sign blanks shall be free of buckling, crevices, warp, dents, cockles, burrs, and/or other irregularities.
 - e. All corners shall be rounded meeting MUTCD radius requirements.
2. Aluminum Extrusion: 0.1 inch thick ASTM B 209 alloy 6063-T5 and 6063-T6.
3. Stainless Steel Sheet: ASTM A240/A240M, stretcher leveled standard of flatness.
4. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II (coated, mar resistant, UV stabilized polycarbonate) with coating on both sides.
5. Softwood Plywood: PS 1 Group 1 with each panel bearing initials DFPA Grade - Trademark of the American Plywood Association; painted to ENGINEER's choice of color unless indicated.

B. Posts: Galvanized structural steel, U-shaped, T-shaped, C-shaped, box-shaped, or round tube, Section 05 12 00, with 3/8 inch diameter mounting holes.

1. Use U-channel posts for parking regulation signs, and signs smaller than 18 in x 18 in. Powder coat gloss black.
2. Use 2 7/8 (outside diameter) 0.160 inch wall thickness round posts for all RRFB and driver feedback sign assemblies. Powder coat gloss black.
3. Use 1 3/4 inch square tubular Telespar galvanized posts for all other signs.

C. Fabricated Supports: Galvanized steel, Section 05 12 00.

D. Sheeting:

1. 3M Diamond Grade DG3 (ASTM Type XI) reflective sheeting series 4000 on the following signs:
 - a. Stop, Yield, Warning, School Zones, and Railroad Crossings.

- b. All signs on arterials.
 - 2. Use 3M High Intensity Prismatic (HIP), ASTM Type IV sheeting for all other signs.
 - 3. 3M 1100 Series Acrylic film
 - 4. 3M 1160 Graffiti coat on all of the following signs: Regulatory, Warning and School
 - 5. 3M4081 fluorescent yellow on all warning signs
 - 6. Signs must be date stamped by month and year. If date stamp on front, install date stamp in sign border.
- E. Prismatic Reflectors: Methyl methacrylate lens meeting FS L-P-380 requirements with aluminum frame.
- F. Bolts, Nuts, Accessories: Galvanized steel, Section 05 05 23.
- G. Cast-in-place Concrete: Class 3000 minimum, Section 03 30 04.
- H. Concrete: Class 4000
- I. RRFB assembly: Tapco RRFB-XL2
- J. Driver feedback assembly: Information Display Company SC15, package 01.

2.2 EXTERIOR SIGNAGE PERFORMANCE REQUIREMENTS

- A. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes 67 degrees C (120 degrees F) ambient and 100 degrees C (180 degrees F) material surfaces.

2.3 COLORS AND FORMAT

- A. Sign Colors and Format: MUTCD.
- B. Provided colors of same reflectorized hue in daylight and night under artificial white illumination.

2.4 FONT

- A. For street name signs, use FHWA font C for all sign characters, 8 inches minimum, 10 inches maximum
- B. FHWA font B may be permissible if approval is granted from City Streets Department.
- C. All arterial street signs are 42"x18" unless specified otherwise.

2.5 ELECTRICAL ROOM SIGNS

- A. 10" W x 14" H Bilingual Electrical Room Authorized Personnel Only sign.
 - 1. Wording:
 - a. "Electrical Room Authorized Personnel Only / Cuarto Electrico Solo Personal Autorizado."
 - 2. Must have outdoor durability of at least 5 years.
 - 3. Corner radius: 1/4".
 - 4. 3.5 Mil Peel and Stick Vinyl Label.
 - 5. 0.040 Rust-free Aluminum
 - 6. Four 7/32" Holes (#10 or 3/16" screws recommended).

2.6 STREET NAME SIGNS

- A. See Draper City Standard Detail SG-01

2.7 PARKING SIGNS

- A. All parking signs are 12"x18"
- B. No Parking sign contains R7-2A with one or more of the following:
 - 1. Arrow, day, zone, or time restriction
- C. FHWA font C for all parking signs.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Locate and preserve utilities, Section 31 23 16.
- B. Excavation, Section 31 23 16.

3.2 INSTALLATION

- A. Do not remove a sign that is being replaced until the new sign is placed and uncovered. Provide temporary covering. Maintain covering until removal.
- B. Unless indicated otherwise use clearance and locations shown in MUTCD. Install posts plumb and in proper alignment. Construct signpost foundations with concrete. Finish foundations flush with or below natural ground.
- C. Establish proper elevation and orientation of all signs, structures, and determine proper sign post lengths as dictated by construction slopes.

- D. Construct overhead support structures where indicated with signs horizontal and perpendicular to roadway. Minimum allowable vertical clearance from high point of pavement is 16.5 feet.
- E. Foundations:
 - 1. In unpaved areas, embed the sign post a minimum 30 inches in native soil.
- F. Install all regulatory, warning and school signs and guide perpendicular to the direction of travel
- G. Install all parking signs at 30 degree to 45° angle to the direction of the roadway.
- H. Install all signs in compliance with the MUTCD height and location requirements.
- I. Touch up exposed fasteners and connecting hardware to match color and finish of surrounding surface.

3.3 WORKMANSHIP

- A. Carefully fabricate and erect signs. Damage signs will be rejected.
- B. Make all vertical joints and cuts flat and true.
- C. Elevator bolts may be used or bolt holes relocated where conflict exists with sign border, legend, or copy.
- D. Lay out and properly balance on the sign face all Type 1 legend and copy before fastening. Plug holes left by shifting of copy or legend with the same type screw used to fasten the legend.
- E. Wash all sign faces before final inspection.

END OF SECTION

SECTION 32 11 23 – UNTREATED BASE COURSE (APWA)

This section shall follow the Utah APWA specifications for untreated base course.

SECTION 32 12 13 – PRIME COAT/TACK COAT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Materials and procedures for applying prime and tack coat.
- B. Blotter materials and procedures for absorbing excess asphalt as required.

1.2 RELATED SECTIONS

- A. Section 01 55 26: Traffic Regulation
- B. Section 32 11 23: Untreated Base Course
- C. Section 32 12 17: Asphalt Material

1.3 REFERENCES

- A. AASHTO M 208: Cationic Emulsified Asphalts
- B. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates
- C. AASHTO T 201: Kinematic Viscosity of Asphalts

1.4 DEFINITIONS

- A. Cutback Asphalt – Asphalt product using a solvent to reduce viscosity. MC-70 and MC-250 as used in this Section, article 2.1 refer to Medium Cure (MC). The number following “MC” describes the viscosity of the product during application, higher numbers indicating higher viscosity (thicker). Do not dilute these products. These products meet the requirements of Section 32 12 17 Asphalt Material.
- B. Emulsified Asphalt – A group of asphalt products using water and soap (emulsifier) to reduce viscosity. These products consist of approximately 60 percent asphalt and 40 percent emulsifier.
 - 1. Refer to Section 32 12 17 for the exact ratio as well as other properties.
 - a. The product is called a “straight” or a “concentrate” emulsion in this condition.
 - 2. CSS 1h and CQS 1h as used in this Section, Article 2.1 refer to Cationic Slow Set and Quick Set respectively.
 - a. The 1h designation refers to the residual binder grade as “hard” or an AC-20.

3. A diluted product may be used to better control distribution when the residual application rate is small (0.03 gal/yd²).
 - a. The product will be referred to as a 1:1 or 2:1 dilute meaning 2 parts emulsion to 1 part water for the latter case when this is done.
- C. Prime coat – Liquid asphalt to a prepared subgrade or untreated base course.
- D. Tack coat – Emulsified asphalt to the existing surface or new pavement surface and intermediate lifts.

1.5 SUBMITTALS

- A. Material invoice or bill of lading.

PART 2 - PRODUCTS

2.1 PRIME COAT

- A. MC-70 or MC-250. Refer to Section 32 12 17 Asphalt Material.
- B. Blotter material – Granular materials, Table 1 when tested according to AASHTO T 27.

Table 1 – Granular Materials	
Sieve Size	Percent Passing
No. 4	90 to 100
No. 10	25 to 80
No. 200	0 to 15

2.2 TACK COAT

- A. CQS-1h or CSS-1h emulsified asphalt. Refer to AASHTO M 208 and Section 32 12 17 Asphalt Material.
 1. Select emulsion according to the time constraints required for Maintenance of Traffic (MOT) and the ability to fully cure before allowing traffic on the roadway.
 - a. Residual asphalt content to be approximately 60 percent.
 - 1) Dilute at terminal only.
 - 2) Do not change dilution before obtaining approval from the Engineer.
- B. Tack coat for paving fabrics is a PG 58-22 or PG 64-22.

- C. Do not use an emulsion or cutback in paving fabric placement.

PART 3 - EXECUTION

3.1 3.1 SURFACE PREPARATION

A. Prime Coat

1. Shape the surface to the required grade and section.
2. Keep the surface free from ruts, corrugations, or other irregularities.
3. Compact the surface according to Section 32 11 23.

B. Tack Coat

1. Clean the surface of all materials that prevent the tack coat from bonding to the existing surface such as mud, dirt, leaves, and water.
2. Cover all tacked surface areas with surfacing materials the same day the tack coat is applied.

3.2 APPLICATION

A. Apply at the following rates:

1. Prime Coat – 0.5 gal/yd²
2. Tack Coat – Refer to Table 2.

Table 2 – Application Rate (gal/yd ²)				
Existing Pavement Condition	Residual	Undiluted	1:1 Dilute	2:1 Dilute
New HMA	0.03	0.05	0.10	0.08
Oxidized HMA	0.05	0.09	0.18	0.13
Milled HMA	0.07	0.12	0.24	0.18
Milled PCCP	0.07	0.12	0.24	0.18
PCCP	0.05	0.09	0.18	0.13

Residual – Asphalt binder content needed on the pavement.

Undiluted and 1:1 and 2:1 Dilute. Adjust the application rate if emulsion is not 60 percent residual asphalt.

3. Obtain approval for the quantities, rate of application, temperatures, and areas to be treated before any application. Application rates may vary according to field conditions.

B. Do not apply prime coat or tack coat:

1. On a wet surface or where surface conditions prevent proper adhesion.
2. When the surface temperature is below 50 degrees F.

- 3. When weather conditions prevent proper adhesion.
- C. Protect all structures including items such as guardrails and guide posts from being spattered or marred.
- D. Use a pressure distributor to apply the asphalt in a uniform, continuous spread.
- E. Keep the viscosity between 50 and 100 centistokes. Refer to AASHTO T 201.
- F. Immediately apply another application to under primed surface.
- G. Apply tack coat between all lifts of Hot Mix Asphalt and to all surfaces, including vertical that will come in contact with Hot Mix Asphalt.
 - 1. Apply prime coat to protect the grade from damage.
- H. Spread blotter material if the prime coat does not penetrate.
 - 1. Use the quantities required to absorb the excess asphalt.
- I. Allow prime or tack coat to fully cure before allowing traffic on paving.

3.3 TRAFFIC CONTROL

- A. Refer to Section 01 55 26 Traffic Regulation.
- B. Maintain the prime coat/tack coat until the next course is placed.
- C. Keep all traffic off the prime coat until it has cured and dried.

END OF SECTION

SECTION 32 12 17 – ASPHALT MATERIAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Asphalt materials binders, emulsions and crack sealant for pavements.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. AASHTO M 81: Cutback Asphalt (Rapid-Curing Type)
- B. AASHTO M 82: Cutback Asphalt (Medium-Curing Type)
- C. AASHTO M 140: Emulsified Asphalt
- D. AASHTO M 208: Cationic Emulsified Asphalt
- E. AASHTO M 226: Viscosity Graded Asphalt Cement
- F. AASHTO M 282: Joint Sealants, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete Pavements
- G. AASHTO M 320: Performance Graded Asphalt Binder
- H. AASHTO R 28: Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
- I. AASHTO T 44: Solubility of Bituminous Materials
- J. AASHTO T 48: Flash and Fire Points by Cleveland Open Cup
- K. AASHTO T 49: Penetration of Bituminous Materials
- L. AASHTO T 50: Float Test for Bituminous Materials
- M. AASHTO T 51: Ductility of Bituminous Materials
- N. AASHTO T 59: Emulsified Asphalt
- O. AASHTO T 201: Kinematic Viscosity of Asphalts (Bitumens)
- P. AASHTO T 228: Specific Gravity of Semi-Solid Asphalt Materials
- Q. AASHTO T 240: Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)

- R. AASHTO T 300: Force Ductility of Asphalt Materials
- S. AASHTO T 301: Elastic Recovery Test of Asphalt Materials by Means of a Ductilometer
- T. AASHTO T 313: Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
- U. AASHTO T 314: Determining the Fracture Properties of Asphalt Binder in Direct Tension
- V. AASHTO T 315: Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
- W. AASHTO T 316: Viscosity Determination of Asphalt Binder Using Rotational Viscometer
- X. ASTM D 2006: Method for Characteristic Groups in Rubber Extender and Processing Oils by the Precipitation Method.
- Y. ASTM D 2007: Characteristic Groups in Rubber Extender and Processing Oils and Other Petroleum Derived Oils by the Clay Gel Absorption Chromatographic Method
- Z. ASTM D 2026: Cutback Asphalt (Slow Curing Type)
- AA. ASTM D 4402: Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
- BB. ASTM D 5329: Sealants and Fillers, Hot-Applied, For Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements
- CC. ASTM D 5801: Toughness and Tenacity of Bituminous Materials
- DD. California Test Methods
- EE. UDOT Materials Manual of Instruction
- FF. UDOT Minimum Sampling and Testing Requirements (MS&TR)
- GG. UDOT Quality Management Plan

1.4 DEFINITIONS

- A. Binder lot – Refer to MS&TR 02745.
- B. Compliance Limit – The limit for acceptance without price reductions, accounting for testing variability, for the listed properties.

- C. Composite Price Reduction – The sum of price reductions for all individual properties associated with a single asphalt binder sample.
- D. Rejection Limit – The limit for acceptance with price reductions. Material not meeting these limits will be rejected and removed and replaced.

1.5 SUBMITTALS

- A. A vendor prepared bill of lading for information showing the following for each material shipment:
 - 1. Type and grade of material
 - 2. Type and amount of additives used, if applicable
 - 3. Destination
 - 4. Consignee's name
 - 5. Date of Shipment
 - 6. Railroad car or truck identification
 - 7. Project number
 - 8. Loading temperature
 - 9. Net weight in tons or net gallons corrected to 60 degrees F, when requested
 - 10. Specific gravity
 - 11. Bill of lading number
 - 12. Manufacturer of asphalt material

1.6 ACCEPTANCE

- A. The Owner accepts, rejects, or applies price reductions to all mix lots for performance-graded asphalt binder (PGAB) lots according to the compliance and rejection limits of Table 1, the Minimum Sampling and Testing Requirements, UDOT Quality Management Plan 509, and the associated mix specification.
 - 1. Rejected mix will be covered according to the associated mix specification including removal or if left in place the associated disincentive dollar amount for the rejected mix.
 - 2. Material not meeting the compliance limit, but within the rejection limit, the price reduction applied to the mix pay item price is calculated as follows:

$$\text{Price Reduction (\%)} = 25 * \frac{(\text{Compliance Limit} - \text{Test Result})}{(\text{Compliance Limit} - \text{Rejection Limit})}$$

3. The composite price reduction will be calculated by summing the price reduction for each parameter if more than one parameter lies outside specification limits.
 - a. The mix material will be rejected if the composite price reduction exceeds 25%.
- B. The maximum composite price reduction from the tested samples is applied to the mix in the binder lot if multiple samples from the binder lot are tested.
- C. Adjacent samples in the preceding, current, or subsequent lots may be tested to assess the extent and limit the amount of mix to be rejected if a binder lot is rejected.

Table 1 – Specification, Compliance, and Rejection Limits for Performance-Graded Asphalt Binders (Applied to the Mix)			
Property	Specification Limit	Compliance Limit	Rejection Limit
G*/sinδ of the original PGAB at high grade temp, (kPa) Rule of 86 or lower	1.00 Min.	0.84 Min.	0.70 Min.
G* of the original PGAB at high grade temp, (kPa)	1.30 Min.	1.25 Min.	1.11 Min.
δ (phase angle) of the original PGAB at high grade temperature, (degrees C). Rule of 92 Binders Rule of 98 Binders	74.0 Max. 71.0 Max.	75.0 Max. 72.0 Max.	77.0 Max. 74.0 Max.
G*/sinδ of the RTFO Residue, (kPa)	2.20 Min.	1.87 Min.	1.53 Min.
Elastic Recovery of RTFO Residue, (%) Rule of 92 Binders Rule of 98 Binders Rule of 104 Binders	80 Min. 85 Min. 90 Min.	75 Min. 80 Min. 85 Min.	65 Min. 70 Min. 75 Min.
G*/sinδ of the PAV Residue, (kPa)	5000 Max.	5250 Max.	5700 Max.
Stiffness of the PAV Residue at the specified low grade temperature +10°C, (MPa)	300 Max.	311 Max.	355 Max.
	150 Min.	145 Min.	125 Min.
Slope (m-value) of the Creep Curve at the specified low grade temperature +10°C	0.300 Min.	0.295 Min.	0.266 Min.
Failure Strain of PAV Residue in Direct Tension at the specified low grade temperature +10°C, (%) Rule of 92, 98, or 104 Binders	Report		
Failure Stress of PAV Residue in Direct Tension at the specified low grade temperature +10°C, (MPa) Rule of 92, 98, or 104 Binders	Report		
Delta Tc of PAV Residue from additional BBR test (use two BBR tests). Rule of 92, 98, or 104 Binders	-1.0 Min.	-2.0 Min.	-3.0 Min.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Each shipment of asphalt material must:
 - 1. Be uniform in appearance and consistency.
 - 2. Show no foaming when heated to the specified loading temperature.
- B. Do not supply shipments contaminated with other asphalt grades or materials.

1.8 GRADE OF MATERIAL

- A. The Engineer determines the grade of material to be used based on the supply source designated by the Contractor when the bid proposal lists more than one grade of asphalt material.

PART 2 - PRODUCTS

2.1 PERFORMANCE GRADED ASPHALT BINDER (PGAB)

- A. Use a qualified supplier according to the UDOT Quality Management Plan 509, Asphalt Binder.
- B. Refer to AASHTO M 320 for all PGABs having algebraic differences less than 92 degrees between the high and low design temperatures.
- C. Refer to AASHTO M 320 modified by Tables 2, 3, 4, 5, 6, 7, 8 and 9 for all PGABs having algebraic differences equal to or greater than 92 degrees between the high and low design temperatures.

Table 2 – PG58-34

Original Binder

Dynamic Shear Rheometer, AASHTO T-315	@ 58° C, G*, kPa	1.30 Min.
	@ 58° C, phase angle, degrees	74.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.

RTFO Residue, AASHTO T 240

Dynamic Shear Rheometer, AASHTO T 315	@ 64° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	80 Min.

PAV Residue, 20 hours, 2.10 MPa, 100° C, AASHTO R 28

Dynamic Shear Rheometer, AASHTO T 315	@ 16° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -24° C, S, MPa	300 Max. 150 Min.
	@ -24° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -24° C, Failure Strain, %	(c)
	@ -24° C, Failure Stress (b), MPa	(c)
Delta Tc from additional BBR test, ASTM D7643	@ -30° C	-1.0 Min.

- (a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.
- (b) No allowances will be given for passing at a colder grade.
- (c) Report test results for DTT with acceptance testing, DTT not required for qc testing

Table 3 – PG64-28

Original Binder

Dynamic Shear Rheometer, AASHTO T-315	@ 64° C, G*, kPa	1.30 Min.
	@ 64° C, phase angle, degrees	74.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.

RTFO Residue, AASHTO T 240

Dynamic Shear Rheometer, AASHTO T 315	@ 64° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	80 Min.

PAV Residue, 20 hours, 2.10 MPa, 100° C, AASHTO R 28

Dynamic Shear Rheometer, AASHTO T 315	@ 22° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -18° C, S, MPa	300 Max. 150 Min.
	@ -18° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -18° C, Failure Strain, %	(c)
	@ -18° C, Failure Stress (b), MPa	(c)
Delta Tc from additional BBR test, ASTM D7643	@ -24° C	-1.0 Min.

- (a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.
- (b) No allowances will be given for passing at a colder grade.
- (c) Report test results for DTT with acceptance testing, DTT not required for qc testing

Table 4 – PG64-34

Original Binder

Dynamic Shear Rheometer, AASHTO T-315	@ 64° C, G*, kPa	1.30 Min.
	@ 64° C, phase angle, degrees	71.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.

RTFO Residue, AASHTO T 240

Dynamic Shear Rheometer, AASHTO T 315	@ 64° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	85 Min.

PAV Residue, 20 hours, 2.10 MPa, 100° C, AASHTO R 28

Dynamic Shear Rheometer, AASHTO T 315	@ 19° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -24° C, S, MPa	300 Max. 150 Min.
	@ -24° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -24° C, Failure Strain, %	(c)
	@ -24° C, Failure Stress (b), MPa	(c)
Delta Tc from additional BBR test, ASTM D7643	@ -30° C	-1.0 Min.

- (a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.
- (b) No allowances will be given for passing at a colder grade.
- (c) Report test results for DTT with acceptance testing, DTT not required for qc testing

Table 5 – PG70-22

Original Binder

Dynamic Shear Rheometer, AASHTO T-315	@ 70° C, G*, kPa	1.30 Min.
	@ 70° C, phase angle, degrees	74.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.

RTFO Residue, AASHTO T 240

Dynamic Shear Rheometer, AASHTO T 315	@ 70° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	80 Min.

PAV Residue, 20 hours, 2.10 MPa, 100° C, AASHTO R 28

Dynamic Shear Rheometer, AASHTO T 315	@ 28° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -12° C, S, MPa	300 Max.
	@ -12° C, m-value	150 Min.
Direct Tension Test, AASHTO T 314	@ -12° C, Failure Strain, %	0.300 Min.
	@ -12° C, Failure Stress (b), MPa	(c)
Delta Tc from additional BBR test, ASTM D7643	@ -18° C	(c)
		-1.0 Min.

- (a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.
- (b) No allowances will be given for passing at a colder grade.
- (c) Report test results for DTT with acceptance testing, DTT not required for qc testing

Table 6 – PG70-28

Original Binder

Dynamic Shear Rheometer, AASHTO T-315	@ 70° C, G*, kPa	1.30 Min.
	@ 70° C, phase angle, degrees	71.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.

RTFO Residue, AASHTO T 240

Dynamic Shear Rheometer, AASHTO T 315	@ 70° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	85 Min.

PAV Residue, 20 hours, 2.10 MPa, 100° C, AASHTO R 28

Dynamic Shear Rheometer, AASHTO T 315	@ 25° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -18° C, S, MPa	300 Max. 150 Min.
	@ -18° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -18° C, Failure Strain, %	(c)
	@ -18° C, Failure Stress (b), MPa	(c)
Delta Tc from additional BBR test, ASTM D7643	@ -24° C	-1.0 Min.

- (a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.
- (b) No allowances will be given for passing at a colder grade.
- (c) Report test results for DTT with acceptance testing, DTT not required for qc testing

Table 7 – PG70-34

Original Binder

Dynamic Shear Rheometer, AASHTO T-315	@ 70° C, G*, kPa	1.30 Min.
	@ 70° C, phase angle, degrees	71.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.

RTFO Residue, AASHTO T 240

Dynamic Shear Rheometer, AASHTO T 315	@ 70° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	90 Min.

PAV Residue, 20 hours, 2.10 MPa, 100° C, AASHTO R 28

Dynamic Shear Rheometer, AASHTO T 315	@ 22° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -24° C, S, MPa	300 Max. 150 Min.
	@ -24° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -24° C, Failure Strain, %	(c)
	@ -24° C, Failure Stress (b), MPa	(c)
Delta Tc from additional BBR test, ASTM D7643	@ -30° C	-1.0 Min.

- (a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.
- (b) No allowances will be given for passing at a colder grade.
- (c) Report test results for DTT with acceptance testing, DTT not required for qc testing

Table 8 – PG76-22

Original Binder

Dynamic Shear Rheometer, AASHTO T-315	@ 76° C, G*, kPa	1.30 Min.
	@ 76° C, phase angle, degrees	71.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.

RTFO Residue, AASHTO T 240

Dynamic Shear Rheometer, AASHTO T 315	@ 76° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	85 Min.

PAV Residue, 20 hours, 2.10 MPa, 100° C, AASHTO R 28

Dynamic Shear Rheometer, AASHTO T 315	@ 31° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -12° C, S, MPa	300 Max.
	@ -12° C, m-value	150 Min.
	@ -12° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -12° C, Failure Strain, %	(c)
	@ -12° C, Failure Stress (b), MPa	(c)
Delta Tc from additional BBR test, ASTM D7643	@ -18° C	-1.0 Min.

- (a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.
- (b) No allowances will be given for passing at a colder grade.
- (c) Report test results for DTT with acceptance testing, DTT not required for qc testing

Table 9 – PG76-28

<u>Original Binder</u>		
Dynamic Shear Rheometer, AASHTO T-315	@ 76° C, G*, kPa	1.30 Min.
	@ 76° C, phase angle, degrees	71.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.
<u>RTFO Residue, AASHTO T 240</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 76° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	90 Min.
<u>PAV Residue, 20 hours, 2.10 MPa, 100° C, AASHTO R 28</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 28° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -18° C, S, MPa	300 Max.
	@ -18° C, m-value	150 Min.
Direct Tension Test, AASHTO T 314	@ -18° C, Failure Strain, %	0.300 Min.
	@ -18° C, Failure Stress (b), MPa	(c)
Delta Tc from additional BBR test, ASTM D7643	@ -24° C	(c)
(a)	Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.	
(b)	No allowances will be given for passing at a colder grade.	
(c)	Report test results for DTT with acceptance testing, DTT not required for qc testing	

2.2 ASPHALTIC CEMENT, LIQUID ASPHALTS, AND REJUVENATING AGENTS

A. Refer to AASHTO M 226, Table 2 with the following modifications:

- Delete and replace ductility at 77 degrees F (25 degrees C) with ductility at 39.2 degrees F (4 degrees C) using the values specified below.

AC - 2.5	AC - 5	AC - 10	AC - 20
50+	25+	15+	5+

B. Cationic and Anionic Emulsified Asphalt

- All standard Slow Setting (SS, CSS), Quick Setting (QS, CQS) Medium Setting (MS, CMS), and Rapid Setting (RS, CRS) grades including all High-Float designations (HF).
- Supply under the Approved Supplier Certification System (ASC).
- Refer to and meet AASHTO M 208 and M 140.

- C. Meet the requirements of one of these tables:
1. Table 10 – Cationic Rapid Setting Emulsified Polymerized Asphalt (CRS 2P)
 2. Table 11 – Latex Modified Cationic Rapid Setting Emulsified Asphalt (LMCRS-2)
 3. Table 12 – Cationic Medium Setting Emulsified Asphalt (CMS-2S)
 4. Table 13 – High Float Medium Setting Emulsified Asphalt (HFMS-2)
 5. Table 14– High Float Medium Setting Emulsified Polymerized Asphalt (HFMS-2P)
 6. Table 15 – High Float Medium Setting Emulsified Polymerized Asphalt (HFMS-2SP)
 7. Table 16 – High Float Rapid Setting Emulsified Polymerized Asphalt (HFRS-2P).
 8. Table 17 –Cationic Rapid Setting Emulsified Asphalt (CRS-2A, B)
- D. Curing Cut-Back Asphalt
1. Refer to specification ASTM D 2026 for slow curing (SC).
 2. Refer to specification AASHTO M 82 for medium curing (MC).
 3. Refer to specification AASHTO M 81 for rapid curing (RC).
- E. Meet the requirements for Emulsified Asphalt Pavement Rejuvenating Agent:
1. Table 18 – Type A
 2. Table 19 – Type B
 3. Table 20 – Type B Modified
 4. Table 21– Type C
 5. Table 22 – Type D

Table 10 – Cationic Rapid Setting Emulsified Polymerized Asphalt (CRS-2P)			
Tests	Test Method	Min.	Max.
Emulsion			
Viscosity , SF, 140° F (60° C), s (Project-site Acceptance/Rejection Limits)	AASHTO T 59	100	400
Settlement (a) 5 days, percent	AASHTO T 59		5
Storage Stability Test (b) 1 d, 24 h, percent	AASHTO T 59		
Demulsibility (c) 35 ml, 0.8% sodium dioctyl Sulfosuccinate, percent	AASHTO T 59	40	
Particle Charge Test	AASHTO T 59	Positive	
Sieve Test, percent	AASHTO T 59		0.10
Distillation			
Oil distillate, by volume of emulsion, percent			0
Residue (d), percent		68	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100 g, 5 s, dmm	AASHTO T 49	80	150
Ductility, 39.2° F (4° C), 5 cm/min, cm	AASHTO T 51	35	
Toughness, lb-in	ASTM D 5801	75	
Tenacity, lb-in	ASTM D 5801	50	
Solubility in trichloroethylene, percent	AASHTO T 44	97.5	
(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than a five-day time unless the purchaser requires the test. (b) The 24-hour (1-day) storage stability test may be used instead of the five day settlement test. (c) The demulsibility test is made within 30 days from date of shipment. (d) Distillation is determined by AASHTO T 59 with modifications to include a 350 ± 5° F (177 ± 3° C) maximum temperature to be held for 15 minutes. Modify the asphalt cement before emulsification.			

Table 11 – Latex Modified Cationic Rapid Setting Emulsified Asphalt (LMCRS-2)			
Tests	Test Method	Min.	Max.
Emulsion			
Viscosity, SF, 122° F (50° C), s (Project Site Acceptance/Rejection Limits)	AASHTO T 59	140	400
Settlement (a) 5 days, percent	AASHTO T 59		5
Storage Stability Test (b) 1 d, 24 h, percent	AASHTO T 59		1
Demulsibility (c) 35 ml, 0.8% sodium Dioctyl Sulfosuccinate, percent	AASHTO T 59	40	
Particle Charge Test	AASHTO T 59	Positive	
Sieve Test, percent	AASHTO T 59		0.3
Distillation			
Oil distillate, by volume of emulsion, percent			0
Residue (d), percent		65	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100 g, 5 s, dmm	AASHTO T 49	40	200
Torsional Recovery (e)		18	
(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than a five-day time unless the purchaser requires the test. (b) May use the 24-hour (1-day) storage stability test instead of the five-day settlement test. (c) Make the demulsibility test within 30 days from date of shipment. (d) Determine distillation by AASHTO T 59, with modifications to include a 350 ± 5°F (177±3°C) maximum temperature to be held for 15 minutes. (e) CA 332 (California Test Method)			
Co-mill latex and asphalt during emulsification			

Table 12 – Cationic Medium Setting Emulsified Asphalt (CMS-2S)		
Tests	Test Method	Specification
Emulsion		
Viscosity, SF, 122° F (50° C), s	AASHTO T 59	50 - 450
Percent residue	AASHTO T 59	60 min
Storage Stability Test, 1d, 24h, percent	AASHTO T 59	1 max
Sieve, percent	AASHTO T 59	0.10 max
Particle charge	AASHTO T 59	Positive
Oil Distillate, percent by volume of emulsion	AASHTO T 59	5-15
Residue		
Penetration, 77° F (25° C), 100g, 5 sec, dmm	AASHTO T 59	100-250
Solubility, percent	AASHTO T 59	97.5 min.

Table 13 – High Float Medium Setting Emulsified Asphalt (HFMS-2)			
Tests	Test Method	Min.	Max.
Emulsion			
Viscosity, SF, 122° F (50° C), s (Project Site Acceptance/Rejection Limits	AASHTO T 59	70	300
Storage Stability Test, 1d, 24 h, percent	AASHTO T 59		1.0
Sieve Test , percent	AASHTO T 59		0.1
Distillation			
Oil Distillate, by volume of emulsion, percent	AASHTO T 59	NA	NA
Residue, percent	AASHTO T 59	65	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100g, 5 s, dmm	AASHTO T 49	50	200
Float Test, 140° F (60° C), s	AASHTO T 50	1,200	
Solubility in Trichloroethylene, percent	AASHTO T 44	97.5	
Ductility, 77° F (25° C) 5cm/min, cm	AASHTO T 51	40	

Table 14 – High Float Medium Setting Emulsified Polymerized Asphalt (HFMS-2P) (a)			
Tests	Test method	Min.	Max.
Emulsion			
Viscosity, SF, 122° F (50° C), s (Project Site Acceptance/Rejection Limits)	AASHTO T 59	100	450
Storage Stability Test, 1 d, 24 h, percent	AASHTO T 59		1.0
Sieve Test, percent	AASHTO T 59		0.1
Distillation			
Oil distillate, by volume of emulsion, percent	AASHTO T 59		7
Residue (b), percent	AASHTO T 59	65	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100 g, 5 s, dmm	AASHTO T 49	70	300
Float Test, 140° F (60° C), s	AASHTO T 50	1,200	
Solubility in trichloroethylene, percent	AASHTO T 44	97.5	
Elastic Recovery, 77° F (25° C), percent	AASHTO T 301	50	
(a) Supply an HFMS-2P (anionic, polymerized, high-float) as an emulsified blend of polymerized asphalt cement, water, and emulsifiers. Polymerize the asphalt cement with at least 3.0% polymer by weight of the asphalt cement before emulsification. The emulsion must be smooth and homogeneous throughout with no white, milky separation, pumpable, and suitable for application through a distributor after standing undisturbed for at least 24 hours.			
(b) Determine the distillation by AASHTO T 59, with modifications to include a 350 ± 5° F (177 ± 3° C) maximum temperature to be held for 15 minutes.			

Table 15 – High Float Medium Setting Emulsified Polymerized Asphalt (HFMS-2SP) (a)			
Tests	Test method	Min.	Max.
Emulsion			
Viscosity, SF, 122° F (50° C), s (Project Site Acceptance/Rejection Limits)	AASHTO T 59	50	450
Storage Stability Test, 1 d, 24 h, percent	AASHTO T 59		1
Sieve Test, percent	AASHTO T 59		0.1
Distillation			
Oil distillate, by volume of emulsion, percent	AASHTO T 59		7
Residue (b), percent	AASHTO T 59	65	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100 g, 5 s, dmm	AASHTO T 49	150	300
Float Test, 140°F (60°C), s	AASHTO T 50	1200	
Solubility in trichloroethylene, percent	AASHTO T 44	97.5	
Elongation Recovery(c), 77° F (25° C), percent	AASHTO T 301	50	
(a) Supply an HFMS-2SP (anionic, polymerized, high-float) as an emulsified blend of polymerized asphalt cement, water, and emulsifiers. Polymerize the asphalt cement with at least 3.0% polymer by weight of the asphalt cement before emulsification. The emulsion must be smooth and homogeneous throughout with no white, milky separation, pumpable, and suitable for application through a distributor after standing undisturbed for at least 24 hours. (b) Determine the distillation by AASHTO T 59, with modifications to include a 350 ± 5° F (177 ± 3° C) maximum temperature to be held for 15 minutes. (c) Report only when penetration is greater than 300 dmm.			

Table 16 – High Float Rapid Setting Emulsified Polymerized Asphalt (HFRS-2P) (a)			
Tests	Test method	Min.	Max.
Emulsion			
Viscosity, SF @ 122° F (50° C), s (Project Site Acceptance/Rejection Limits)	AASHTO T 59	50	450
Storage Stability Test (b) 1 d, 24 h, percent	AASHTO T 59		1
Demulsibility 0.02 N Ca Cl ₂ , percent	AASHTO T 59	40	
Sieve Test, percent	AASHTO T 59		0.1
Distillation			
Oil distillate, by volume of emulsion, percent	AASHTO T 59		3
Residue (b), percent	AASHTO T 59	65	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100 g, 5 s, dmm	AASHTO T 49	70	150
Float Test, 140° F (60° C), s	AASHTO T 50	1,200	
Solubility in trichloroethylene, percent	AASHTO T 44	97.5	
Elastic Recovery, 77° F (25° C), percent	AASHTO T 301	58	
(a) Supply an HFMS-2SP (anionic, polymerized, high-float) as an emulsified blend of polymerized asphalt cement, water, and emulsifiers. Polymerize the asphalt cement with at least 3.0% polymer by weight of the asphalt cement before emulsification. The emulsion must be smooth and homogeneous throughout with no white, milky separation, pumpable, and suitable for application through a distributor after standing undisturbed for at least 24 hours.			
(b) Determine the distillation by AASHTO T 59, with modifications to include a 350 ± 5°F (177±3°C) maximum temperature to be held for 15 minutes.			

Table 17 – Cationic Rapid Setting Emulsified Asphalt (CRS-2A,B)			
Tests	Test Method	Min	Max
Emulsion			
Viscosity, SF, 122° F (50° C), s (Project Site Rejection/Acceptance Limits)	AASHTO T 59	140	400
Storage stability test, 24 h, percent	AASHTO T 59		1
Demulsibility, 35 mL 0.8 percent Sodium Dioctyl Sulfosuccinate, percent	AASHTO T 59	40	
Particle charge test	AASHTO T 59		Positive
Sieve test, percent	AASHTO T 59		0.10
Distillation			
Oil distillate, by volume of emulsion, percent	AASHTO T 59		0
Residue, percent	AASHTO T 59	65	
Use PG58-22 and PG64-22 as base asphalt cement for CRS-2A, B, respectively. Specification for high temperature performance – original and RTFO G*/sinδ within 3° C of grade.			

Table 18 – Emulsified Asphalt Pavement Rejuvenating Agent Concentrate Type A		
Property	Test Method	Limits
Viscosity, SF, 77° F (25° C), s	AASHTO T 59	15 Min 40 Max
Residue , percent W (a)	AASHTO T 59	60 Min. 65 Max.
Miscibility Test (b)	AASHTO T 59	No Coagulation
Sieve Test, percent W (c)	AASHTO T 59	0.20 Max.
5-day Settlement, percent W	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
Light Transmittance , %	UDOT MOI 8-973	30 Max.
Cement Mixing	AASHTO T 59	2 Max.
Residue from Distillation (a)		
Viscosity, 140° F (60° C), mm ² /s	ASTM D 4402	150 - 300
Flash Point, COC, ° F (° C)	AASHTO T 48	385 Min.
Asphaltenes, percent W	ASTM D 2006	0.4 Min. 0.75 Max.
Maltene Distribution Ratio (PC + A ₁)/(S + A ₂) (d)	ASTM D 2006	0.3 Min. 0.6 Max
Saturated Hydrocarbons, S (d)	ASTM D 2006	21 Min. 28 Max.
PC/S Ratio (d)	ASTM D 2006	1.5 Min.
(a) AASHTO T 59, Evaporation Test, modified as follows: Heat a 50 gram sample to 300°F until foaming ceases, then cool immediately and calculate results. (b) AASHTO T 59, modified as follows: Use a 0.02 Normal Calcium Chloride solution in place of distilled water. (c) AASHTO T 59, modified as follows: Use distilled water in place of a two percent sodium oleate solution. (d) Chemical composition by ASTM Method D-2006-70: PC= Polar Compounds, A ₁ = First Acidaffins A ₂ = Second Acidaffins, S = Saturated Hydrocarbons		

Table 19 – Emulsified Asphalt Pavement Rejuvenating Agent Concentrate Type B		
Tests	Test Method	Limits
Viscosity, SF, 77° F (25° C), s	AASHTO T 59	25 - 150
Residue, percent W	AASHTO T 59 (mod) (a)	62 Min.
Sieve Test, percent W	AASHTO T 59	0.10 Max.
5-day Settlement	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
Pumping Stability (b)		Pass
Residue from Distillation (a)		
Viscosity @ 140° F (60° C), mm ² /s	AASHTO T 201	2,500 - 7,500
Solubility in 1,1,1 Trichloroethylene, percent	AASHTO T 44	98 Min.
Flash Point, COC	AASHTO T 48	204° C, Min.
Asphaltenes, percent W	ASTM D 2007	15 Max.
Saturates, percent W	ASTM D 2007	30 Max.
Aromatics, percent W	ASTM D 2007	25 Min.
Polar Compounds, percent W	ASTM D 2007	25 Min.
(a) Determine the distillation by AASHTO T 59 with modifications to include a 300 ± 5° F (149 ± 3° C) maximum temperature to be held for 15 minutes.		
(b) Test pumping stability by pumping 475 ml of Type B diluted 1 part concentrate to 1 part water, at 77° F (25° C) through a ¼ inch gear pump operating at 1750 rpm for 10 minutes with no significant separation or coagulation in pumped material.		
Type B – an emulsified blend of lube oil or lube oil extract and petroleum asphalt.		

Table 20 – Emulsified Asphalt Pavement Rejuvenating Agent Concentrate Type B Modified		
Property	Test Method	Limits
Viscosity, SF, 77° F (25° C), s	AASHTO T 59	50 - 200
Residue(a), percent W	AASHTO T 59	62 Min.
Sieve Test, percent W	AASHTO T 59	0.20 Max.
5-day Settlement, percent W	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
Pumping Stability (b)		Pass
Residue from Distillation (a)		
Viscosity (c) 275° F (135° C), cP	ASTM D 4402	150 - 300
Penetration, 77° F (25° C), dmm	AASHTO T 49	180 Min.
Solubility in 1,1,1 Trichloroethylene, percent	AASHTO T 44	98 Min.
Flash Point, COC, ° F (° C)	AASHTO T 48	400(204) Min.
Asphaltenes, percent W	ASTM D 2007	20 - 40
Saturates, percent % W	ASTM D 2007	20 Max.
Polar Compounds, percent W	ASTM D 2007	25 Min.
Aromatics, percent W	ASTM D 2007	20 Min.
PC/S Ratio	ASTM D 2007	1.5 Min.
(a) Determine the distillation by AASHTO T 59 with modifications to include a 300±5°F (149 ± 3° C) maximum temperature to be held for 15 minutes. (b) Pumping stability is tested by pumping 475 ml of Type B diluted 1 part concentrate to 1 part water, at 77° F (25° C) through a ¼ inch gear pump operating at 1750 rpm for 10 minutes with no significant separation or coagulation in pumped material. (c) Brookfield Thermocel Apparatus-LV model. ≥ 50 rpm with a #21 spindle, 7.1 g residue, at > 10 torque		
As required by the Asphalt Emulsion Quality Management Plan 508, UDOT Minimum Sampling and Testing Requirements, the supplier certifies that the base stock contains at least 15% by weight of Gilsonite Ore. Use the HCL precipitation method as a qualitative test to detect the presence of Gilsonite.		

Table 21 – Emulsified Asphalt Pavement Rejuvenating Agent Concentrate Type C		
Property	Test Method	Limits
Viscosity, SF, 77° F (25° C), s	AASHTO T 59	10 - 100
Residue (a), percent W (Type C supplied ready to use 1:1 or 2:1.	AASHTO T 59	30 Min. 1:1 40 Min. 2:1
Sieve Test, percent W (b)		0.10 Max.
5-day Settlement, percent W	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
pH (May be used if particle charge test is inconclusive)		2.0 - 7.0
Pumping Stability (c)		Pass
Tests of Residue from Distillation (a)		
Viscosity, 275° F (135° C), mm ² /s	AASHTO T 201	475 - 1,500
Solubility in 1,1,1 Trichloroethylene, percent	AASHTO T 44	97.5 Min.
RTFO mass loss, percent W	AASHTO T 240	2.5 Max.
Specific Gravity	AASHTO T 228	0.98 Min.
Flash Point, COC	AASHTO T 48	232° C, Min.
Asphaltenes, percent W	ASTM D 2007	25 Min., 45 Max.
Saturates, percent W	ASTM D 2007	10 Max.
Polar Compounds, percent W	ASTM D 2007	30 Min.
Aromatics, percent W	ASTM D 2007	15 Min.
(a) Determine the distillation by AASHTO T 59 with modifications to include a 300 ± 5° F (149 ± 3° C) maximum temperature to be held for 15 minutes. (b) Test method identical to AASHTO T 59 except that distilled water is used in place of 2% sodium oleate solution. (c) Test pumping stability by pumping 475 ml of Type diluted 1 part concentrate to 1 part water, at 77° F (25° C) through a ¼ inch gear pump operating at 1750 rpm for 10 minutes with no significant separation or coagulation in pumped material.		
As required by the Asphalt Emulsion Quality Management Plan Section 508, UDOT Minimum Sampling and Testing Requirements, the supplier certifies that the base stock contains at least 10% by weight of Gilsonite ore. Use the HCL precipitation method as a qualitative test to detect the presence of Gilsonite.		

Table 22 – Emulsified Asphalt Pavement Rejuvenating Agent Concentrate Type D		
Property	Test Method	Limits
Viscosity, SF, 77° F (25° C), s	AASHTO T 59	30 - 90
Residue, (b) percent W	AASHTO T 59	65
Sieve Test, percent W	AASHTO T 59	0.10 Max.
pH		2.0 - 5.0
Residue from Distillation (b)		
Viscosity, 140° F (60° C), cm ² /s	AASHTO T 201	300 - 1200
Viscosity, 275° F (135° C), mm ² /s	AASHTO T 201	300 Min.
Modified Torsional Recovery (a) percent	CA 332 (Mod)	40 Min.
Toughness, 77° F (25° C), in-lb	ASTM D 5801	8 Min.
Tenacity, 77° F (25° C), in-lb	ASTM D 5801	5.3 Min.
Asphaltenes, percent W	ASTM D 2007	16 Max.
Saturates, percent W	ASTM D 2007	20 Max.
(a) Torsional recovery measurement to include first 30 seconds.		
(b) Determine the distillation by AASHTO T 59 with modifications to include a 300 ± 5° F (149 ± 3° C) maximum temperature to be held for 15 minutes.		

2.3 HOT-POUR CRACK SEALANT FOR ASPHALT PAVEMENT

- A. Combine a homogenous blend of materials to produce a sealant according to properties and tests in Table 23.
- B. Packaging and Marking – Supply sealant pre-blended, pre-reacted, and pre-packaged in lined boxes weighing no more than 30 lb.
 1. Use a dissolvable lining that will completely melt and become part of the sealant upon subsequent re-melting.
 2. Deliver the sealant in the manufacturer's original sealed container.
 - a. Clearly mark each container with the manufacturer's name, trade name of sealant, batch or lot number, and recommended safe heating and application temperatures.

Table 23 – Hot-Pour Asphalt Pavement Crack Sealant			
Application Properties			
Workability	Pour readily and penetrate 0.25 inch and wider cracks for the entire application temperature range recommended by the manufacturer.		
Curing	No tracking caused by normal traffic after 45 minutes from application.		
Asphalt Compatibility ASTM D 5329, Section 14	No failure in adhesion. No formation of an oily ooze at the interface between the sealant and the asphalt pavement or softening or other harmful effects on the asphalt pavement.		
Material Handling	Follow the manufacturer's safe heating and application temperatures.		
Test Method	Property	Minimum	Maximum
AASHTO T 51	Ductility, modified, 1cm/min, 39.2° F (4° C), cm	30	
UDOT method 967	Cold Temperature Flexibility	no cracks	
AASHTO T 300 (a)	Force-Ductility, lb force		4
ASTM D 5329	Flow 140°F (60° C), 5 hrs 75° angle, mm		3
AASHTO M 282 (b)	Tensile-Adhesion, modified	300%	
AASHTO T 228	Specific Gravity, 60° F (15.6° C)		1.140
ASTM D 5329	Cone Penetration, 77° F (25° C), 150 g, 5 sec., dmm		90
ASTM D 5329	Resilience, 77° F (25° C), 20 sec., percent	30	
ASTM D 4402	Viscosity, 380°F (193.3°C), SC4-27 spindle, 20 rpm, Cp		2,500
ASTM D 5329	Bond, Non-Immersed as specified in AASHTO M 282		Pass
(a) Maximum of 4 lb force during the specified elongation of 30 cm @ 1 cm/min, 39.2° F (4° C).			
(b) Delete Bond, Non-Immersed modification in AASHTO M 282. Perform tensile-adhesion test according to ASTM D 5329.			

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 32 12 20 – HYDRATED LIME

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Products and procedures for incorporating hydrated lime into all asphalt mixes.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. AASHTO M 303: Lime for Asphalt Mixtures
- B. ASTM C 110: Physical Testing of Quicklime, Hydrated Lime, and Limestone
- C. ASTM C 1097: Hydrated Lime for Use in Asphalt Cement or Bituminous Paving Mixtures
- D. ASTM C 1602: Mixing Water Used in the Production of Hydraulic Cement Concrete
- E. UDOT Materials Manual of Instruction
- F. UDOT Quality Management Plans

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS Not Used

- A. List all contractor submittals

1.6 QUALITY ASSURANCE

- A. Use a supplier of Hydrated Lime that is pre-qualified through UDOT Quality Management Plan 510.
- B. Comply with UDOT Quality Management Plan 514, Hot-Mix Asphalt.

PART 2 - PRODUCTS

2.1 HYDRATED LIME

- A. Hydrated Lime – Refer to AASHTO M 303, Type I.
 - 1. Refer to ASTM C 1097, Physical Requirements.
 - 2. Use test method ASTM C 110.

2.2 WATER

- A. Use potable water or water according to ASTM C 1602.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Add hydrated lime to all asphalt pavement mixes.
1. Add lime as determined in the approved mix design.
 2. Base the amount of hydrated lime used on the dry weight of the virgin aggregate.
 3. Use either Method A or B, unless Method B is specified.
 4. Use Method A only when the mix is produced by a Certified Hot-Mix Asphalt Supplier. Refer to the UDOT Quality Management Plan 514 Hot-Mix Asphalt.
- B. Method A – Dynamic Feed Lime Slurry
1. Lime Slurry –At least three parts water to one part lime by weight.
 - a. Adjust the amount of added water to meet the 3:1 lime slurry to account for the moisture in the stockpile.
 - b. Use lime slurry with a minimum of one part water by weight of lime.
 2. Add at least 1 percent lime by weight of the virgin aggregate.
 3. Deliver lime slurry to the twin shaft pugmill for mixing with aggregate.
 - a. Use a virgin aggregate/lime mixture that contains at least 3 percent water by weight of the virgin aggregate after the pugmill.
 4. Adjust quantity (percent) of lime as necessary, based on results of Hamburg Wheel Tracker test.
 5. Verify that Lime Slurry equipment is operating at all times.
 - a. The Engineer may require Method B, marination of the aggregate/hydrated lime mixture in the stockpile if the HMA is supplied without hydrated lime slurry treatment.
- C. Method B – Lime and Aggregate Stockpile Marination
1. Method B is an option for a Certified Hot Mix Asphalt Supplier.
 2. Method B is required for all Hot-Mix Asphalt Suppliers that are not certified according to the UDOT Quality Management Plan 514 Hot-Mix Asphalt.
 - a. The Engineer will inspect the marination process when the HMA supplier is not certified at the time of production.

3. The Owner applies a deduction for mix produced by a non-certified supplier to cover the cost of the inspection.
 - a. The deduction is according to the UDOT Quality Management Plan 514 Hot-Mix Asphalt.
 4. Provide sufficient free moisture to thoroughly wet the aggregate and activate the lime before introducing hydrated lime.
 - a. The aggregate/lime mixture will contain at least 3 percent water by weight of the virgin aggregate.
 5. Add at least 1½ percent lime by weight of the virgin aggregate.
 6. Thoroughly mix wet aggregate/lime mixture in a twin shaft pugmill.
 7. Marinate the aggregate/lime mixture in the stockpile for at least 48 hours.
 8. Adjust quantity (percent) of lime as necessary, based on results of Hamburg Wheel Tracker test, UDOT Materials Manual of Instruction 990.
 9. Use the wet cured aggregate within 60 days except as otherwise provided in the UDOT Quality Management Plan 514 Hot-Mix Asphalt.
- D. Mixing Methods A and B – Provide a horizontal twin shaft pugmill.
1. Adjust mixing paddles in the pugmill so that the aggregate being discharged is completely coated by the lime slurry.
 2. Do not allow volume of material in the pugmill to extend above the vertical position of the blade tips.

3.2 QUALITY CONTROL

- A. Tolerance Controls
1. Tolerance lime weight vessel static calibration ± 1.5 percent
 2. Dynamic delivery calibration ± 1.5 percent
 3. Inlet flow meter ± 2 percent
 4. Discharge flow meter ± 1.5 percent

END OF SECTION

SECTION 32 17 23 – PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Paints for pavement striping.
- B. Words and other markings in paint or plastic film.
- C. One-way or two-way prismatic reflectors for pavement marking. Short description of what is included in this section.

1.2 RELATED SECTIONS Not used

1.3 REFERENCES

- A. AASHTO Standards:
 - 1. M 237 Epoxy Resin Adhesive for Bonding Traffic Markers to Hardened Concrete.
 - 2. M 247 Glass Beads Used in Traffic Paint.
 - 3. M 248 Ready-Mixed White and Yellow Traffic Paints.
 - 4. M 249 White and Yellow Reflective Thermoplastic Striping Material (Solid Form).
- B. ASTM Standards:
 - 1. D 638 Tensile Properties of Plastics.
 - 2. E 303 Measuring Surface Frictional Properties Using the British Pendulum Tester.
- C. FS Standards:
 - 1. LS-300 Sheeting and Tape, Reflective: Nonexposed Lens.
 - 2. 141 Paint, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling, and Testing.
 - 3. 370 Instrumental Photometric Measurements of Retroreflective Materials and Retroreflective Devices.
- D. DOT Standards:
 - 1. Utah Manual on Uniform Traffic Control Devices for Streets and Highways (Utah MUTCD).

2. Utah Department of Transportation (UDOT), Standard Specification 02765

1.4 DEFINITIONS **Not Used** (or provide list of definitions needed for this section)

1.5 SUBMITTALS

- A. Primer specifications to be used for tape applications.
- B. Manufacturer's affidavit certifying paint products meet or exceed material requirements of this section.
- C. Sample of prismatic reflector to be used along with manufacturer's statement of the reflector's minimum reflective area and specific intensity at the 0.2 degree observation angle.
- D. Manufacturer's recommendation for type of epoxy adhesive to be used when installing prismatic reflectors and markers.
- E. Samples of each thermoplastic or preformed plastic pavement markings along with a statement of how the materials will be applied.

PART 2 - PRODUCTS

2.1 ALKYD RESIN PAINT

- A. White or yellow Type F (Fast dry) ready-mixed, AASHTO M 248.

2.2 THERMOPLASTIC PAINT

- A. A. White or yellow, AASHTO M 249.

2.3 PAINT

- A. Ennis-Flint High Build Fast Dry Waterborne Traffic Paint
- B. Federal spec TT-P-1952E Type III

2.4 REFLECTIVE TAPE

- A. Type II white or yellow with a Class 1 (pressure-sensitive) adhesive, FS L-S-300.

2.5 THERMOPLASTIC PAVEMENT MARKINGS

- A. Ennis Flint Pre Mark

2.6 PRISMATIC REFLECTORS

- A. Unless indicated otherwise, provide single lens snowplow resistant reflectors of the color indicated:

1. With a cast iron housing and acrylic prismatic reflector.
2. With an overall size not less than nine (9) inches long, five (5) inches wide, and 1-3/4 inch thick with a 7/16 inch maximum projection above the roadway.
3. With a minimum reflective area of 1.6 square inches per face.

B. Reflector Specific Intensity:

Color	Intensity at 0.2 degree Observation Angle	
	0 degree Entrance Angle	20 degree Entrance Angle
White	3.0	1.2
Yellow	1.8	0.72

2.7 EPOXY ADHESIVE

- A. Epoxy: Provide a minimum adhesion value of 1.1 pounds per inch width, AASHTO M 237.

2.8 GLASS BEADS IN PAVEMENT MARKING PAINT

- A. Heavy metal concentration: Manufacturer must provide a certificate of compliance stating that all beads contain no more than the amounts listed for the following materials as determined by testing performed according to EPA test methods 3052 and 6010C.

1. Other suitable x-ray fluorescence spectrometry analysis methods may be used to screen samples of glass spheres for arsenic, antimony and lead content.

Heavy Metal Materials	
Material	Level (ppm, total)
Arsenic	200
Antimony	200
Lead	200

- B. Longitudinal lines – Refer to AASHTO M 247, specific properties with the following exceptions:

1. Gradation:

Gradation	
Sieve Size	Accumulated Percent Passing
No. 18	65-80
No. 30	30-50
No. 50	0-5

2. Coating – Dual coating for optimum adhesion and embedment.
3. Roundness – 80 percent true spheres below the number 30 sieve. Refer to ASTM D 1155.
4. Color/Clarity – Colorless/clear and free of carbon residue.
5. Refractive Index – Minimum 1.51 by oil immersion method.
6. Air Inclusions – Less than 5 percent by visual inspection.
7. Hardness – Beads above the number 30 sieve exhibit an average hardness of C70.5 when measured using the Rockwell C scale method and using a minimum sample of 100 beads.
8. Crushing Strength – Beads above the number 30 sieve exhibit an average crushing strength of 60,000 psi when measured by the L/D2 method and with a minimum sample of 100 beads.
9. Chemical Resistance – Beads resistant to hydrochloric acid, water, calcium chloride, and sodium sulfide. TT-B Federal Specification 1325C sections 4.3.6 to 4.3.9.

- C. Transverse Markings – Refer to AASHTO M247, Specific Properties, with the following exceptions:

1. Gradation:

Gradation	
Sieve Size	Accumulated Percent Passing
No. 20	90-95
No. 30	45-70
No. 50	5-25
No. 80	0-5

2. Coating – Dual coating for optimum adhesion and embedment.
3. Roundness – Have at least 75 percent true spheres.

4. Refractive Index – Minimum 1.51 by oil immersion method.
5. Air Inclusions – Less than 10 percent by visual inspection.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

- A. Use equipment manufactured for pavement marking. Use workers experienced in operating such equipment.
- B. Use equipment capable of applying a strip, or strips with a width tolerance of plus or minus 1/4 inch. Equip machine with an automatic skip control giving a 10 feet long marked segment and a 30 feet long gap within a linear tolerance of six (6) inches over that cycle.
- C. If applying glass beads, locate bead applicator directly behind and synchronized with marking applicator.
- D. For thermoplastic paint materials, use equipment that is designed to agitate the paint to prevent scorching, discoloration, or excessive high temperatures.

3.2 PREPARATION

- A. Broom or flush the surface to remove dirt, loose stones, or other foreign material.
- B. Mark roadway between control points established by ENGINEER. ENGINEER will establish points on tangent at least every 100 feet and at 25 feet long intervals on curves. Maintain the line within 1 inch of the established control points. ENGINEER may also designate other pavement striping locations such as stop bars, crosswalks, zebra striping, etc.
- C. Markings that adhere to asphalt concrete or Portland cement concrete by either a pressure sensitive precoated adhesive or an epoxy cement shall mold to the pavement contours by traffic action at normal pavement temperatures and shall be ready for traffic immediately after application.
- D. Begin pavement painting and marking operations not later than 24 hours after receipt of written order by ENGINEER.
- E. Apply striping and markings per MUTCD requirements.
- F. Apply all materials in accordance with manufacturer's and ENGINEER's directions.

3.3 INSTALLATION – PAINT STRIPING

- A. Apply paint striping at a thickness of 18 mils.
- B. Apply at conditions recommended by manufacturer

- C. Apply glass beads at a rate of 5.9 to 6.1 pounds per gallon of paint
- D. Protect markings until dry by placing approved guarding or warning device as necessary. Remove any markings not authorized, damaged, smeared, or otherwise damaged as approved by ENGINEER.

3.4 ALKYD RESIN PAINT STRIPING

- A. Adjust pavement striping machine to apply paint at rate recommended by paint manufacturer.
- B. Glass Bead Application Rate: 5.9 to 6.1 pounds per gallon of paint.
- C. Protect the markings until dry by placing approved guarding or warning device wherever necessary. Remove any markings not authorized or smeared or otherwise damaged, or correct as approved by ENGINEER.

3.5 THERMOPLASTIC PAINT STRIPING

- A. Clean off dirt, glaze, and grease before prestripping.
- B. Prestripe the application area with a binder material that will form, when sprayed, a continuous film over pavement surface, and will dry rapidly and mechanically adhere to pavement surface. Install material in varying widths if indicated.
- C. Extrude thermoplastic material at a temperature of 412 plus or minus 12 deg F from approved equipment to produce a line 1/8 inch to 3/16 inch thick, continuous and uniform in shape, and have clean and sharp dimensions.
- D. Do not use material that produces fumes that are toxic, obnoxious, or injurious to persons or property.
- E. Apply so finished lines have well-defined edges free of waviness.
- F. Glass Beads Application Rate: Six (6) pounds of glass beads to every 100 square feet of marking.

3.6 TAPE STRIPING

- A. Apply pavement marking tape as indicated or directed. ENGINEER will establish control points.
- B. Apply tape only on surfaces that are dry and free of oils, grease, dust and dirt, and primed at the rate of approximately 1 quart per 60 feet with an approved primer material.
- C. Maintain the line on established control points. Apply intermittent pavement marking tape 24 inches long, spaced approximately 100 feet on tangents, and

approximately 25 feet on curves unless otherwise directed. The ENGINEER will designate other pavement striping locations such as stop bars, crosswalks, zebra striping, etc.

- D. Press down tape immediately after application until it adheres and conforms to pavement surface.
- E. Completely remove all tape on sections where tape conflicts with revised traffic lanes before opening new lanes to traffic.

3.7 PAVEMENT MARKING FILMS

- A. Use pavement marking films that are capable of being applied to new, dense, and open-graded asphalt concrete wearing courses during paving operation in accordance manufacturer's instructions, and that are capable of conforming to pavement contours through the action of traffic at normal pavement temperatures.
- B. Use a pavement marking film that is capable of use for patching worn areas of the same type film.
- C. Apply before traffic is allowed on freshly paved surface.
- D. Unless indicated otherwise, provide Type C, Class II, polymer film markings in specified widths and shapes. Provide and layout words and marking symbol configurations per MUTCD requirements and as indicated.
- E. When indicated, inlay markings in fresh asphalt surface by a compaction roller during the paving operation.
- F. Apply all markings in accordance with manufacturer's recommendations.

3.8 PRISMATIC REFLECTOR INSTALLATION

- A. Install reflectors by cutting pavement and partially filling cut area with epoxy adhesive. Place reflector housing in the adhesive and apply pressure to properly seat. Allow epoxy to completely set before allowing traffic on markers.
- B. Install marker so that housing edges are flush with pavement and so that the angle formed by the longitudinal axis of the marker and the adjacent pavement stripe does not exceed five (5) degrees.

3.9 WORDS, SYMBOLS AND OTHER MARKINGS

- A. Wet sandblast existing or temporary pavement markings that may be confusing. Removal of markings by high-pressure water may be used if approved by ENGINEER.
- B. Apply word markings, letters, numerals and symbols with indicated stencils and templates. In the absence of such information all stencils and templates shall be

identical to those currently used by OWNER.

3.10 TEMPORARY PAVEMENT MARKINGS

- A. Renew when stripes and markings have lost 50 percent of their original visual effectiveness.

END OF SECTION

SECTION 32 19 00 – PAVEMENT SMOOTHNESS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Acceptance testing and determination of a minimum International Roughness Index (IRI) for pavement smoothness of Hot Mix Asphalt (HMA), Open Graded Surface Course (OGSC), Bonded Wearing Course (BWC), Stone Matrix Asphalt (SMA), and Portland Cement Concrete Pavement (PCCP) rehabilitation using a profiler, approved and certified by the Department.
- B. Application of Incentive/Disincentive for pavement smoothness.

1.2 RELATED SECTIONS

- A. Section 32 12 13: Prime Coat/Tack Coat
- B. Section 02981: Grinding Pavement

1.3 REFERENCES

- A. AASHTO M 328: Inertial Profiler
- B. AASHTO R 43: Quantifying Roughness of Pavements
- C. AASHTO R 54: Accepting Pavement Ride Quality When Measured Using Inertial Profiling Systems
- D. AASHTO R 57: Operating Inertial Profiling Systems
- E. ASTM E 2560: Standard Specification for Data Format for Pavement Profile
- F. UDOT Materials Manual of Instruction

1.4 DEFINITIONS

- A. Category 1 Pavements
 - 1. Newly constructed pavement surfaces having two or more opportunities for improving ride.
- B. Category 2 Pavements
 - 1. Newly constructed pavement surfaces without two or more opportunities for improving ride.

C. Opportunity to Improve Ride

1. Placing Granular Borrow, Untreated Base Course, Treated Base Course, Open-Graded Surface Course (OGSC), Bonded Wearing Course (BWC), Stone Matrix Asphalt (SMA), Cold-In-Place Recycling, Hot-In-Place Recycling, and each lift of paving.
2. Rotomilling greater than 1.5 inches in depth.
3. Lane leveling is not considered an opportunity to improve ride.

D. Pavement Section

1. Each travel lane or median, 0.1 mile long. Sections include:
 - a. All traffic lanes
 - b. Ramps
 - c. Medians 8 ft and wider
 - d. Turn lanes
 - e. Approach slabs with final riding surfaces placed as part of the contract
2. Each pavement section is laid out consecutively from the start of the project.
3. Localized Roughness Criteria also applies to bike lanes and shoulders.

E. Structure Section

1. Each travel lane or median, 0.1 mile long. Sections include:
 - a. Bridges, approach slabs, and pavement within 25 ft of the approach slab with final riding surfaces placed as part of the contract.

F. Wheel Path

1. A continuous parallel line 2.5 ft inside the lane or median lines.

G. Mean Roughness Index (MRI)

1. Average of two-wheel path IRIs taken from each pavement section.

H. Localized Roughness

1. Profile deviations in a continuous 25 ft pavement as identified using the ProVAL "Smoothness Assurance" analysis, calculating IRI with a continuous short interval of 25 ft [7.62 m] and the 250-mm filter applied.

1.5 SUBMITTALS

- A. Certifications for profilers and operators, for information.
- B. Summary report of acceptance profile testing for the project, including electronic file, for information. Refer to AASHTO R 43.
- C. Original raw data files compatible with the ASTM E 2560 standard. Refer to AASHTO R 43.
 - 1. Data files collected prior to beginning work for Category 2 pavements.
 - 2. Data files collected before corrective work.
 - 3. Data files collected for final acceptance.

1.6 GENERAL REQUIREMENTS

- A. Certify operators and equipment according to UDOT Materials Manual of Instruction 995.
 - 1. Use the prescribed filter settings from the certification for all measurements in this Section.
- B. Perform work necessary to prepare the pavement for testing, including sweeping.
- C. The Department may perform Independent Assurance testing according to AASHTO R 54 Verification Testing; coordinate this testing with the Engineer.

1.7 ACCEPTANCE

- A. The Department evaluates longitudinal deviations for all roadways using acceptance profiles performed by the Contractor.
 - 1. Determine IRI using the most recent version of Profile Viewer and Analysis (ProVAL) software. Refer to AASHTO R 54 and ASTM E 2560. Identify areas of localized roughness using the ProVAL "Smoothness Assurance" analysis, calculating IRI with a continuous short interval of 25 ft [7.62 m] and the 250-mm filter applied.
 - 2. Determine MRI for each Pavement Section and Structure Section with 250-mm filter applied.
- B. Limit transverse pavement deviations to less than 3/16-inch from the lower edge of a 10-foot straightedge.
- C. Pavement smoothness is evaluated before and after corrective work. Final pavement smoothness acceptance is based on the profile of the final surface of all Pavement Sections of the project.

- D. Structure smoothness is evaluated before and after corrective work. Final structure smoothness acceptance is based on the profile of the final surface of all Structure Sections of the structure.
- E. Limit localized roughness as specified in Table 1.

Table 1 – Localized Roughness Limits	
Roadway	IRI w/base length of 25 ft. (in./mile)
Interstate including ramps	≤ _____
Bridge decks, approach slabs & transitions, manholes and valves	≤ _____
Non-interstate	≤ _____
Urban roadways with speed limits less than 45 mph	≤ _____
Shoulders and Bike Lanes	≤ _____ (single profile)

1. Include profile deviations from bridge decks, approach slabs and transitions, manholes, valves, and other facilities in the profile when the contract requires the adjustment, new construction or reconstruction of these facilities.
2. Exclude profile deviations from bridge decks, approach slabs and transitions, manholes, valves, and other facilities in the profile when the contract does not include adjustment, new construction or reconstruction of these facilities.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION

3.1 MRI OF ORIGINAL ROADWAY SURFACE

- A. Profile existing roadway surface before beginning construction to determine MRI_o for Category 2 pavements.

3.2 PAVEMENT PROFILE CORRECTION

- A. Perform preliminary profiling and roadway smoothness evaluation to identify any defects exceeding acceptance limits.
- B. Correct defects before performing acceptance testing.

1. Measure and correct localized roughness defects in the underlying surface before placement of a final surface of OGSC, BWC, or SMA.
2. Correct localized roughness defects across lanes, medians, and shoulders in widths terminating at a lane line, edge of pavement, or center of the lane either by grinding with a device approved by the Engineer or by surface replacement as approved by the Engineer. Refer to Section 02981.
 - a. Include areas not eligible for incentive/disincentive. Refer to this Section, Article 1.8, paragraph C.
3. Taper corrected areas for smooth transverse transitions and surface drainage.
4. Re-profile for correction verification before acceptance testing.
5. Seal corrected areas in BWC, OGSC, HMA, and SMA with a flush coat application.
 - a. Apply the emulsion according to Section 32 12 13 for tack coat.

3.3 ACCEPTANCE TESTING

- A. Notify the Engineer at least two working days before performing acceptance testing for pavement smoothness.
 1. Clearly define each of the pavement sections to be evaluated.
- B. Perform acceptance testing for smoothness after all corrective work has been performed.
 1. Collect longitudinal profiles in each wheel path and in the center of each paved shoulder and bike lane using Department certified profilers and operators in accordance with AASHTO R 54, R 57 and M 328.
 - a. Collect profiles with no filters applied.
 2. Determine the MRI for each Pavement Section.
 3. Determine the MRI for each Structure Section.
 4. Determine localized roughness using IRI.
 5. Submit a summary report within two working days that includes pavement section identification, structure section identification, profile results, and bump locations showing localized roughness corrections by section.

3.4 PAVEMENT THICKNESS

- A. Determine PCCP thickness after smoothness acceptance testing.
- B. Re-test other pavements for thickness after grinding as determined by the Engineer.

END OF SECTION

SECTION 32 21 26 – FENCES AND GATES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Right-of-way fences and gates.

1.2 RELATED SECTIONS

- A. Section 03 30 40: Portland Cement Concrete
- B. Section 06 05 00: Timber and Timber Treatment

1.3 REFERENCES

- A. AASHTO M 111: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- B. AASHTO M 181 Chain-Link Fence
- C. AASHTO M 232: Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- D. AASHTO M 279: Metallic-Coated, Steel Woven Wire Fence Fabric
- E. AASHTO M 280: Metallic-Coated (Carbon) Steel Barbed Wire
- F. AASHTO M 281: Steel Fence Posts and Assemblies, Hot-Wrought
- G. ASTM A 392: Zinc-Coated Steel Chain Link Fence Fabric
- H. ASTM A 641: Zinc-Coated (Galvanized) Carbon Steel Wire
- I. ASTM F 1083: Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
- J. American Wood-Preservers' Association (AWPA) Book of Standards
- K. National Electrical Code (NEC)
- L. Utah Department of Transportation (UDOT), Standard Drawings for Roadway and Bridge Construction (2017 Edition, including applicable Supplemental Drawings)

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS Not Used

PART 2 - PRODUCTS

2.1 WIRE MESH FENCE

- A. Refer to AASHTO M 279.
- B. Grade 60, nominal 0.099 inch farm grade wire mesh fencing with 6 inch vertical wire spacing.
- C. Class I zinc coating.

2.2 TYPE G WILDLIFE FENCE

- A. Galvanized, heavy duty wildlife fence fabric with fixed knots with 12 ½ gauge line and stay wires, and 6 inch vertical line spacing. Refer to AASHTO M 279.
- B. V-mesh fencing material with doubled and twisted 12½ gauge line wires with 14 gauge V-wires. Refer to AASHTO M 279.
- C. Heavy gauge chain-link, galvanized 9 gauge 2⅜ inch mesh as an alternative. Refer to ASTM A 392.
- D. Class I Zinc Coating.

2.3 BARBED WIRE

- A. Galvanized barbed wire. Refer to AASHTO M 280.
- B. Three strands of nominal 0.099 inch diameter wire twisted with a four-point nominal 0.080 inch barbs no more than 5 inches on center.

2.4 TENSION WIRE

- A. Barbless 9 gauge Class 1 Zinc Coating. Refer to AASHTO M 181.

2.5 UNTREATED WOOD POSTS FOR LINES, GATES, ENDS, AND CORNERS

- A. Native juniper.
- B. Line posts must have a minimum circumference of 10 inches.
- C. Gate, brace, and corner posts must have a minimum circumference of 12 inches.
- D. All posts must be sound, free of decay and defect, and structurally suitable.

2.6 TREATED WOOD POSTS AND WOOD BRACE RAILS

- A. Sound Douglas-fir, hemlock, or pine that is free from decay, splits, multiple cracks, any other defect, and structurally suitable.

- B. Round or sawed rectangular post and braces.
 - 1. Round posts must have a minimum diameter of 5 inches.
 - 2. Gate brace and corner posts must have a diameter of at least 5 inches.
 - 3. Rectangular posts must have a dimension of at least 4 inches x 6 inches.
 - 4. Square members, at least 4 inches x 4 inches, may be rough sawn or S4S lumber.
 - 5. No post or pole rail may deviate from a straight edge placed along its length by more than $\frac{1}{2}$ the diameter of the post or pole rail.
 - 6. Taper (diameter differential) in round members must not exceed 2 inches in 10 ft.
 - 7. Fabricate posts and brace rails before pressure treating the wood members.
 - 8. Refer to Section 06 05 00 for post and brace rail treatment.
 - 9. Apply field treatment preservatives according to AWPA Standard M4 after field drilling. Refer to AWPA Standard M4, Section 7ppp for accepted field treatment preservative systems.
 - 10. Keep round posts free of bark, protruding knots, and other irregularities.

2.7 METAL POSTS AND BRACES

- A. Refer to AASHTO M 281 or ASTM F 1083.
 - 1. Omit anchor plate only if the post is set in a concrete footing with a minimum cross sectional dimension of 4 inches and a depth equal to full penetration of the post.
- B. Coat fasteners with a Class 1 Coating according to ASTM A 641.
 - 1. Hot-dipped galvanized posts or painted posts may be used. Refer to AASHTO M 111.

2.8 TUBULAR-STEEL FRAME GATE WITH WIRE FABRIC

- A. Gates are not to exceed 10 feet in width.
- B. Gates greater than 7 feet require one vertical support of 1.675 inch galvanized steel tubing.
 - 1. Place pipe braces vertically in the center of each gate.
- C. Provide an adjustable truss rod of $\frac{3}{8}$ inch minimum diameter to prevent sagging on gates.

- D. Dimensions shown and specified are the minimum clear openings between gate posts. The supplier must provide a gate with fittings to fill the opening.
- E. Use wire mesh fence for gates.
- F. Supply hot-dipped galvanized steel fittings. Refer to AASHTO M 232.
- G. Frame and walk gates must be made of 1.875 inch galvanized steel tubing.
- H. Fastener for single gates must be an 18 inch length of galvanized chain secured to the gate at one end and fitted with a snap fastener on the loose end.
- I. All double drive gates must have a center latch in place of a chain fastener. A pin from the latch must fit in a socket embedded in concrete.
- J. Use 180 degree industrial hinges.
 - 1. Use hinges that will not twist, turn or allow sagging of the gate.
 - 2. Verify gates are capable of being opened and closed easily by one person.
 - 3. Pintles for gates on wood posts must be $\frac{5}{8}$ inches in diameter or larger.

2.9 FASTENERS

- A. Galvanized 9 gauge staples at least 1½ inches in length.
- B. Galvanized 9 gauge hog rings.
- C. Galvanized rail end caps and set screws.

2.10 ORNAMENTAL FENCE

- A. Galvanized fabric for a Class 1 Coating. Refer to AASHTO M 279.
- B. Galvanized posts, frames, and fittings. Refer to AASHTO M 232.
- C. Fabricate according to FG Series Standard Drawings.

2.11 CONCRETE

- A. Class B concrete. Refer to Section 03 30 40.
- B. Contractor may substitute higher class of concrete.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clear and grade a minimum area to permit proper fence installation.

3.2 INSTALLATION

- A. Install end-braced posts in existing cross fences when intersected by the new right-of-way fence.
- B. Brace corner post in two directions.
- C. Brace end and gate posts in one direction.
- D. Compact backfill material around post to the density of the surrounding ground
- E. Cut wood posts to the designated height and slant top at an approximate 30 degree angle.
- F. Use 3/8 inch diameter x 8 inch long galvanized steel dowels to connect wood braces to the adjacent posts.
- G. Tension brace wires until installation is rigid.
- H. Rail end caps and set screw, bolt or butt weld metal braces to the metal posts.
- I. Support each timber brace with two No. 6 gauge galvanized iron wires fastened to the wood posts.
- J. Remove sags from fence fabric without causing tension crimps to fail.
- K. Install grounds according to industry standard anywhere electric transmission, distribution, or secondary lines cross a wood post fence. Refer to National Electrical Safety Code, Section 9.
- L. Install fence fabric and barbed wire on the side of the post away from the roadway.
 - 1. Attach each strand of barbed wire to the post.
- M. Install fences according to FG Series Standard Drawings.

END OF SECTION

SECTION 32 84 00 – PRESSURIZED IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The work covered by this section consists of furnishing all labor, materials, equipment, and supplies for installation of new drip irrigation system.
- B. Any minor items of labor or materials not specifically noted on the drawings or specifications; but necessary for the proper completion of the work, are considered incidental to and are to be included in the work. All work must meet DFCM design requirements as specified in https://dfcm.utah.gov/wp-content/uploads/design_requirements.pdf.

1.2 REFERENCES

- A. ASTM B 88: Copper Pipe
- B. ASTM B 687: Brass, Copper, and Chromium-Plated Pipe Nipples
- C. ASTM D 1784: Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated poly (Vinyl Chloride) (CPVC) Compounds
- D. ASTM D 1785: Poly (Vinyl Chloride) PVC Plastic Pipe, Schedules 40, 80, and 120.
- E. ASTM D 2464: Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings; Schedule 80
- F. ASTM D 2466: Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings; Schedule 40
- G. ASTM D 2672: Joints for IPS PVC Pipe Using Solvent Cement
- H. ASTM F 656: Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- I. ASSE 1013: Reduced Pressure Backflow Assembly
- J. ASTM D 1557: Compaction of Soil Backfills
- K. ASTM D 2940: Graded Aggregate Material
- L. NFPA 70: National Electrical Code
AASHTO M 288: Geotextile Specifications for Highway Applications.

1.3 DEFINITIONS

- A. Lateral Lines: The system of pipes that carry water from the valves to the emitters.
- B. Mainline: The system of pipes that carry water from the Point of Connection (POC) to the valves.
- C. Trench Backfill and Bedding Material:
 - 1. Backfill: Soil material used to fill a trench.
 - 2. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 3. Final Backfill: Backfill placed over initial backfill to fill a trench.
 - 4. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

- A. Product Information: Submit manufacturer product sheets, technical data, and installation instructions for all of the irrigation system components specified to DFCM Representative for approval before ordering.
- B. As-Built Drawings: Provide 2 copies, red-lined plan layout and details illustrating mainline, sleeves and lateral lines location, size, and assembly. Include, type of valves, controllers, fittings and accessories.
 - 1. Zoning Chart: Show each irrigation zone and its control valve with a separate color designation on an 11x17 size, laminated (3 ml) exhibit. These charts will be stored in the controller enclosure.
 - 2. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.
- C. Operating and Maintenance Documents: Provide all operation and maintenance manuals to the Engineer (controller, hand held radio, automatic control valves, gate valve keys, quick coupler key, etc.) as part of the project close-out procedures

1.5 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.6 PROJECT COORDINATION

- A. Coordinate to insure irrigation sleeves and conduits are placed in all required locations.
- B. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify DFCM no fewer than five days in advance of proposed interruption of water service.
 - 2. Do not proceed with interruption of water service without written permission.
- C. Pressure (PSI) Verification: verify that design/installation pressures at the point of connection are adequate.
- D. Utility Locate: Notify Blue Stakes 800-662-4111 or www.bluestakes.org locating service before work begins.

1.7 WARRANTY

- A. Provide a one (1) year warranty for irrigation work and system components from the Date of Final Acceptance.

1.8 INSPECTIONS

- A. Coordinate with the Engineer and DFCM Representative to have irrigation system inspections as work for the following stages is complete. Obtain approval before proceeding with the next work task or risk removal and replacement of work installed without additional compensation.
 - 1. Sleeving location, depth, type and size.
 - 2. Irrigation manifold

3. Mainline depth, type, marking and size (open trench required)
4. Wire connections, size, depth, color
5. Mainline connections and thrust blocks
6. Hydrostatic test as specified
7. Box supports, markings, valve ID tags
8. Controller type, stations, location, enclosure
9. Controller installation, power connection, certification
10. Lateral line depth, type and size (open trench required)
11. Head and emitter types, spacing and swing joints
12. Water audit
13. Turn over extra equipment, warranties, as-builts (Record Drawings)

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Mainline: Solvent welded schedule 40 PVC, 1". ASTM D 1784 and ASTM D 1785.
- B. Pipe Fittings: Solvent welded schedule 40 PVC. Meet ASTM D 2466.
 1. All fittings with constant pressure sized 2-inches or larger and making 90-degree directional changes are required to be Harco ductile fittings and have concrete kicker blocks supporting each outside corner of the 90-degree fitting.
- C. Valve Fittings: Solvent welded schedule 40 PVC. Meet ASTM D 2464.
- D. Risers: Threaded schedule 80 PVC. Meet ASTM D 2464.
- E. Copper Pipe: Type K as specified in ASTM B 88.
- F. Copper Fittings: Wrought or cast as specified in ASTM B 687.

- G. Polyethylene (PE) Pipe and Fittings: PE controlled OD pipe, PE butt or PE socket-type fittings

2.2 SLEEVES

- A. Solvent welded Schedule 40 PVC pipe and socket fittings, Meet ASTM D 1785.

2.3 VALVES

- A. Gate Valve: Matco-Norca model 503, threaded bronze construction, 200 psi rated (minimum) and sized according to mainline.
- B. Manual Drain Valve: ¾ inch bronze body, angle valve with replaceable seat disc and brass cross handle.
- C. Ball Valve: Spears or approved equal, PVC commercial valve, socket or threaded; line sized.

2.4 BACKFLOW PREVENTER

- A. Reduced Pressure Backflow Assembly Device (ASSE 1013) Model: Wilkins 975 XLU or approved equal.
- B. Bronze body and caps constructed with wear and corrosion resistant internal parts complete with bronze quarter turn ball valves.
- C. Capable of being tested and serviced without removal of device from the line.

2.5 AUTOMATIC CONTROL VALVES

- A. Automatic Control Valves for Drip Application: Rain Bird: Drip Valve Control Zone Kit; XCZ-075-PRF with ¾" Low Flow Valve, ¾" Pressure Regulating RBY Filter, and 30 psi pressure regulator.

2.6 QUICK COUPLER

- A. Signature: Model 7642, 1" NPT with cover
- B. #4 Rebar: Hot-dipped galvanized
- C. Steel Gear Clamps: 3-inch diameter minimum

2.7 DRIP IRRIGATION SPECIALTIES

- A. Point Source Emitters:
 - 1. 1/2" Distribution Tubing: Rain Bird T63-100
 - 2. 1/4" Distribution Tubing: Rain Bird T22-50
 - 3. Xeri-Bug™ Single Outlet Emitter: Rain Bird XB-20PC
 - 4. 1/4" Tubing Stake with Cap: Rain Bird TS-025 WCAP

2.8 AUTOMATIC CONTROLLER

- A. Rain Bird Controller – TBOS2-CM2 Battery-operated Controller with 2 stations and TBOS2-FTUS field transmitter or approved equal. Place in valve box.

2.9 BOXES AND ENCLOSURES FOR VALVES AND OTHER COMPONENTS

- A. Valve box and cover with open bottom and openings for piping; designed for installing flush with grade. Carson Industries or approved equal.
 - 1. Material: HDPE Plastic
 - 2. Size: Verify that equipment fits within boxes with sufficient clearance for maintenance purposes.
 - 3. Shape: Round, square or rectangle to accommodate below grade irrigation equipment, extra wires, etc.
 - 4. Cover:
 - a. Lettering: IRRIGATION
 - b. Provide bolt down cover option
 - c. Color: tan or similar
- B. Washed Aggregate: Cleaned angular gravel or crushed stone, graded from 3/4 inch minimum to 1 1/2 inches maximum.
- C. Backflow Enclosure: Hot Rok
 - 1. Use Select-A-Box feature when ordering to ensure enclosure will have sufficient clearance for code and maintenance purposes.

2. Cover Material: Thixotropic polyester resin reinforced with fiberglass strand.
 - a. Provide locking option.
 - b. Provide 4-inch concrete pad around backflow device for cover anchoring.
 - c. Cover Color: Tan or similar
 - d. Insulated

2.10 JOINT PRIMER AND SOLVENT CEMENT

- A. Refer to ASTM F 656 and ASTM D 2672.

2.11 TEFLON TAPE

- A. Use quality grade, domestically made 0.004 inch (± 0.001) on threaded joints.

2.12 DETECTABLE WARNING TAPE

- A. Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 2 inches wide, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; color: blue for water system identification.

2.13 PIPE BEDDING MATERIAL

- A. Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Preparation
 1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

2. Protect and maintain erosion and sedimentation controls during earth moving operations.

B. Dewatering

1. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
2. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - a. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

C. Excavation for Trenches

1. Excavate trenches to indicated gradients, lines, depths, and elevations.
2. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
3. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to provide minimum cover over top of underground piping according to the following:
 - a. Irrigation Mainline Piping: Minimum depth of 24 inches below finished grade
 - b. Lateral Piping: 18 inches.
 - c. Distribution Tubing: 2 inches (including mulch)
 - d. Drain Piping: at low point in system
 - e. Air Vac: at high point in system
 - f. Sleeves: 24 inches.
4. Clearance: 8 inches each side of pipe, sleeve or conduit.
5. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide

continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

- a. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

6. Trenches within Tree Driplines- and Plant-Protection Zones:

- a. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
- b. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

D. Subgrade Inspection

- 1. Notify Inspector when excavations have reached required subgrade.
- 2. If Inspector determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

E. Trench Backfilling

- 1. Prevent soils, rocks or debris from entering pipes or sleeves. Place and compact backfill in excavations promptly, but not before completing the following:
 - a. Surveying locations or accurately measuring location from adjacent hard surfaces of underground utilities for Record Drawings.
 - b. Testing and inspecting underground utilities.
 - c. Removing trash and debris.
- 2. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- 3. Place backfill on subgrades free of mud, frost, snow, or ice.

4. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
5. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
6. Install detectable warning tape directly above mainline during backfilling of trenches at a depth of 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

F. Soil Moisture Control

1. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content and per geotechnical report specifications.
 - a. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

G. Compaction of Soil Backfills and Fills

1. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
 - a. For mainline trenches under hardscape, compact each layer of initial and final backfill soil material to the specified percentage for finish surface.
 - b. For mainline trenches in planting areas, compact each layer of initial and final backfill soil material to 85 percent.
2. Repair Irrigation system and plants at no additional cost.

3.2 INSTALLATION

- A. General: Plans are diagrammatic. Proceed with installation in accordance with the following:

1. Install stop and waste valves, backflow preventers and other equipment required by local authorities according to Utah Laws and Regulations to make system complete.
2. Install mainline, automatic control valves, lateral lines, fittings, and heads/drip lines as specified.
3. Thoroughly flush mainlines before installing automatic control valves, and laterals before installing drip emitters. Flush supply lines thoroughly before installing backflow preventers or other regulating devices.

B. Sleeving

1. Coordinate sleeving installations before placing pavement.
2. Install sleeves under all driveways and other paving where irrigation mainlines and/or lateral lines cross.
3. Extend ends of pipe a minimum of 12 inches beyond the edge of pavement and be mark with rebar stakes and paint.
4. Run tracer wire the length of the sleeve.
5. Cap all sleeves until pipes and wires are installed to keep sleeve free of dirt and debris.
6. Place controller wires in a separate sleeve from the mainline.
7. Install sleeves in straight lines and without bends.

C. Piping:

1. Assemble all mainline and lateral lines in accordance with manufacturer's recommendations with no cul-de-sacs.
2. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.
3. Install piping free of sags and bends.
4. Install groups of pipes parallel to each other, spaced to permit valve servicing.
5. Install fittings for changes in direction and branch connections.

6. Install unions adjacent to valves and other components with 2-inches or smaller pipe connections.
 7. Lay piping on solid sub-base, uniformly sloped without humps or depressions.
 8. Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.
- D. Automatic Controller:
1. Place in Valve Box.
 2. Provide a laminated copy of the controller charts indicating valve station numbers and field locations and attach it inside the controller.
 3. Program the controller to provide the appropriate amount of water

for each station.
 4. Supply the Engineer with manufacturer's warranties and operating instructions for the controller.
- E. Automatic Drip Control Valves:
1. Install at plan locations according to detail.
 2. Use Schedule 80 PVC pipe for nipples on valve header, length as necessary.
 3. Install valves 2 maximum per each standard, plastic valve box and provide 12 inches of expansion loop / slack wire at all connections inside valve box.
- F. Manual Drains: Install at locations indicated on plans and according to detail.
- G. Quick-Coupler Valves: Install using $\frac{3}{4}$ inch Schedule 80 PVC nipples for risers and elbows. Locations as indicated on plans and details.
- H. Backflow Preventers:
1. Install assembly using the detail.
 2. In below grade installations, provide washed aggregate drain sump.

- I. Valve Access Boxes:
 - 1. Install over all automatic control valves, manual control valves, or zone shutoff valves and sized to provide adequate room for maintenance.
 - 2. Install valve boxes 1 inch above finish grade (top of rock mulch) and place perpendicular to adjacent curbs, sidewalks, or driveways.
 - 3. Imprint a valve control number on each valve box cover that corresponds to the valve controller clock that is a minimum of one-inch high and in a permanent and legible manner.
 - 4. Place washed aggregate in sump as shown on plans.
- J. Drip Irrigation Specialty Installation
 - 1. Install freestanding emitters on pipe riser to mounting height indicated.
 - 2. Install drip tubes with direct-attached emitters on ground.
 - 3. Install drip tubes with remote-discharge on ground with outlets on off-ground supports at height indicated.
 - 4. Install off-ground supports of length required for indicated mounted height of device.
 - 5. Install application pressure regulators and filter units in piping near device being protected, and in control-valve boxes.

3.3 TESTING AND INSPECTION OF SYSTEM AND COMPONENTS

- A. Following construction, a Water Use Efficiency Review (Audit) will be conducted by a certified Landscape Irrigation Auditor. The auditor shall be independent of the contractor, design firm and owner/developer of the project. The water performance audit will verify that the irrigation system complies with the minimum standards required by this ordinance. The auditor shall furnish a certificate to the DFCM, Engineer, and installer certifying compliance with the minimum distribution requirements and an irrigation schedule.
- B. Perform Required Tests and Inspections for the Following:
 - 1. Backflow Preventer Certification: Provide certification.

2. Mainline Inspection: Depth, type, size, marking tape, connections, and thrust blocks prior to backfill.
 3. Lateral Line Inspection: Depth, type, size, and fittings prior to backfill.
 4. Leak Test: After installation and before backfilling, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 5. Hydrostatic pressure test on mainline.
 6. Hydrostatic pressure test on lateral lines.
 7. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation. Conduct in the presence of the DFCM's Representative.
 8. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 9. Irrigation Audit. Performed by a third party to verify specified efficiency ratings are achieved, retest failed zones after required adjustments to confirm specified efficiency ratings are achieved.
- C. Any irrigation installation will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports for hydrostatic pressure tests and irrigation audit and submit to DFCM's Representative.

3.4 IRRIGATION INSTALLATION INSPECTION

- A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that controllers are installed, connected and performance is acceptable to the DFCM Inspectors.
 3. Verify that electrical wiring installation complies with manufacturer's recommendation.
- B. Adjusting
1. Adjust settings of controllers.
 2. Adjust automatic control valves to provide flow rate at rated operating pressure required for each circuit.

3. Adjust valve boxes, except those intended to be mounted aboveground, so they will be 1 inch above finish grade.
 4. Make adjustments as required by irrigation audit to meet the specified efficiency requirements.
- C. Clean-up and protection
1. During irrigation installation, keep adjacent paving, construction, and work area clean and in an orderly condition.
 2. Protect any existing or newly planted materials from damage due to irrigation installation operations and operations of other contractor and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
 3. Clean adjacent hard surfaces of dirt, debris, and mud resulting from installation and testing of irrigation system.
- D. Demonstration
1. Train DFCM's maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

END OF SECTION

SECTION 32 90 10 – LANDSCAPE PLANTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnishing and installing plant material including amended planting soil (compost) and tree staking.

1.2 RELATED SECTIONS

- A. Section 32 84 00 – Pressurized Irrigation

1.3 REFERENCES

- A. ANSI Z 60.1: American Standard for Nursery Stock

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS

- A. A copy of the plant purchase order indicating plant names, sizes, quantities, and unit prices. Submit within 90 calendar days from the Notice to Proceed.
- B. Plant substitutions:
 - 1. Obtain a signed statement from three wholesale nurseries, noted for stocking the specified plants, indicating that the plants are unavailable.
 - 2. Submit to the Engineer the signed statements and a written request indicating the size and species of the unavailable plants and their suggested replacements.
 - 3. Substitutions will not be approved after 120 calendar days from the Notice to Proceed
- C. All necessary inspection certificates for each shipment of plants as required by Utah Laws and Regulations.

1.6 QUALITY ASSURANCE

- A. Reject plants not meeting ANSI Specification
- B. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
 - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main

-
- body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 12 inches above the root flare.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- C. Plant Material Observation: Schedule with the Engineer and DFCM Representative to inspect plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Engineer and DFCM Representative retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
- D. Pre-Installation Conference: Conduct conference at Project Site.
- E. Inspections: Coordinate landscape inspections with the Engineer and DFCM Representative as listed below. Obtain approval from Engineer and DFCM Representative before proceeding with the next item or risk removal and replacement of work installed without additional compensation.
1. Pre-construction meeting
 2. Approve topsoil and agronomics soil test and recommendations
 3. Verify soil preparation/amendments
 4. Verify plant species, size, quality, quantities and location.
 5. Planting depth, staking
 6. Finish grade
 7. Substantial completion inspection
 8. Review of punch list
 9. Final acceptance

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Secure required plants at a nursery within 60 calendar days from the Notice to Proceed for the Landscape Contractor.
- B. Grow plants under full exposure to climatic conditions similar to those found on the project for a minimum of 60 calendar days.
- C. Notify the Engineer and DFCM Representative at least 14 calendar days before delivering the plants to the site and arrange for plant inspection.
- D. Deliver plant materials to the work site in covered vehicles just before placement. Maintain delivered plants in a healthy condition.

1. Replace all wilted, wind-burned, or stressed plants at no additional cost to DFCM.
 2. Protect balled and burlapped rootballs from sun and wind by covering with soil or other suitable material if not planted immediately upon delivery.
 3. Place delivered plant materials for inspection as follows:
 - a) Trees of the same species in groups with adequate spacing for inspection.
 - b) Shrubs and groundcovers of the same species in groups.
- E. Maintain delivered plants in a healthy condition.
1. Replace all wilted, wind-burned, or stressed plants at no additional cost to DFCM.
 2. Protect balled and burlapped rootballs from sun and wind by covering with soil or other suitable material if not planted immediately upon delivery.
 3. Place delivered plant materials for inspection as follows:
 - a. Trees of the same species in groups with adequate spacing for inspection.
 - b. Shrubs and groundcovers of the same species in groups.
- F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.8 PLANT INSPECTION AND ACCEPTANCE

- A. Replace unacceptable plant material within 14 days after notification from the Engineer and DFCM Representative.
- B. The Engineer and DFCM Representative schedule all inspection dates.
- C. Make the required replacements and notify the Engineer and DFCM Representative for re-inspection.

1.9 SCHEDULE

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 1. Tree Planting: September 1st to May 31st
 2. Shrub Planting:
 - a. Spring Planting: March 15th to June 15th

- b. Fall Planting: August 15th to November 1st

PART 2 - PRODUCTS

2.1 PLANTS

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
1. Trees with clipped, damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide legible labels attached to all plants, flats, bundles, or other containers indicating botanical genus, species, and size.
- C. Supply containerized plants with root systems fully established in the container.

2.2 TREE STAKES

- A. Stakes: Stakes: Rough-sawn, sound, new lodgepole pine, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
- B. Proprietary Tying Device: Flex Strap™ Tree Tie

2.3 COMPOST

- A. Supply compost made from organic materials, including animal manures, straw, yard trimmings, sawdust or other forest wood products, which have been through a high temperature composting process.
1. The process involves treating the materials with natural micro-organisms and regularly turning the compost piles to provide adequate oxygenation and ensure complete pasteurization.

2. Supplied compost to be decomposed to a maximum thickness of 1/4 inch and be a consistent dark brown to black in color, within a pH range of 5.5 to 7.0, and free of plastics, metals, weed seeds and offensive odors
3. Backfill plants with a mixture of soil excavated from the pit and compost at a rate of 2-parts soil and 1-part compost.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that area prepared to receive plants is graded properly as per plan, all work is completed in the area. Over excavate tree pits and have 1.2 cu yds amended soil and shrub pits 0.22 cu yds amended soil.
- B. Have the irrigation system installed and fully operational before installing plants.
- C. Stake or delineate locations of plants for approval before installation.

3.2 INSTALLATION

- A. General
 1. Install plants according to the plan details.
 2. Within one hour of installation, water the plants to saturate the rootball to a minimum of 4 inches below and around the plant hole. Add more amended soil backfill if settling occurs.
- B. Containerized Plants
 1. Excavate plant holes to twice the diameter and the same depth of the rootball.
 2. Carefully remove the plant from its container, scarify the sides and bottom of the rootball if needed and place it in the prepared hole.
 3. Place 0.22 cu yds of amended soil in 4 inch lifts around the rootball of each plant and eliminate voids by tamping or water-settling the soil between each lift.
- C. Trees
 1. Excavate plant holes to twice the diameter and the same depth of the rootball.
 2. For boxed trees, place boxed tree to edge of the hole, tip, and remove bottom boards from box. Gently place the tree in the prepared hole with box slides intact.
 3. For other trees, gently remove burlap and wire cage from rootball, and dispose of burlap and cage. Gently place the plant in the prepared hole.

4. Remove the straps and box side boards without disturbing the root ball.
 5. Place 1.2 cu yds of amended topsoil in 4 inch lifts around the rootball of each tree and eliminate voids by tamping or water- settling the soil between each lift.
- D. Install trunk stabilization for trees as follows unless otherwise indicated:
1. Stake all trees subject to wind damage. Use a minimum of two stakes of length required to penetrate at least 24 inches below bottom of backfilled excavation and to extend above grade to the dimension shown on the tree planting detail. Set vertical stakes and space to avoid penetrating root balls or root masses.
 2. Install tying system sized and positioned as recommended by manufacturer and according to manufacturer's written instructions. Use 2 strap ties per tree.

3.3 CLEAN AND MAINTAIN

- A. Remove foreign materials from site such as containers, burlap, twine, and trash collected during installation.
- B. Remove any tags, labels, or other items attached to the plant material after final plant inspection.
- C. Water and maintain the plants in a healthy condition until the final plant inspection.
- D. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- E. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

END OF SECTION

SECTION 32 90 20 – ROCK MULCH

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Types of rock mulch and application requirements.

1.2 REFERENCES

- A. AASHTO M 288: Geotextile Specifications for Highway Applications.
- B. ASTM D 4791: Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.3 SUBMITTALS

- A. Samples for Verification:
 - 1. Rock Mulch: Submit to the Engineer a 5-gallon bucket ½ full of type of rock mulch required, labeled with source of mulch. Provide sample typical of the rock mulch to be delivered and installed on the site that is an accurate indication of color, texture, and makeup of the material for approval 14 days before installation.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not dump or store rock mulch near structures, utilities, walkways and pavements, or on existing plants..
- B. Provide control measures to prevent displacement of rock mulch to adjacent properties.

PART 2 - PRODUCTS

2.1 ROCK MULCH

- A. Rock Mulch A: Hard, durable stone, washed, of following type, size range, and color:
 - 1. River Rock
 - a. Size Range: 1 to 3 inches

- b. Color: Grey
- B. Rock Mulch B: Hard, rounded, durable stone, washed, of following type, size range, and color:
 - 1. Calico Cobble or River Cobble:
 - a. Size Range: 2 to 6 inches
 - b. Color: Tan
- C. Rock Mulch C: Hard, crushed rock, washed, of following type, size range, and color:
 - 1. Crushed Rock
 - a. Size Range: 3/4 to 1 inch
 - b. Color: Grey

PART 3 - EXECUTION

3.1 PREPARATION

- A. Complete all required grading, irrigation, trench settling, and planting before applying rock mulch.

3.2 APPLICATION

- A. Rock Mulch A
 - 1. Apply a minimum 4-inch thickness of rock mulch over the areas per construction plan layout and details and 1 inch below adjacent finish grades/surfaces.
- B. Rock Mulch B
 - 1. Apply a minimum 4-inch thickness of rock mulch over the areas per construction plan layout and details and 1 inch below adjacent finish grades/surfaces.
- C. Rock Mulch C
 - 1. Apply a minimum 6-inch thickness of rock mulch over the areas per construction plan layout and details and 1 inch below adjacent finish grades/surfaces

END OF SECTION

SECTION 32 92 19 – SEEDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish all labor, materials and equipment as required to apply seed. This includes but is not limited to preparing ground, sowing seeds and other management practices on areas shown on the project drawings and in accordance with this specification.

1.2 RELATED SECTIONS **Not Used**

1.3 REFERENCES **Not Used**

1.4 DEFINITIONS

- A. A sandy soil is one with a USDA soil texture classification of any of the following: sand, loamy sand, sandy clay loam, or a sandy clay.
- B. A non-sandy soil is one with a USDA soil texture classification of any of the following: loam, silt loam, silt, clay loam, silty clay loam, silty clay, or clay.

1.5 SUBMITTALS

- A. Submit for information, copy of the purchase order documenting that all seeds, including substitutions, have been acquired before the seeding window begins.
 - 1. Refer to this Section, article 1.6 for seeding information.
 - 2. List the common and botanical name for each seed species on the purchase order.
- B. Submit for information, certification that turf sod is nursery grown and contains a minimum of three varieties of Kentucky Blue Grass.
- C. Submit for information, certification indicating the date and time sod was cut at the nursery.
- D. Submit for information, fertilizer labels.
- E. Submit for information legible copy of Seed Certification – Include the following on seed certification reports and labels:
 - 1. Botanical name (include variety if applicable)
 - 2. Common name
 - 3. Name of seed testing laboratory

4. Lot number and address of the seed company
 5. Weed seed (percent)
 6. Other crop seed (percent)
 7. Inert matter (percent)
 8. Pure live seed (percent)
 9. Noxious weed seed (name and rate of occurrence)
 10. Date tested (month and year)
 11. Germination (percent)
 12. Hard seed (percent)
 13. Net weight (do not include container weight)
 14. Pure live seed weight
 15. Collection locations for native shrub and tree species (state, county, elevation)
- F. Submit for information manufacturer's directions on drill calibration two working days before seeding.

PART 2 - PRODUCTS**2.1 SEED**

- A. Supply seed on a pure live seed (PLS) basis.
- B. Meet the Utah Seed Act.
- C. Provide inoculated legume seed.
- D. Each variety of seed shall be furnished and delivered in separate bags or containers. Provide germination or tetrazolium test data for each variety of seed. Date of tests shall be within nine months of the time of seeding.

2.2 EROSION CONTROL MULCH AND MAT

- A. Straw Mulch - straw mulch shall be oat, wheat or rice straw. The straw mulch shall be free of Johnson grass or other noxious weeds and foreign materials. It shall be kept in a dry condition and shall not be molded or rotted.
- B. Erosion Control Mat - as described in Section 31 32 19 - Geosynthetics.

PART 3 - EXECUTION

3.1 GENERAL

- A. All seed shall be certified noxious weed free.
- B. Do not use wet, moldy or damaged seed.
- C. Notify the Engineer two working days before seeding.
- D. Complete all seeding on or before October 30

3.2 SECURE SEED

- A. Submit seed certification based on PLS and results of germination tests. The purchase order should list the common and botanical name for each seed species.

3.3 SEED SUBSTITUTIONS

- A. Before requesting a seed substitution, contact the major seed companies in the state to verify that the seed is unavailable.
- B. Have the Engineer contact the Landscape Architect, who developed the seed mix, to verify the seed is unavailable and to recommend a seed substitution.
- C. Replacement seed shall be of equal or greater function to the originally specified seed.

3.4 MIXING SEED

- A. Mix and bag the different varieties of seed in the presence of the Engineer.
- B. Obtain the seed from the same lots from where it was sampled.
- C. Mix the different seed varieties to provide an even blend.
- D. Bag the mixed seed and label and seal the container.

3.5 SEED APPLICATION RATES PER ACRE

- A. Seed all areas using the appropriate seed mix listed in the following tables according to location and/or soil conditions.

Seed Schedule

Seed No.	Species Name		Number of Seeds per pound	Drill Seed			Broadcast Seed		
	Botanical	Common		Pounds of pure live seed per acre	Percent of mix	Seeds per sq. ft.	Pounds of pure live seed per acre	Percent of mix	Seeds per sq. ft.
1	Agropyron cristatum 'Roadcrest'	RoadCrest wheatgrass	265,250	3.00	15.51%	18.27	4.50	15.51%	27.40
2	Elymus wawawaiensis	Snake River wheatgrass	120,000	4.00	9.36%	11.02	6.00	9.36%	16.53
3	Festuca ovina 'Covar'	Covar sheep fescue	680,000	2.50	33.14%	39.03	3.75	33.14%	58.54
4	Poa secunda spp. Sandbergii 'High Plains'	High plains sandberg bluegrass	925,000	1.50	27.05%	31.85	2.25	27.05%	47.78
5	Thinopyrum intermedium 'Tegmar'	Tegmar intermediate wheatgrass	88,000	4.50	7.72%	9.09	6.75	7.72%	13.64
6	Linum lewisii 'Maple Grove'	Maple Grove blue flax	170,000	1.00	3.31%	3.90	1.5	3.31%	5.85
7	Penstemon Eatonii 'Richfield'	Richfield firecracker penstemon	400,000	0.50	3.90%	4.59	0.75	3.90%	6.89
Total				17.00	100.00%	117.75	25.50	100.00%	176.63

3.6 SEED BED PREPARATION

- A. Do not work topsoil or seed when the soil is saturated or frozen.
- B. If a crust has formed on the topsoil, loosen the ground surface to a depth of 1 inch.
- C. If the topsoil has produced weeds, remove them before seeding.
- D. Prior to seeding, moisten the soil to a depth of 6-8 inches.

3.7 METHODS

- A. Drill Seeding
 1. Use the drill method of seeding accessible slopes 3:1 and flatter. Use a rangeland type drill equipped with a depth band, seed box agitator, seed metering device, furrow opener, and packer wheels.
 2. Calibrate the drill using the manufacturer's directions in the presence of the Engineer.

3. Meet the specified application rate.
 4. Space drill rows 6 to 8 inches and drill seeds 3/8 inch to 1/2-inch in depth.
 5. Drill along the contour of the slope.
 6. Maintain the drill at the calibrated setting throughout the seeding operation.
- B. Broadcast Seeding
1. Use the broadcast method of seeding on all areas that were not drill seeded.
 2. If seed is to be hand broadcast, it shall be broadcast in two directions at right angle to each other.
 3. Rake seed into the soil perpendicular to the slope.

3.8 EROSION CONTROL MULCH

- A. On slopes 3:1 and flatter, apply straw mulch with a minimum stalk length of 8 inches and at a minimum rate of 3000 lbs. Per acre or erosion control mat according to section 31 35 00 Geotextiles.
- B. On slopes steeper than 3:1 install erosion control mat according to section 31 35 00 Geotextiles.
- C. The moisture content of the straw shall not be greater than 20 percent.
- D. Anchor the straw mulch into the soil by the crimping method.

3.9 TIMING

- A. All seeding and slope stability measures shall be in place no later than three (3) weeks after topsoil has been placed to finished grade.

3.10 INSPECTION

- A. Following the completion of the initial revegetation, the Engineer shall inspect the work to be certain that installation is as per supplier and/or manufacturer recommendations.
- B. If the work is not approved, the Contractor shall replant and/or reseed and/or stabilize all areas within the initial area of disturbance and take all other actions reasonably necessary as directed by the Engineer to provide erosion control and slope and/or area stabilization within the initial area of disturbance.

3.11 WARRANTY PERIOD

- A. An 18 month warranty period (the Warranty Period) shall commence after work is approved. At the end of the Warranty Period, the Owner will make an inspection to determine whether or not the revegetation growth has taken hold and the disturbed areas are established and stabilized i.e. lack of rill or gully erosion.
- B. The technical procedure in determining if the vegetation has been established enough to stabilize the soil against either rill or gully erosion is the quadrant frame method or the step transect method. Both methods are a way of comparing plant production, biomass cover and erosion in the revegetated area with the same in an adjacent undisturbed and/or native site. Either method will be performed at several randomly selected locations along the project.
- C. If at the end of the Warranty Period the Owner determines that the vegetation is unsatisfactory, the Contractor shall install new measures or repair the old measures as directed by the Owner.

END OF SECTION

SECTION 33 01 10 – GENERAL WATER PIPING REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

- A. This section describes the general requirements for water piping including piping, flanges, bolts, nuts, gaskets, and miscellaneous piping items.
- B. This section also applies to steel piping for sewer pump stations.
- C. Unless specifically noted otherwise, all piping materials, flanges and other components shall be designed for a minimum of 133 psi working pressure. Where higher pressures are required, use the higher pressure.
- D. If plans and specifications are silent APWA standards shall govern.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Concrete Institute (ACI): 301, Standard Specification for Structural Concrete.
 - 2. American Public Works Association (APWA)
 - 3. ASTM International (ASTM):
 - a. A497, Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
 - b. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 4. American Society of Mechanical Engineers (ASME):
 - a. B16.5, Pipe Flanges and Flanged Fittings NPS ½ Through 24 Metric/Inch Standard.
 - b. B16.47 Large Diameter Flanges and Flanged Fittings Through 60 Metric/Inch Standard.
 - c. B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
 - d. B36.10M, Welded and Seamless Wrought Steel Pipe.

- e. BPVC SEC V, Nondestructive Examination.
 - f. BPVC SEC VIII, Div. 1, Rules for Construction Pressure Vessels.
 - g. BPVC SEC 1X, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
 - h. PCC-1 Guidelines for Pressure Boundary Bolted Flange Joint Assembly.
5. American Water Works Association (AWWA):
- a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm Through 1200 mm), for Water and Other Liquids.
 - b. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - c. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm). C210 Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - e. C217, Cold-Applied Petroleum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Buried Steel Water Pipelines.
 - f. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
 - g. C221, Fabricated Steel Mechanical Slip-Type Expansion Joints.
 - h. C606, Grooved and Shouldered Joints.
6. NSF International (NSF): 61B, Drinking Water System Components - Health Effects.

1.3 DEFINITIONS OF BURIED AND EXPOSED PIPING

- A. Buried piping is piping buried in the soil commencing on the interior of concrete walls or floor slabs of a structure. Where a coating is specified, provide the coating up to and through the structure wall as indicated in Sections 09 90 00 and shown in the plans. Piping

encased in concrete is considered to be buried.

- B. Exposed piping is piping in any of the following conditions or locations.
 - 1. Above ground.
 - 2. Inside buildings, vaults, or other structures.

1.4 SUBMITTALS

- A. Action Submittals:
 - 1. Detailed shop drawings, in accordance with Section 01 30 00, Submittals, showing pipe details, material type (ASTM or other), special fittings and bends, dimensions, coatings, and other pertinent information.
 - 2. Layout drawing showing location of each pipe section and each special.
 - 3. Pipe wall thickness or pressure class as applicable.
 - 4. Wall thickness, reinforcing, and strength calculations.
 - 5. Product Data: Manufacturer's data for couplings, saddles, gaskets, and other pipe accessories. Indicate maximum rated working pressure and test pressure for each item.
 - 6. A complete and coordinated submittal of all flanges on the project. Include information sufficient to verify complete compliance with the plans and specifications for all items relating to all flanges including, but not limited to:
 - a. Flange ASTM/AWWA standard, class, facing, quantities and where used.
 - b. Flange details.
 - c. Gasket details: type, material, diameter, thickness.
 - d. Bolts, rods, nuts, washers: all lengths, quantities, bolt / hole diameters, material strengths, torque requirements for gaskets submitted, metal finishes (zinc plated) provide all materials and dimensions mentioned in PCC-1 Guidelines.
 - e. Facing details: finish grade, faces with and without gasket groves.

- f. Mating flange facing for all valves, meters, dismantling joints, insulating flanges, etc.
 - 7. Prevent Thermal movement
 - a. Before construction, submit Contractor's plan to control thermal movements during installation and backfill including preventing thermal forces on wall and floor thrust rings during casting and curing.
- B. Informational Submittals:
 - 1. Submit affidavit of compliance with referenced standards (e.g., AWWA, ASME, ASTM, etc.).
 - 2. Submit certified copies of mill test reports for bolts and nuts, including coatings if specified. Provide recertification by an independent domestic testing laboratory for materials originating outside of the United States.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with manufacturer's recommendations and as specified in individual Specification(s) following this section.
- B. Marking at Plant: Mark each pipe and fitting at plant. Include date of manufacture, manufacturer's identification, specification standard, diameter of pipe, wall thickness, dimension ratio, pipe class, pipe number for laying purposes, and other information required for type of pipe.
- C. Pipe, specials, and fittings received at Project Site in damaged condition will not be accepted.
- D. Gasket Storage: Store rubber gaskets in cool, well ventilated place, and do not expose to direct rays of sun. Do not allow contact with oils, fuels, petroleum, or solvents.
- E. Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.
- F. Handling:
 - 1. Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage

coating or lining, or kink and bend pipe ends is not permitted.

2. Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials. Do not use chains or cables.
3. Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of

pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workmen. Slings shall bear uniformly against pipe.

4. Pipe and fittings shall not be stored on rocks or gravel with particles that are greater than 1 inch in diameter, or other hard material that might damage pipe. This includes storage area and along pipe trench.

PART 2 - PRODUCTS

2.1 PIPE

- A. As specified in the individual Specification(s) following this section
- B. For schedule 80 PVC pipe and solvent weld material, comply with ASTM D1785 and ASTM D1784. Install per manufacturer instructions.

2.2 JOINTS

- A. As specified in the individual Specification(s) following this section. Where piping connects to wall pipes, meters, valves, or other equipment, the pipe ends shall match the ends of the wall pipes, meters, valves, or equipment.

2.3 COUPLINGS

- A. General:
 1. Couplings, which include dismantling joints, shall be rated for appropriate operating pressure and hydrostatic test pressure.
 2. Exposed, bolted, sleeve-type couplings including dismantling joints shall be lined and coated with epoxy in accordance with Per Section 09 90 00 and these specifications.

- B. Standard Weight SST Pipe with Grooved Ends Couplings
 - 1. Grooved couplings, in accordance with AWWA C606. System shall provide for flexible or rigid joints as shown on Drawings.
 - 2. Gaskets shall be EPDM and shall conform to ASTM D2000.
- C. Bolting Materials for Couplings: Same as bolts and nuts for flanges.
- D. If carbon steel or ductile couplings are used, zinc prime and then epoxy per AWWA C210 and these specifications, and then wire bond and cathodically protect them.
- E. Stainless Steel Grooved End Couplings: Victaulic Model, 475 or equal, but rated to the test pressures plus 30 psi (180 psi min).

2.4 FLANGES

- A. Comply with all detailed requirements for a comprehensive flange submittal.
- B. Steel flanges shall be forged material per ASTM A 105/A 105M. See ductile iron pipe specifications for ductile iron flanges.
- C. Wrap buried flanges with petroleum wax tape per Section 09910.
- D. Coordinate and mate all flanges and gaskets in submittals (for valves, meters, insulating flanges, couplings, etc.) so that mating flanges are both of the same flange type and coordinate facing. Unmated flanges (of dissimilar facing, gasket or type) shall be corrected at Contractor expense.
- E. Comply with all detailed requirements and provide a comprehensive flange submittal. Submit each mated flange assembly signed jointly by the manufacturer of both flanges (i.e. pipe to valve, valve to meter, meter to dismantling joint, etc).

2.5 STAINLESS STEEL BOLTS AND NUTS FOR BURIED FLANGES

- A. Bolts for buried flanges shall be Type 316 stainless steel, ASTM A193/ A193M, Grade B8M hex head bolts; and ASTM A194/A194M, Grade 8M hex head nuts. Fabricate in accordance with ASME B18.2.2. Provide washers for each bolt and nut. Washers shall be of the same material as the nuts
- B. Lubricant for stainless steel nuts and bolts shall be chloride free and shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O-Seal, or equal.

2.6 GASKETS

- A. Use full-face gaskets 1/8-inch thick acrylic or aramid fiber bound with nitrile. Products: Garlock "Bluegard," Klinger "Klingersil C4400," or equal. Gaskets shall be suitable for a pressure of 500 psi at a temperature of 400°F.

2.7 FIRE HYDRANTS

- A. Construct fire hydrants per Draper City Standards plans and specifications except as designated with its shop applied, salt-resistant, 3-coat Coat and line per Section 09 90 00. (MC Mio Zinc 100, Ferrox B 100, and MC Luster 100-Safety Red), and Detail 2.1 to 2.6.

2.8 PIPE MARKING TAPE & TRACER WIRE

- A. As specified in Section 31 20 00, Earthwork and Dewatering.

PART 3 - EXECUTION

3.1 GENERAL

- A. Do not lay, weld or backfill any pipe at temperatures below 35 degrees F without Construction Manager acceptance.
- B. Notify Construction Manager at least 2 weeks prior to fabrication of pipe or fittings.
- C. Furnish feeler gauges of proper size, type, and shape for use during installation for each type of pipe furnished with rubber gasket joints.
- D. Distributing Materials: Placement of materials shall not be hazardous to traffic or to general public, obstruct access to adjacent property, or obstruct others working in area. The Construction Manager shall determine if the placement of materials does not comply with specifications.

3.2 EXAMINATION

- A. Verify size, material, joint types, elevation, and horizontal location of existing pipeline to be connected to new pipeline or new equipment.
- B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.
- C. Damaged Coatings and Linings: Repair using coating and lining materials in accordance with manufacturer's instructions.
- D. Damaged Pipe: Pipe sections that have damage to the bell end spigot end or

barrel shall be replaced at no additional cost to the Owner.

3.3 PREPARATION OF TRENCH

- A. Maximum trench length and trench preparations shall be as specified in Section 31 20 00, Earthwork and Dewatering.

3.4 INSTALLATION

- A. General:
 - 1. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
 - 2. Install individual pipe lengths in according to approved lay diagram. Misplaced pipe shall be removed and replaced.
 - 3. Inspect pipe and fittings before installation, clean ends thoroughly, remove foreign matter and dirt from inside.
 - 4. At all times when the Work of installing pipe is not in progress, all openings into the pipe and the ends of the pipe in trenches or structures shall be kept tightly closed to prevent entrance of small animals, mud, and other foreign materials into the pipe. Failure to do so will result in Owner requiring Contractor to pressure wash the pipe interior.
 - 5. Flanged Joints:
 - a. Install perpendicular to pipe centerline.
 - b. Bolt Holes: Straddle vertical centerline, aligned with connecting equipment flanges or as shown on Drawings.
 - c. To provide uniform bearing and proper bolt tightness
 - 1) Bolts 1-inch and smaller: Use torque-limiting wrenches.
 - 2) Bolts >1-inch: Use hydraulic bolt tensioners (see ASME PCC-1, paragraph 10, first NOTE).
 - d. Tighten flange bolts progressively, drawing up bolts

on opposite sides gradually until bolts have uniform tightness around the flange.

- e. Install grease caps.

6. Couplings:

- a. Install in accordance with manufacturer's written instructions.
- b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
- c. Remove pipe coating, if necessary, to obtain smooth surface.
- d. Clean gaskets before installation.
- e. If necessary, lubricate with gasket lubricant for installation on pipe ends.
- f. Tighten coupling bolts progressively, drawing up bolts on opposite sides gradually until bolts have uniform tightness.

B. Buried Pressure and Gravity Sewer Pipe:

- 1. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown on Drawings.
- 2. Trench Grade Preparation:
 - a. Refer to Section 31 20 00, Earthwork and Dewatering.
- 3. Trench Backfill: Refer to Section 31 20 00, Earthwork and Dewatering.
- 4. Placement:
 - a. Keep trench dry until pipe laying and joining is completed.
 - b. Provide and use proper implements, tools, and facilities for safe and proper prosecution of the Work.
 - c. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of a crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings.

- d. Do not drop or dump pipe materials into trench.
 - e. Measure for grade at pipe invert, not at top of pipe.
 - f. Excavate trench bottom and sides of ample dimensions to permit proper joining, welding, visual inspection, and testing of entire joint.
 - g. Prevent foreign material from entering pipe during placement.
 - h. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
 - i. In general, lay pipe upgrade with bell ends pointing in direction of laying.
 - j. Check gasket position with feeler gauge to assure proper seating for rubber-gasket joint pipe.
 - k. After joint has been made, check pipe alignment and grade.
 - l. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
 - m. Take all necessary precautions to prevent the pipe from floating prior to backfilling due to water entering the trench or from backfilling with CLSM.
 - n. The Contractor shall assume full responsibility for any damage due to this cause and shall at its own expense, restore and replace the pipe to its specified condition and grade if it is displaced due to floating.
5. Tolerances:
- a. Deflection From Horizontal Line: (at Joints) Maximum 2 inches.
 - b. Deflection From Vertical Grade: Do not deviate from line or grade, as shown on Drawings, more than 1/2 inch, provided that such variation does not result in a level or reverse sloping invert. Reverse sloping inverts are not allowed.

- c. Vertical Deflection is measured at pipe control line (centerline of invert as called out on profile)
 - d. Joint Deflection:
 - 1) PVC Pipes: Maximum allowable deflection = 0.2 degrees.
 - 2) Other Pipes: Maximum of 75 percent of manufacturer's recommendation.
 - e. Horizontal position of pipe centerline on alignment around curves maximum variation of 1 foot from position shown.
- 6. Depth of Cover Over Top of Pipe: As shown on the Drawings.
 - 7. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until accepted by Construction Manager.

3.5 CORROSION PROTECTION

- A. Notify Construction Manager at least 3 days prior to start of shop assembly of Ductile Iron Piping assemblies, coating application, corrosion protection wire bonding work to allow Construction Manager to witness shop assembly, coating, and corrosion bond wire assembly work.

3.6 CORROSION MONITORING

- A. Provide and install test stations on pipeline as shown on the Drawings and Specified in Section 13114, PIPE BONDING AND TEST STATIONS.

3.7 ELECTRICAL CONTINUITY

- A. Pipe joint bonds shall be as shown on the Drawings and Specified in Section 13114, CORROSION MONITORING.
- B. Test all pipeline joints for electrical continuity as specified in Section 13114, CORROSION MONITORING.

3.8 PIPE BEDDING AND PIPE ZONE MATERIAL

- A. Place pipe bedding and pipe zone material in

accordance with Section 31 20 00, EARTHWORK AND DEWATERING.

3.9 AS-BUILT SURVEYING

- A. After connecting each joint (welded, fused, etc) and before backfilling each pipe, survey at 50-foot intervals x, y, z coordinates of top center of each HDPE pipe.
- B. Submit surveyed coordinates 1 day after they are surveyed, by email to Construction Manager or designated representative.

3.10 CLEANING AND DISINFECTION

- A. Maintain the pipe clean from sediment, cementitious materials and other debris throughout construction.
- B. Before hydrostatic testing and disinfection, sweep clean the bottom of the pipe of all dust, sand, grout residual, and other debris. Then flush pipe interior with clean water to remove all dust from the entire inside of pipe. Notify Construction Manager to inspect the pipe before filling with water to test and disinfect.

3.11 HYDROSTATIC TESTING FOR WATER PIPELINES

- A. Comply with all Draper City standards and the following.
- B. Pipeline Hydrostatic Test. Hydrostatic and leakage test all pipelines and pipe appurtenances per this section.
- C. Provide records of each piping installation during the testing. These records shall include:
 - 1. Date and times of test.
 - 2. Identification of process, pipeline, or pipeline section tested or retested, pipe material and pipe specification.
 - 3. Test fluid.
 - 4. Test HGL.
 - 5. Remarks: Leaks identified (type and location), types of repairs, or corrections made.

6. Certification by Contractor that the leakage rate measured conformed to the specifications.
- D. Testing Equipment. Provide calibrated pressure gauges, pipes, bulkheads, pumps, compressors, chart recorder, and meters to perform the hydrostatic testing.
- E. Testing Preparation.
 1. Notify Construction Manager in writing 5 days prior to each test.
 2. Perform testing in presence of Construction Manager.
 3. Test newly installed pipelines.
 4. Using potable water as test medium, water pipelines pipes shall successfully pass a leakage test prior to acceptance. Supply of temporary water shall be furnished by Contractor.
 5. Furnish testing equipment and perform tests in manner satisfactory to Construction Manager. Testing equipment shall provide observable and accurate measurements of leakage under specified conditions.
 6. Provide temporary piping to carry test fluid to the

piping that is to be tested. After the test has been completed and demonstrated to comply with the specifications, disconnect and remove temporary piping and plug corp stops and taps or connections to the existing piping from which the test fluid was obtained.
 7. Isolate new pipelines that are connected to existing pipelines.
 8. Conduct field hydrostatic test on buried piping after trench has been completely backfilled. Testing may, as approved by Construction Manager, be done prior to placement of asphaltic concrete or roadway structural section.
 9. Provide temporary drain lines needed to carry testing fluid away from the pipe being tested. Remove such temporary drain lines after completing the pressure testing. Pipes shall remain full after testing

F. Hydrostatic Testing of Buried Pipelines

1. Thrust Blocks. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after concrete is placed.
2. Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on the full area of pipe.
3. Expel air from pipe system during filling. Expel air through fire hydrants and through manually operated 1-inch corp stops shown on plans at high points besides line valves. Contractor shall propose and provide all air release valves and other equipment he feels needed to successfully pass hydrotest.
4. Absorption Time. When testing mortar-lined (or PVC) piping fill pipe with water and allow it to soak for at least 48 hours to absorb water before conducting pressure test.
5. Test Procedure:
 - a. Test Pressure: 200 psi.
 - b. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
 - c. Maintain hydrostatic test pressure continuously 24 hours, adding additional make-up water by means of a positive displacement hydraulic force pump as necessary to restore test pressure.
 - d. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system.
 - e. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

- f. If measured leakage exceeds allowable leakage or if leaks are visible, repair defective pipe section and repeat hydrostatic test.
 - g. Allowable Leakage: Maximum allowable leakage shall not exceed amount stated in AWWA C200.
6. Maximum Allowable Leakage is defined by:

$$\frac{ND(P)}{L} = \frac{7400}{7400}^{1/2}$$

where:

L = Allowable leakage, in gallons per hour.

N = Number of joints in tested line.

D = Nominal diameter of pipe, in inches.

P = Average test pressure during leakage test, in pounds per square inch.

7. If the actual leakage exceeds the allowable on any test, locate and correct the faulty work and repeat the test. Restore the work and all damage resulting from the leak and its repair. Pay for water needed for retesting.

END OF SECTION

SECTION 33 05 24 – WELDED STEEL PIPE AND SPECIALS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section includes materials testing and installation of welded steel pipe and specials; also designated as “WSP”.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Society of Mechanical Engineers (ASME):
 - a. B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
 - b. B36.10M, Welded and Seamless Wrought Steel Pipe.
 - c. BPVC SEC V, Nondestructive Examination.
 - d. BPVC SEC VIII, Div. 1, Rules for Construction of Pressure Vessels.
 - e. BPVC SEC IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
 2. American Society for Nondestructive Testing Inc. (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Non-Destructive Testing.
 3. American Water Works Association (AWWA):
 - a. C200, Steel Water Pipe – 6 inch (150 mm) and Larger.
 - b. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied.
 - c. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger - Shop Applied.
 - d. C206, Field Welding of Steel Water Pipe.
 - e. C207, Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In.
 - f. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
 - g. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

- h. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - i. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - j. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
 - k. C215, Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines.
 - l. C216, Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
 - m. C217 Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
 - n. C222, Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings.
 - o. C602, Cement-Mortar Lining of Water Pipelines in Place – 4 in. (100 mm) and Larger.
 - p. C604, Installation of Buried Steel Water Pipe – 4 In. (100 mm) and Larger.
 - q. M11 (Manual), Steel Pipe - A Guide for Design and Installation.
4. American Welding Society (AWS):
- a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
 - b. A3.0, Standard Welding Terms and Definitions.
 - c. D1.1, Structural Welding Code – Steel.
 - d. QC 1, Standard for AWS Certification of Welding Inspectors.
5. ASTM, International (ASTM):
- a. A20, Standard Specification for General Requirements for Steel Plates for Pressure Vessels.
 - b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

- c. Section II A SA-106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
- d. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- e. A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
- f. A435/A435M, Standard Specification for Straight-Beam Ultrasonic Examination of Steel Plates.
- g. A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service.
- h. A572/A572M, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
- i. A770/A770M, Standard Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications.
- j. A1018/A1018M, Standard Specification for Steel, Sheet and Strip, Heavy Thickness Coils Hot Rolled, Carbon, Structural, High-Strength and Low-Alloy, Columbium or Vanadium and High-Strength Low-Alloy with Improved Formability.
- k. D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
- l. E329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- m. E1255, Standard Practice for Radioscopy.
- 6. International Institute of Welding (IIW).
- 7. International Organization for Standardization (ISO).
- 8. NSF International (NSF):
 - a. 60, Drinking Water Treatment Chemicals - Health Effects.
 - b. 61, Drinking Water System Components - Health Effects.
- 9. Steel Pipe Fabricators Association (SFPA).

1.3 DEFINITIONS

- A. Fittings and Specials: Including, but not limited to fittings, closure pieces, bends, elbows, reducers, tees, wyes, bifurcations, crosses, outlets, manifolds, nozzles, wall sleeves, bulkheads, and other piping and appurtenances fabricated from steel plate, sheet, or coils as required to provide the Work, complete. Specials shall also include piping above ground or inside structures.
- B. Acronyms:
 - 1. CJP: Complete Joint Penetration.
 - 2. CWI: Certified Welding Inspector.
 - 3. MT: Magnetic Particle Testing.
 - 4. NDE: Nondestructive Examination.
 - 5. NDT: Nondestructive Testing.
 - 6. PJP: Partial Joint Penetration.
 - 7. PQR: Procedure Qualification Record.
 - 8. PT: Liquid Penetrant Testing.
 - 9. RT: Radiographic Testing.
 - 10. UT: Ultrasonic Testing.
 - 11. VT: Visual Testing.
 - 12. WPQ: Welder/Welding Operator Performance Qualification.
 - 13. WPS: Welding Procedure Specification.

1.4 DESIGN REQUIREMENTS

- A. Fittings and Specials:
 - 1. Design reinforcement, unless otherwise shown.
 - 2. Design in accordance with AWWA Manual M11, AWWA C200, and AWWA C208.
- B. Pipe Layout: Design complete pipeline layout, in accordance with AWWA Manual M11:

1. General:
 - a. Base stationing and elevation convention as shown on Drawings.
 - b. Maximum Laying Lengths:
 - 1) Maximum laying lengths shall be limited to 50 feet.
 - 2) Select lengths to accommodate installation operation.
2. Include, as Minimum:
 - a. Specific number, location, and direction of each pipe, joint, and fitting or special. Number each pipe in installation sequence.
 - b. Station and centerline elevation at changes in grade or horizontal alignment.
 - c. Station and centerline elevation to which spigot end of each pipe will be laid.
 - d. Elements of curves and bends, both in horizontal and vertical alignment.
 - e. Location of mitered pipe sections, beveled ends for alignment conformance, butt straps, and deep bell lap joints for temperature stress control.
 - f. Location of closures, cutoff sections for length adjustment, temporary access manways, vents, and weld lead outlets for construction convenience.
 - 1) Provide for adjustment in pipe laying headings and to conform to indicated stationing.
 - 2) Changes in location or number will require Construction Manager approval.
 - g. Location of bulkheads, both those shown and as required, for hydrostatic testing of pipeline.
 - h. Details of specials with developed plan dimensions, wall thickness, reinforcing at openings, joint welding details, etc.
- C. Welding Procedure Specification (WPS):
 1. Qualified by testing in accordance with ASME BPVC SEC IX for shop welds and AWS D1.1 for field welds.

2. Procedure Qualification Records (PQRs) conducted on unlisted base metal (most coil products are unlisted base metals) to be production welded as required in the referenced welding Code shall be traceable to heat lots.
3. Written WPS required for welds, both shop and field.
4. Notch-tough welding that requires heat input control shall be required:
 - a. AWS D1.1/D1.1M prequalified welding procedures are not allowed.
 - b. WPS used to shop fabricate pipe shall be qualified per ASME BPVC SEC IX and shall include Supplementary Essential Variables.
 - c. WPS used to field install pipe shall be qualified for heat input control in accordance with AWS D1.1/D1.1M.
 - d. PQRs shall be qualified for notch tough welding with consideration for thickness of steel, test temperature, and Charpy V-notch CVN values. Refer to AWS D1.1/D1.1M, Table 4.6 PQR Supplementary Essential Variable Changes for CVN Testing Applications Requiring WPS Requalification for SMAW, SAW, GMAW, FCAW, and GTAW and Section 4, Part D Requirements for CVN Testing, Option A (three specimens). The CVN test temperature and acceptance shall be the same as pipe base metal specified herein.
- D. Stulling (Strutting):
 1. Design stulling for pipe, specials, and fittings such that damage is avoided during handling, storage, and installation.
 2. Design such that pipe deflection is prevented and to support backfill, plus backfilling and compaction equipment loads.
- E. NSF Certification: All materials which may contact drinking water, including pipes, gaskets, lubricants and O-Rings, shall be ANSI-certified as meeting the requirements of NSF Standard 61, Drinking Water System Components - Health Effects. To permit field-verification of this certification, all such components shall be appropriately stamped with the NSF logo.

1.5 SUBMITTALS

- A. Action Submittals:
 1. Shop Drawings showing pipe layout.
 2. Material list and steel reinforcement schedules for materials specified.

3. Fabrication Information:
 - a. Design calculations for fittings and specials including opening reinforcement details of collars, wrappers, and crotch plates.
 - b. Pipe and fitting details for temporary and permanent facilities indicating:
 - 1) Cylinder thickness.
 - 2) Manufacturing tolerances.
 - 3) Maximum angular deflection limitations of field joints.
 - 4) Closure sections and cutoffs for field length adjustment.
 - 5) Bulkheads, including details for removal of test bulkheads and repair of lining.
 - 6) Weld lead outlets and plugs.
 - 7) Stulling size, spacing, and layout.
 - c. Welded joint details including:
 - 1) Butt joints.
 - 2) Miter-cut ends for alignment conformance.
 - 3) Lap joints.
 - 4) Deep bell lap joints required for control of temperature stresses.
 - 5) Butt strap joints.
4. Welding Data (Shop and Field Welding):
 - a. Show on a weld map, location, type, size, and extent of welds with reference call out for WPS and NDE numbers in tail of weld symbol.
 - b. Distinguish between shop and field welds.
 - c. Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal.
 - d. Welding and NDE symbols shall be in accordance with AWS A2.4.

- e. Welding terms and definitions shall be in accordance with AWS A3.0.
 - f. Submit welding data together with shop drawings as complete package.
- 5. Product data for the following:
 - a. Pipe:
 - 1) Material data.
 - 2) Chemical and physical test reports showing data consistent with specified requirements for each heat of steel proposed for use.
- B. Informational Submittals:
 - 1. Certificates:
 - a. Manufacturers' Services, Manufacturer's Certificate of Compliance that products furnished meet requirements of this Specification.
 - 2. Pipe Manufacturer's written Quality Assurance/Control Plan.
 - 3. Statements of Qualification:
 - a. Pipe manufacturer and fittings/specials fabricator.
 - b. Welding subcontractor qualifications and certified payrolls.
 - c. Welders or Welding Operators:
 - 1) Name of welder and certification stamp number.
 - 2) Welding procedures/positions for which welder is qualified.
 - 3) Certification date and current certification status.
 - 4) Welding experience (log)
 - d. Certified Welding Inspector.
 - e. NDT Quality Control Personnel.
 - 4. Procedures:

- a. Shop and field welding information: At a minimum include a complete welding code paper trail with linkage to Shop Drawings that includes the following:
 - 1) Written WPS and PQR.
 - a) Provide complete joint dimensions and details showing bevels, groove angles, root face, and root openings for all welds.
 - b) Notch-tough welding shall be required. For shop welding, address supplementary essential variables in addition to essential variables as indicated in ASME Section IX, QW-251.2.
 - c) For field welding, heat-input, control PQR essential variables as indicated in AWS D1.1 shall be included. For shop and field welding, provide heat-input table on WPS's for welder guidance.
 - d) PQR's for notch-tough welding shall document heat-input control by monitoring volts, amps, and travel speed or time-rate of change of weld metal volume as calculated by measuring change in electrode length over a period of time. Charpy V-notch tests shall be conducted on weld metal and heat affected zone. Test coupons shall be oriented transverse to final direction of rolling. Full size Charpy specimen test acceptance shall be same as base metal specified herein.
 - 2) Written NDT procedures.
 - 3) Current WPQ.
 - 4) Written description of proposed sequencing of events or special techniques such as:
 - a) Controlling pipe wall temperature stress during installation.
 - b) Minimizing distortion of steel.
 - c) Shop-Applied Cement-Mortar Lining: Include a description of machine to be used. List similar projects where machine was used, pipe size and footage.
 - d) Monitoring pipeline temperatures during installation.

- b. Written weld repair procedures for the Work.
 - c. Field coating application and repair.
 - d. Field lining application and repair.
 - e. Written consumable control procedure for welding materials demonstrating:
 - 1) How consumables will be stored to comply with manufacturer's written instructions.
 - 2) How consumables will be dried in ovens prior to use.
 - 3) How consumables which become wet will be reconditioned.
5. Reports:
- a. Source Quality Control Test Reports:
 - 1) Hydrostatic testing.
 - 2) Destructive weld testing.
 - 3) Nondestructive weld testing.
 - 4) Steel impact testing using Charpy V-notch method.
 - 5) Coating and lining factory Site visit letter by qualified manufacturer's technical representative.
 - b. Field Quality Control Test Reports include:
 - 1) Weld tests, including re-examination of repaired welds, on each weld joint for the following tests, as applicable:
 - a) Visual Testing (VT).
 - b) Radiographic Testing (RT).
 - c) Ultrasonic Testing (UT).
 - d) Magnetic Particle Testing (MT).
 - e) Liquid Penetrant Testing (PT).
 - f) Leak Testing (LT).

Submit welding reports daily to Owner field representative.

- 2) Coating and lining Site visit letter by qualified technical representative.
- c. Cement-mortar lining compressive strength tests in accordance with AWWA C205.
- d. Cement-mortar coating absorption tests in accordance with AWWA C205.
- 6. Field Testing Plan: Submit at least 15 days prior to testing and include at least the following information:
 - a. Testing dates.
 - b. Piping system and sections to be tested.
 - c. Method of isolation.
 - d. Method of conveying water from source to system being tested.
 - e. Calculation of maximum allowable leakage for piping sections to be tested.

1.6 CONTRACTOR QUALITY ASSURANCE

A. Qualifications:

- 1. Pipe Manufacturer:
 - a. Experienced in fabricating pipe of similar diameters, lengths, and wall thickness required for the Work.
 - b. Steel Pipe Fabricators Association (SPFA), Lloyd's Registry Certification, or ISO 9000 Certification.
 - c. Demonstrate current production capability for volume of work required for this Project.
 - d. Experience shall include successful fabrication to AWWA C200 standards of at least 30,000 linear feet of 24-inch diameter or larger pipe, with wall thickness of 1/4 inches or greater.

- e. Experience shall be applicable to fabrication plant facilities and personnel, not company or corporation that currently owns fabrication facility or employs personnel.
- 2. Fittings and Specials Fabricator:
 - a. Experienced in fabricating fittings and specials of similar diameters and wall thickness required for the Work.
 - b. Steel Pipe Fabricators Association (SPFA), Lloyd's Registry Certification, or ISO 9000 Certification.
 - c. Demonstrate current production capability for volume of work required for this Project.
 - d. Experience shall include successful fabrication to AWWA C200/ C208 standards of at least 25 fittings of 24-inch diameter or larger pipe, with wall thickness 1/4 inch or greater, in the past 5-years.
 - e. Experience shall include successful fabrication of at least five crotch plate fittings or specials requiring post weld heat treatment within past 5-year period.
 - f. Experience shall be applicable to fabrication shop facilities and personnel, not company or corporation that currently owns fabrication facility or employs personnel.
- 3. Field Welding Subcontractor:
 - a. Contractor shall perform all field welding (except tack welding) through either one or two welding subcontractors.
 - b. Welding subcontractor shall show experience of successfully completing the lap-welding of over 2000 feet of pipe (24-inch or larger) in the last 10 years. For each project referenced, submit client names, contact persons and phone number of each.
 - c. Welding subcontractor shall show current license in state of Utah.
- 4. Welders and Welding Operators:
 - a. Shop Welders: In accordance with ASME BPVC SEC IX.
 - b. Field Welders: In accordance with AWS D1.1.
- 5. Certified Welding Inspector (CWI):
 - a. In accordance with AWS QC 1, with knowledge of appropriate welding code for the Work.

- b. After receiving CWI qualification, CWI shall have 5 years, or more, professional experience of welding inspection similar to the Work.
 - 6. NDT Quality Control Personnel:
 - a. In accordance with requirements of Recommended Practice No. SNT-TC-1A, Level II.
 - b. After receiving NDT qualification, NDT personnel shall have at least 5 years of professional experience related to NDT inspection similar to the Work.
- B. Certified Welding Inspector (CWI) For Shop Welding:
 - 1. In accordance with AWWA C200 and as follows.
 - 2. Responsibilities:
 - a. Verify conformance of specified materials and their proper storage.
 - b. Monitor conformance to approved WPS.
 - c. Monitor conformance to approved NDT procedure specifications.
 - d. Monitor conformance of WPQ.
 - e. 100 percent visual inspection before, during and after welding.
 - f. Supervise NDT personnel and evaluate test results.
 - g. Maintain records and prepare report confirming results of inspection and testing.
- C. Certified Welding Inspector (CWI) For Field Welding:
 - 1. In accordance with AWWA C206, AWS D1.1, and as follows.
 - 2. Responsibilities:
 - a. Verify conformance of specified materials and their proper storage.
 - b. Monitor conformance to approved WPS.
 - c. Monitor conformance to approved NDT procedure specifications.
 - d. Monitor conformance of WPQ.
 - e. 100 percent visual inspection before, during and after welding.

- f. Supervise NDT personnel and evaluate test results.
 - g. Maintain records and prepare report confirming results of inspection and testing.
- D. Per items 1.05.B.5.b, and 1.06.B and 1.06.C above, Contractor shall provide all CWI's, CWI services noted, and to submit CWI inspection records daily, within one day after inspections are performed for all welds in the field, and within one week after inspections are performed for all welds in in the shop.

1.7 DELIVERY, HANDLING, AND STORAGE

- A. Pipe Marking:
 - 1. Legibly mark installation sequence number on pipe, fittings, and specials in accordance with piping layout.
 - 2. Special pipe sections and fittings shall be marked at each end with notation "TOP FIELD CENTERLINE".
 - 3. Mark/paint the word "TOP" on outside top spigot of each pipe section.
 - 4. Mark "TOP MATCH POINT" for compound bends per AWWA C208 so end rotations can be easily oriented in field.
- B. Delivery:
 - 1. Securely bulkhead or otherwise seal ends of pipe, specials, and fittings prior to loading at manufacturing Site.
 - 2. Pipe ends shall remain sealed until installation.
 - 3. Damage to pipe, fittings, or specials, including linings and coatings, found upon delivery to Job Site shall be repaired to Construction Manager's satisfaction or removed from Site and replaced.
- C. Storage:
 - 1. Support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.
 - 2. Support on sand or earth berms free of rock exceeding 3 inches in diameter.
 - 3. To keep salt in air off pipe ends, do not remove plastic end caps until pipe is in trench and joints are it about to be assembled.

1.8 SEQUENCING AND SCHEDULING

- A. Notify Construction Manager in writing of the following:
 - 1. Pipe Manufacturing: Not less than 14 days prior to starting.

2. Not less than 5 days prior to start of each of the following:
 - a. Welding.
 - b. Coating application.
 - c. Lining application.
 - d. Shop hydrostatic testing.

PART 2 – PRODUCTS

2.1 GENERAL

- A. The pipeline and fittings shall have a minimum thickness of 1/4 – or larger is specified on the plans. The pipeline shall have a thickness to provide for a pressure rating of 200 psi.
 1. Do not submit or provide a steel thickness less than that shown on plans.
 2. For the 24 Inch Transmission Main Pipe: diameter shall be the finished inside diameter after lining, so a 24-inch WSP with a 3/8-inch thick mortar lining shall have a *minimum* steel cylinder inside diameter of 24.7 inches.
 3. For pipes under 24 inch diameter: diameter shall be per ASME B36.10, so a 12 inch WSP shall have a steel outside diameter of 12.75 inches, and for 3/8-inch thick wall and 1/4-inch mortar lining, finished lining shall be 11.5 inches in diameter.
- B. Pipe: Manufacturing of steel pipe, fittings, and specials shall be under direction of one pipe Supplier. Responsibility shall include, at minimum, coordinating work of other suppliers for fittings and specials.
- C. Steel pipe, fittings, and specials shall be manufactured, tested, inspected, and marked to comply with AWWA C200 and additional requirements of these Contract Documents. In lieu of collar reinforcement, pipe, fittings, or specials with outlets may be fabricated in their entirety of steel plate having thickness equal to sum of pipe wall plus required reinforcement.

2.2 PIPE BARREL

- A. Steel: Provide steel coils for spiral welded steel pipe or steel plate for straight seam welded steel pipe per AWWA C200 and as follows:
 1. Specified Minimum Yield Strength: 36,000 psi.
 2. Specified Minimum Tensile Strength: 60,000 psi.

3. Measured Yield Strength: 85% maximum of Measured Tensile Strength.
4. Minimum Elongation in 2-inch Gauge Length: 19 percent.
5. Weld-Ability: Maximum carbon equivalent of 0.45, as measured using AWS D1.1, Annex XI, Guideline on Alternative Methods for Determining Preheat formula:
$$CE = C + ((Mn + Si)/6) + (Cr + Mo + V)/5 + (Ni + Cu)/15.$$
6. Pressure Vessel Quality as follows:
 - a. Coils: Continuous cast process, fully-killed, fine grained practice conforming to physical, manufacturing and testing requirements of ASTM A1018/A1018M, SS, Grade 40 (modified).
 - b. Plate:
 - 1) Fully-killed, conforming to ASTM A20, fine grained practice conforming to physical, manufacturing and testing requirements of ASTM A516/A516M, Grade 70.
 - 2) Steel Chemistry: Conform to ASTM A516/A516M, Grade 70. Steel plates that are over 1-inch thick shall be normalized.
 - c. Toughness:
 - 1) Charpy V-notch Acceptance Criteria: Transverse specimen orientation, full size specimens, 25 foot-pounds energy at test temperature of 30 degrees F.
 - 2) Frequency: See paragraph Steel Toughness Testing.

2.3 FITTINGS AND SPECIALS

- A. Fabrication: Shop fabricate. No field fabrication will be allowed, unless approved by Construction Manager.
- B. Crotch Plate: Fabricate from fully killed, fine grain, pressure vessel steel conforming to ASTM A516/A516M, Grade 70, and as follows:
 1. Plates shall be normalized.
 2. Sulfur content shall not exceed 0.005 percent. Carbon shall not exceed 0.20 percent. Manganese shall not exceed 1.20 percent.

3. Charpy V-notch tests in direction transverse to final rolling shall be performed per ASTM A370 on full size specimens of coupons taken from each plate. Acceptance shall be 25 foot-pounds at 30 degrees F.
4. Carbon equivalent shall not exceed 0.45 percent.
- C. Wall Thickness: Where thickness of pipe wall (steel plate) is not specified, provide standard weight pipe and nominal pipe size. Refer to ASME B36.10M for definitions of wall thickness for standard weight pipe and nominal pipe size (NPS).
- D. Reinforce to withstand either internal pressures, both circumferential and longitudinal, or external loading conditions, whichever is greater.
- E. Elbows, Unless Otherwise Indicated:
 1. Minimum Radius: 2.5 times pipe diameter or as indicated on Drawings
 2. Maximum Miter Angle: 11-1/4 degrees on each section resulting in a maximum deflection angle of 22.5 degrees per miter weld as recommended in AWWA C208.
 3. Bevels: Vary bevels on miters to provide a constant weld groove angle. For a 11-1/4 degree miter, (22.5 degrees miter weld) bevels must vary from 18.75 degrees on OD of bend to 41.25 degrees on ID of bend to provide a constant 60 degree groove angle for CJP welding.
 4. Complete joint penetration (CJP) welds on miter welds.
- F. Outlets:
 1. Smaller than 24 Inches: Fabricate from ASTM A53/A53M, Type E or S, Grade B, standard weight steel pipe.
 2. Fabricate collar or wrapper reinforcement using same steel as specified for main pipe barrel.
- G. Steel Butt-Weld Fittings:
 1. Smaller than 24 Inches: In accordance with ASME B16.9 conforming to ASTM A234/A234M.
 2. Standard weight.
 3. Taper pipe wall at welds at 4:1 to connect pipes of different wall thickness.

4. Coordinate difference in diameter convention between specials and AWWA C200/C208 pipe and fittings to provide complete piping system as shown.

2.4 JOINTS

A. Shop Welded:

1. Fabricate in accordance with AWWA C200 as modified herein.
2. Complete joint penetration (CJP) butt joints shall be used for longitudinal, girth, and spiral welds, unless otherwise indicated.
3. Lengths of pipe shall not be shop-joined using lap joints.

B. Field Welding:

1. Butt Welded Joints: field butt welded joints are not allowed. Shop weld all butt joints.
2. Single welded and double welded lap joints shall be field welded with full (pipe wall) thickness fillet welds in accordance with AWWA C200, unless noted otherwise.
3. Double welded lap joints and butt-strap joints shall be tapped and drilled for testing in accordance with AWWA C206.

C. Miter-End Cuts:

1. Welded Lap Joints:
 - a. As shown on Drawings.
 - b. Moderate deflections and long radius curves may be made using miter-end cuts.
 - c. Maximum Total Allowable Angle: 3 degrees per pipe joint.
 - d. Provide miter-cut that is cold expanded square with face of miter-cut on bell ends only.
 - e. Mitering of spigot ends will not be permitted.
2. Welded Butt Joints
 - a. Maximum Total Allowable Angle: 2.5 degrees per pipe joint.
 - b. Minimum Pipe Wall Thickness: 3/8 inch.
 - c. Welded Butt joints shall be CJP

D. Special Temperature Control Joint:

1. Provide a special longer bell end (Special Temperature Control Joint) at a maximum spacing of 300-feet to account for movement on the installed pipe due to temperature changes.
2. Minimum Special Temperature Control Joint length is shown on Drawings.

2.5 STULLING (STRUTTING)

A. Materials:

1. Shop-Lined Pipe: Wood stulls and wedges.
2. Unlined Pipe: Steel or wood.

B. Install stulling for pipe, specials, and fittings in accordance with approved submittal and as soon as practical after pipe is fabricated or, for shop-lined pipe, after lining has been applied.

C. Install stulling in manner that will not harm lining.

2.6 COATINGS

A. Buried steel pipeline coatings shall be in accordance with Section 09 90 00, Pipeline Coatings and Linings.

2.7 CEMENT-MORTAR and EPOXY LINING

A. Buried steel pipeline linings shall be in accordance with Section 09 90 00, Pipeline Coatings and Linings.

B. Polyethylene **Caps and Keeping Field Joints Free of Salt.**

1. Protect metal field joints from getting salt on them before, during, and after joints are completely assembled.
2. Before leaving pipe factory, tightly clamp a heavy polyethylene (12 to 20 mils thick) cap, or bulkhead, over all pipe ends and openings. **Caps shall function to both keep moisture in mortar linings and also to keep salt off field joints.** Clamps shall not damage coatings. Caps shall remain intact during shipping and storage until 5 minutes before final joint assembly.
3. Don't remove caps if wind is blowing salt in the air, if there is water in the trench, or if there are other risks of getting salt on metal pipe ends.

4. If caps are punctured and salt has not entered pipe, they may be immediately resealed with tape, if the tape makes caps air-tight.
5. If cap is removed more than 5 minutes before joint assembly, wash pipe end with soap and clean water, and dry it before field joining.
6. After field joining, immediately weld and coat joint. If salt gets on pipe during joining, immediately wash it off with clean water and dry it with salt free towels, then immediately complete joint and coating.
7. Owner representative may frequently field test pipe ends to make sure they are kept free of salt.

2.8 SOURCE QUALITY CONTROL

- A. Steel Toughness Testing (for plate or coil > 7/16" thick):
 1. Include three impact specimens; conduct test in direction transverse to final direction of rolling.
 2. Coils:
 - a. Definitions:
 - 1) Initial Charpy Testing requires each coil of each heat be tested to verify uniformity of steel. This test shall be done prior to Production Charpy Testing below.
 - 2) Production Charpy Testing requires a random coil from each heat be tested to verify consistency. This test shall be done after to Initial Charpy Testing above.
 - b. Conduct Initial Charpy Testing of 5 percent of steel for pipe and specials. Take test coupons from each coil of each heat at locations of outer, middle, and inner wrap of coil. Middle coil test coupons may be taken from ends of full-length pipes that are closest to middle of coil.
 - c. Conduct Production Charpy Testing on random coil of each heat on 95 percent of steel for pipe and specials.
 - d. Coils that do not qualify shall not be used in production of pipe.
 3. Plate:
 - a. Conduct Charpy Tests on each plate in accordance with ASTM A20.

- b. Conduct on full-size (10 mm by 10 mm) specimens from each plate in accordance with ASTM A20.
 - c. Plates that do not qualify shall not be used in production of pipe.
- B. Crotch Plate:
 - 1. Submit Charpy tests for all crotch plate materials.
 - 2. Through-Thickness tension testing shall be performed with acceptance criteria per Article 5 of ASTM A770/A770M on each plate.
 - 3. Straight-Beam Ultrasonic Examination shall be conducted with acceptance criteria per Article 6 of ASTM A435/A435M on each plate.
 - 4. Plates that do not qualify shall not be used.
- C. Shop Hydrostatic Pressure Test: In accordance with AWWA C200 Section 5.2, except as follows:
 - 1. General: Unless specified otherwise, testing of pipe, fittings, and specials shall be performed before lining and coating is applied.
 - 2. Pipe: maintain test pressure for at least 1 minute and for sufficient time to observe all weld seams do not leak.
 - 3. Fittings and Specials:
 - a. If fabricated from untested straight pipe, test to minimum pressure equal to field test pressure.
 - b. Except as otherwise specified herein, no additional shop hydrostatic test will be required on fittings and specials fabricated from successfully tested straight pipe.
 - c. Hydrostatically test fittings and specials with crotch plates, regardless of whether or not straight pipe sections used were previously tested.
- D. Joints, Lap-Welded:
 - 1. Fit test minimum of 5 joints, selected by Construction Manager, of each pipe size used:
 - a. Join pipe ends with proposed adjacent pipe end.
 - b. Match-mark pipe ends.

- c. Record Actual Annular Space:
 - 1) Maximum space at any point.
 - 2) Minimum space at any point.
 - 3) Space at 90-degree intervals; top, bottom, and spring line on both sides.
- E. Shop Nondestructive Testing:
 - 1. Welds: 100 percent visually examined by CWI to criteria in ASME BPVC SEC VIII, Division 1.
 - 2. Butt Joint Welds (including Groove Welds): Spot radiographically examine pipe in accordance with ASME BPVC SEC VIII, Div. 1, Par. UW-52. Ultrasonically examine welds (meaning test 100% of all welds ultrasonically per ASME BPVC SEC VIII, Division 1, UW-53), that, in opinion of Construction Manager, cannot readily be radiographed.
 - 3. Fillet Welds: 100 percent examine using magnetic particle inspection method in accordance with ASME BPVC SEC VIII, Division 1.
 - 4. Air test collars and wrappers in accordance with AWWA C206
- F. To keep salt in air off pipe ends, keep polyethylene caps securely on all pipe ends. Owner representative may test pipe ends which have caps removed or damaged to verify there is no salt on them. If salt is found, wash and dry pipe ends until salt is removed before completing pipe welding and coating.
- G. Inspection of Pipe Fabrication Procedure: OWNER will select and provide independent testing agency to observe pipe fabrication. Agency staff shall have experience in observation of steel pipe fabrication in accordance with ASTM E329. Representative of agency shall be present full time while pipe is being fabricated and while protective coating and lining is applied.
- H. Provide a letter to Construction Manager certifying that pipe furnished meets requirements of this section.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Joints and related work for field assembly of fittings and specials shall conform to requirements for straight pipe, unless otherwise shown.

2. Line and Grade: per Section 02500, GENERAL PIPING REQUIREMENTS.
3. Make minor field adjustments by pulling standard joints.
 - a. Maximum Allowable Angle: 75 percent of manufacturer's recommended, or angle that results from 3/4-inch pull out from normal joint closure, whichever is less.
 - b. Maximum Allowable Gap: 1/8 inch between bell and spigot at weld location.
4. Horizontal and vertical deflections shall be on alignment shown on plans. Fabricated horizontal and vertical elbows shall be at locations shown in plans.

3.2 DELEVERY AND TEMPORARY STORAGE OF PIPE AT SITE

- A. Keep plastic caps over pipe field joints (ends) until pipe is joint assembly. After cap removal, don't touch pipe joints with anything that has salt on it – wind-blown salt in air, hands, gloves, clothing, slings or other items which may transfer salt onto pipe joint surfaces.
- B. Transport pipe to the jobsite on padded bunks with nylon tie-down straps to protect the pipe.
- C. Store pipe on earth berms or timber cradles adjacent to the trench in the numerical order of installation.

3.3 HANDLING OF PIPE

- A. Lift pipes with spreader beams or wide belt slings or as recommended by the pipe manufacturer. Do not use cable slings or chains directly bearing on the pipe. Lift pipes at two points, at approximately 1/3 to 1/4 of the pipe length from the pipe ends.
- B. Maintain internal braces placed in pipes 24 inches and larger in diameter until backfilling is completed.
- C. Maintain at lest one brace at each end of steel pipe to be lined in the field. Provide additional vertical stulls before installing and backfilling welded steel pipe.

3.4 KEEPING SALT OFF PIPE ENDS AND OUT OF PIPE INTERIOR

- A. During field storing and pipe laying operations, take precautions to keep salt from getting on the pipe ends or into the pipe interior.

- B. Do not allow surface or groundwater to contact the pipe until joints and pipe zone is completed. Set pipe in trench on imported pipe zone material and backfill pipe zone with imported "salt free" material without letting native soils within 2 feet of incomplete field joints.
- C. Do not allow materials (i.e. hands, gloves, tools, clothing, Etc.) with salt on them within 2 feet of incomplete field joints. Workers and welders joining joints pipes shall uses washed and salt-free hands, gloves, clothing, tools and supplies. When welding under pipe, provide a salt free bed for welders to work on – such as imported bedding without groundwater, or a salt-free barrier.

3.5 PLACEMENT OF PIPE IN TRENCH

- A. Control water in trench per Section 02200, EARTHWORK.
- B. Lay pipes uphill if the grade exceeds 10 percent. Lay pipes with bell facing uphill if the grade exceeds 30 percent. Secure pipes from sliding. Where the grade exceeds 30 percent, weld each joint sufficiently to support the next but in no case less than 3/16-inch throat thickness around the full pipe circumference.
- C. Keep backfilling up with pipelaying. Where grade exceeds 30 percent, no more than five joints totaling 100 feet of pipe shall remain unbackfilled.
- D. Excavate below the subgrade as shown in the drawings. If in rock, complete excavation to a uniform foundation free of protruding rocks. Complete stabilization of foundation, per Section 02200, EARTHWORK, and then place material specified for the bedding in Section 02200, EARTHWORK. Place and compact the bedding as specified in Section 02200, EARTHWORK.
- E. Cut a depression to accommodate the pipe bell and external joint filler form and spaces to permit removal of the pipe handling slings.
- F. Lay each section of pipe in order and position shown on the installation schedule. Lower the pipe onto the bedding and install it to line and grade along its full length on firm bearing, except at the bell and at the sling depressions.
- G. When installing beveled pipe, do not deviate from the pipe top mark by more than 2 inches from the vertical line passing through the pipe center.
- H. Complete and coat field joints Section 02500 and Section 09 90 00.

3.6 WELDED JOINTS

- A. No field welding is allowed until all welding submittals are returned indicating Owners representative has accepted them.

- B. Minimum steel cylinder overlap for welded joints shall be 1-inch. Single lap joint fillet weld (either inside or outside of pipe) each joint for its full circumference with a full (3/8-inch) fillet weld.
- C. Conform to AWS D1.1, AWWA C206, approved welding procedures, and referenced welding codes. In case of conflict AWS D1.1 shall govern. Preheat and Interpass temperature requirements for unlisted base metals shall be determined according to AWS D1.1, *Annex XI Guideline on Alternative Methods for Determining Preheat*. Rejectable weld defects shall be repaired or redone, and retested until sound weld metal has been deposited in accordance with appropriate welding codes.
- D. Control of Temperature Stresses
 - 1. In accordance with AWWA C206, the approved temperature stress control submittal, and this Specification.
 - 2. To control temperature stresses, the unbackfilled Special Temperature Control Joint area of pipe shall be shaded from the direct rays of the sun by use of properly supported awnings, umbrellas, tarpaulins or other suitable materials until the pipe is backfilled at least 1 foot over the top of the pipe. The Special Temperature Control Joint area is defined as the entire length of pipe left exposed. Shading materials shall not rest directly on pipe, but shall be supported to allow air circulation around pipe. Shading of Special Temperature Control Joints is not required when ambient air temperature is below 50 degrees F.
 - 3. Locate Special Temperature Control Joints at 300 foot intervals.
 - 4. Design, furnish and install a pipeline temperature monitoring system consisting of thermocouple temperature gauges to monitor temperature of steel pipe wall in the trench. Gauges shall be located at top inside surface of pipe at intervals not exceeding 50 feet.
 - 5. Temperature Control Requirements:
 - a. Before and during pipe backfilling, pipeline steel temperature shall be at or below 90 degrees F. This may limit backfilling operations to only occur in the early morning hours. The specified temperature shall be monitored and controlled for at least 3 hours after placement of pipe backfill. Provide supplemental cooling as required.
 - b. Place pipe backfill from a single heading starting at one Special Temperature Control Joint and proceed toward next Special Temperature Control Joint.
 - c. During period of pipe backfill placement, pipeline section that is partially backfilled shall be shaded as indicated in above.

Temperature of partially backfilled pipe shall not be allowed to exceed 110 degrees F. Provide supplemental cooling as required.

- d. Prior to welding the Special Temperature Control Joints, the pipeline extending 300 feet each direction from the joint shall be maintained at or below 75 degrees F. Additionally, the pipeline extending 300 feet each direction from the joint shall be backfilled to at least 1 foot over the top of the pipe. At the specified temperature of 90 degrees or below, the Special Temperature Control Joint shall be welded. Begin and complete the weld during the coolest time interval of the 24-hour day. Use the pipeline temperature monitoring system data to demonstrate to Construction Manager the coolest interval of the day.
- e. After field welding of the Special Temperature Control Joint, the pipe temperature for 150 feet in each direction shall be maintained below 110 degrees F for a minimum of 24 hours after the Special Temperature Control Joint area has been backfilled to at least 1 foot over the top of the pipe.

3.7 PIPELINE CLOSURE ASSEMBLIES

- A. Provide a pipeline closure assembly to unite sections of pipe laid from opposite directions and to adjust field length of pipe. Field trim pipe ends only when approved by, and in presence of, Construction Manager.
- B. Closure assemblies shall be fabricated and assembled as indicated on the drawings.
- C. Coating joint exterior per Section 09 90 00, Pipeline Coatings and Linings.

3.8 MORTAR LINING OF JOINTS

- A. Cement-Mortar Lining: For pipe with shop-applied cement-mortar lining, place lining at joints in accordance with AWWA C205.
- B. Provide a robotic video camera inspection of entire pipeline interior, including all completed mortar lined joints, as evidence to Owner that joints have be properly mortar lined
- C. Completing interior mortar joints for pipes smaller than 24-inches diameter:
 - 1. Insert a tight fitting swab or squeegee in bell end of pipe in trench.

2. When ready to insert the spigot, coat face of cement mortar lining at bell with a sufficient amount of stiff cement mortar to fill the space between adjacent mortar linings of the two pipes to be joined.
 3. Immediately after joining the pipes, draw swab or squeegee through the pipe to remove all excess mortar and expel it from the open pipe end.
 4. Do not move the pipe after the swab has been pulled past the joint.
 5. For pipes with field welded joints, tack weld the joint after the swab has been pulled. Cover joint exterior with secure, salt-free, polyethylene sheet to prevent salt intrusion, and let mortar harden for 4 hours min before field welding joint. Welding on pipe with fresh mortar joints will evaporate the moisture in the mortar and result in failure of the joint.
 6. After completing weld, if there is salt on joint, wash it with clean water and dry it. Then apply shrink sleeve and mortar coatings.
- D. Completing interior mortar joints for pipes 24-inches and larger diameter. After welding and coating joints and backfilling pipe, complete and trowel-finish all interior mortar joints from inside pipe. Keep salt out of the pipe and mortar joints.

3.9 FIELD QUALITY CONTROL

A. Field Welding:

1. VT inspect 100% all welds and all passes.
CWI to mark acceptance or rejection of all passes of all welds.
2. PT inspect 100% of all field fillet welds (MT not allowed in salt environments).
3. RT Inspect 1% of length of butt joints
4. Weld Acceptance:
 - a. If, in the opinion of Construction Manager, inspections indicate inadequate weld quality, percentage of welds inspected shall be increased.
 - b. If less than 100 percent of welds are specified for inspection, Construction Manager may select inspection location at random.
 - c. VT: Perform VT per AWS D1.1 Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.
 - d. UT: Perform UT of CJP groove welds in accordance with AWS D1.1, Paragraph 6.13.1.

- e. RT: Perform RT of CJP butt joint welds (at frequency noted above) in accordance with AWS D1.1, Paragraph 6.12.1.
 - f. PT or MT inspect:
 - 1) Perform on fillet and PJP groove welds in accordance with AWS D1.1, Paragraph 6.10.
 - 2) Acceptance shall be in accordance with VT standards specified above.
 - g. Remove in manner that permits proper and complete repair by welding.
 - h. Caulking or peening of defective welds is not permitted.
 - i. Retest unsatisfactory welds.
5. Submit test results to Construction Manager within one week after test.

3.10 CLEANING

- A. After sweeping the pipe clean and before hydrostatic test, flush pipes with hoses and pressurized water to remove dirt and debris. Remove all foreign matter, including ponded water.
- B. For pipelines 24 inches or larger in diameter, acceptable alternatives to flushing are use of high-pressure water jet, sweeping, or scrubbing. Water, sediment, dirt, and foreign material accumulated during this cleaning operation shall be discharged, vacuumed, or otherwise removed from the pipe.

3.11 HYDROSTATIC TESTING

- A. See Section 02514, PRESSURE TESTING OF PIPING.

3.12 OPERATIONS INCIDENTAL TO JOINT COMPLETION

- A. Install metallic jumper bond or bars where detailed in the drawings.
- B. Plan joint completion to accommodate temporary test bulkheads for hydrostatic testing.

3.13 PROTECTION OF MORTAR LINING

- A. Until the pipeline is filled with water, install bulkheads and apply moisture inside the bulkhead portions in a manner that will effectively prevent the drying out of the mortar lining.

3.14 MANUFACTURER'S SERVICES

- A. Onsite Observation: When requested by the Construction Manager, the pipe fabricator shall provide an experienced staff member to be onsite while the pipe and fittings are being installed. The staff member shall be onsite for the first week for each of the contractor's pipe installation crews and a minimum of 8 hours per month thereafter until completion of pipe installation unless otherwise directed by the Construction Manager. The staff member's duties shall include, but not be limited to the following:
 - 1. Observe the installation and welding of the pipe and fittings.
 - 2. Report any concerns to the Construction Manager on-site observer.
 - 3. Answer questions and provide assistance to the Construction Manager and the Contractor.

END OF SECTION

SECTION 33 11 00 - WATER DISTRIBUTION AND TRANSMISSION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Water distribution and transmission system identification, valves, boxes, service connections and accessories.
- B. This section is applicable to potable water pressure systems, but may be used to specify not-potable water pressure systems.

1.2 REFERENCES

- A. Applicable water company requirements.
- B. AWWA C600: AWWA Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.
- C. AWWA C800: AWWA standard for Underground Service Line Valves and Fittings.
- D. AWWA C900: AWWA Standard for PVC Pressure Pipe.

1.3 PERFORMANCE REQUIREMENTS

- A. A vertical minimum clearance of 10" and a horizontal minimum clearance of 36" shall be maintained from any other underground facility or structure, unless authorized otherwise by Engineer.
- B. Depth of Cover:
 - 1. 36" minimum for service lines.
 - 2. 48" minimum for main lines.
 - 3. If Engineer authorizes less cover, provide additional protection to withstand frost and external loads.
- C. Piping Testing Schedule: In accordance with Section 33 11 25. Conduct test after thrust blocks have sufficiently hardened. Provide signs and types of equipment connections and fittings which match pipe materials when pressure testing systems.
- D. Remove any section of pipe already placed by Contractor which is found to be defective or damaged. Repair or replace without additional cost.

- E. Disinfection of Potable Water System: In accordance with Section 33 13 00.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's technical product data and installation instruction.
- B. Test Reports: Submit testing data indicated in Section 01 45 00.
- C. Operating and Maintenance: Include maintenance data, parts lists, product data, and shop drawings.

1.5 PROJECT CONDITIONS

- A. Minimize neighborhood traffic interruptions and barricade stockpiles in accordance with the latest version of the MUTCD manual.
- B. Secure acceptance of pipeline lateral tie-in work.
- C. Repair public and private facilities damaged by Contractor.
- D. Clearly identify and promptly set aside defective or damaged pipe.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

- A. Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, and capacities indicated.
- B. Where not indicated, provide proper selection as determined by installer to comply with installation requirements.
- C. Provide sizes and types of equipment connections for fittings of materials which match pipe materials used in pressure piping systems. Where more than one type of material or product is indicated, selection is installer's option.
- D. Provide pipe fittings and accessories of same material and weight or class as pipe, with joining method indicated or recommended by manufacturer.

2.2 VALVES

- A. As indicated and in accordance with Section 33 12 16.
- B. Locate on tee, at each intersection, and not more than 1,000 feet between valves.

2.3 VALVE BOX

- A. Markings: On cover of valve box, cast the following as applicable; "WATER" or "IRRIG"

2.4 VALVE CHAMBER

- A. Basin: Cast-in-place concrete, with base riser section or precast base riser section with integral floor.
- B. Steps: Plastic, cast into valve chamber sidewalls greater than 4 feet deep.
- C. Top: Flat slab concrete.
- D. Frame and Cover: Asphalt coated, heavy duty ductile iron with flat top design and "Water" (or other applicable utility) lettering. Shape and size as indicated.

2.5 MORTAR AND CONCRETE

- A. Mortar: Portland cement.
- B. Concrete:
 - 1. Cast-in-place, Class 3000 minimum.
 - 2. Precast, Class 4000 minimum.

2.6 TAPPING SADDLES

- A. For tapping saddles used for service connections to plastic pipe, provide full circle saddles. For all other pipe provide double strap bronze alloy, ductile iron, or stainless steel saddles.
- B. Provide tapping saddles that have a minimum rated working pressure of 300 psi, neoprene Buna N gaskets, and bronze tapered threads.

2.7 ACCESSORIES

- A. Anchorages: Provide anchorages for tees, wyes, crosses, plugs, caps, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages.
- B. Corporation Stops: All bronze with taper threads.
- C. Hydrant and Valve: In accordance with Section 33 12 19.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify trench cut is ready to receive Work, and excavations, dimensions, and elevations are as indicated.
- B. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation in accordance with Section 31 23 33.
- B. Remove large stones or other hard matter which could damage pipe or impede backfilling or compaction.
- C. Examine areas and conditions under which materials and products are to be installed. DO not proceed with system installation until unsatisfactory conditions have been corrected in manner acceptable to system installer.
- D. Clearly identify and promptly set aside defective or damaged pipe.
- E. Use machine pipe cutting tool acceptable to pipe manufacturer.

3.3 LOCATING POTABLE WATER PIPE

- A. Locate potable water pipe at least 10 feet horizontally, from sewer pipe.
- B. Where potable water pipe crosses under or within 18" over gravity-flow sewer lines provide pressure pipe with no joint located within 10 feet of the crossing.
- C. Do not place potable water lines in the same trench with sewer lines, storm drains or electric wires.

3.4 PIPE AND FITTING INSTALLATION

- A. Ductile-iron Pipe: Install in accordance with AWWA C600.
- B. Polyethylene Pipe: For 3" and smaller pipe follow AWWA C901. Install all other sizes in accordance with manufacturer's installation instructions.
- C. Copper Tube: Install in accordance with CDA "Copper Tube Handbook".
- D. Polyvinyl Chloride Pipe: Install in accordance with AWWA C900.

3.5 SETTING VALVES AND VALVE BOXES

- A. Install valves plumb with stems pointing up.

- B. Set valve box over valve; adjust to finish grade and plumb.
- C. Clean any dirt or foreign material from inside of box.

3.6 SERVICE CONNECTIONS

- A. Apply for and pay for applicable permits from Draper City Department of Public Utilities for the indicated size and location of tap to water main. Comply with all connection requirements of the Specifications.
- B. Make all service taps with a tapping machine acceptable to the water company. Use teflon tape on all taps unless indicated otherwise.
- C. Locate service taps in the upper quadrant of the main line, approximately at 45 degrees. The minimum distance between taps is 24", with a 5 degree stagger. Do not make service taps within 24" of the end of the main line.
- D. Service saddles are required on all taps unless indicated otherwise.
- E. Install service lines to property line or as directed by Engineer.

3.7 CONCRETE THRUST BLOCKS

- A. Do not make hydrostatic tests until thrust block concrete has set.
- B. Provide thrust blocks, or metal tie rods and clamps or shackles, on plugs, caps, tees, and bends deflecting 22-1/2 degrees or more either vertically or horizontally.
- C. Unless otherwise indicated or directed by Engineer, place the base and bearing sides of thrust blocking directly against undisturbed earth.
- D. Sides of thrust blocking not subject to thrust may be placed against forms. Place thrust blocking so the fitting joints will be accessible for repair.
- E. Poly FM No. 1 grease and 8 mil vinyl wrap fittings and spools.

3.8 BACKFILLING

- A. Trenches, in accordance with Section 31 23 33.

3.9 CLEANING

- A. Flush all pipelines after pressure testing.

- B. Flush lines through hydrants or, if a hydrant does not exist at the end of the line, install a tap of sufficient size to meet requirements of Section 33 11 25.

END OF SECTION

SECTION 33 11 12 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Basic piping materials and methods.
- B. Related Sections:
 - 1. Section 33 11 25 - Piping Systems Testing.
- C. All products in project that come in contact with potable water supplies or come in contact with chemicals that are injected in the potable water supply shall meet NSF 60 and 61 Standards and shall be appropriately stamped with the NSF or certifying agency logo

1.2 REFERENCES

- A. American Society of Testing and Materials (ASTM):
 - 1. A 106 - Specification for Seamless Carbon Steel Pipe for High Temperature Service.
 - 2. D 2240 - Test Method for Rubber Property - Durometer Hardness.

1.3 DEFINITIONS

- A. Aboveground Piping: Piping within buildings, tunnels, or other structures without regard to elevation of piping, or exposed piping outside buildings and structures.
- B. Underground Piping: Piping actually buried in soil or cast in concrete.

1.4 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. Except in details, piping is indicated diagrammatically. Sizes and locations are indicated on the Drawings. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings.
- B. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
 - 1. Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Time.

1.5 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Restraining Piping – Unless otherwise noted, restrain all pipe joints, both below or above grade, for all pipe materials and diameters. Thrust blocks are not allowed.
2. Connections To Existing Piping:
 - a. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings.
 - 1) Protect domestic water supplies from contamination.
 - a) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
 - b) Provide devices approved by owner of domestic water supply system to prevent flow from other sources into the domestic supply system.
 - b. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
 - c. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
3. Connections Of Dissimilar Metals:
 - a. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
 - b. Nonferrous metals include aluminum, copper, and copper alloys.

PART 2 - PRODUCTS

2.1 GASKETS

A. Gaskets for Steel Piping:

1. Suitable for pressures equal to and less than 250 pounds per square inch gauge, temperatures equal to and less than 100 degrees Fahrenheit, and raw sewage service.
 2. Neoprene with minimum durometer hardness value of 70 when tested in accordance with ASTM D 2240, Type A; minimum 3/32 inch thick for less than 10 inch pipe; minimum 1/8 inch thick for 10 inch and larger pipe. Provide gaskets with inserted 13 ounce nylon fabric cloth for pipes 20 inch or larger.
 2. Manufacturers: One of the following or equal:
 - a. Garlock, Style 8798.
 - b. John Crane.
- B. Gaskets for Flanged Joints in Polyvinyl Chloride and Polyethylene Piping:
1. Suitable for pressures equal and less than 250 pounds per square inch gauge, temperatures equal and less than 120 degrees Fahrenheit, polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine including fluorochemicals and gaseous fluorine.
 2. Teflon ring or teflon envelope with nonasbestos filler.
 3. Manufacturers: One of the following or equal:
 - a. Garlock.
 - b. John Crane.
- C. Gaskets for Flanged Joints in Polyvinyl Chloride, Chlorinated Polyvinyl Chloride, Ductile Iron, or Steel Water Piping:
1. Gaskets shall be full-faced, 1/8" thick, and NSF61 approved for contact with potable water.
 2. Suitable for hot or cold water, pressures equal and less than 250 pounds per square inch gauge, and temperatures equal and less than 160 degrees Fahrenheit.
 3. Material: Teflon ring; or teflon envelope with nonasbestos filler.
 4. Manufacturers: One of the following or equal:
 - a. Garlock.
 - b. Bluegard.

- c. John Crane.

2.2 PIPE SUPPORTS

- A. Floor stands and stanchion saddles with U-bolt hold down yokes.
 - 1. Manufacturer, one of the following or equal:
 - a. Grinnell Figure 259.
 - b. Bergen-Patterson, Figure 125.
- B. Riser Supports.
 - 1. All elbows to be supported from the floor shall be furnished and installed as base elbows, whether so indicated on the Plans or not. Supports for the base fittings shall be adjustable metal supports or concrete piers as shown on the Plans, or as directed by the Engineer.
 - 2. Riser clamps manufacturer, one of the following or equal:
 - a. Grinnell Figure 261.
 - b. Elcen, Figure 29.

2.3 PVC PIPING

- A. Use Schedule 80 (glued) under 6-inch diameter and C-900 DR-18 (gasketed) for 6" and larger unless otherwise noted.

2.4 GROOVED END COUPLINGS

- A. Grooved end (GE or GRV) couplings shall be Victaulic Style 77, or equal, unless otherwise noted.

2.5 WAX TAPE COAT BURIED METAL PIPING

- A. All buried metal piping, valves, fittings, bolting, appurtenances and joints that are not coated per Section 09 9100 Pipeline Lining and Coating shall be wax tape coated per Section 09 97 10 and AWWA C217. Do not join dissimilar metals even if wax tape coated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Existing Conditions:

1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions which may affect construction of underground piping before starting excavation for new underground piping and appurtenances.
2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.2 WALL AND SLAB PENETRATIONS

- A. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, pilasters, columns, piers, and beams unless specified or otherwise indicated on the Drawings.
- B. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.
1. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
 2. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
 3. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
 4. Seal spaces between pipes and sleeves.
- C. Cast couplings or wall pieces in walls for penetrations of buried rigid piping including cast iron, ductile iron, reinforced concrete, and vitrified clay through structures.
1. Provide couplings or wall pieces with mechanical push-ons, or similar flexible joints at outside faces of walls.
 2. Provide additional similar joints in piping at transition points between trenches and structure excavations.
- D. Link Seal: Use 2 link seals where seal is used to seal at wet wall sleeves. Mount one seal on the inside face of the wall and the other on the outside face of the wall. Coordinate the inside diameter of the wall sleeve with the size of the seal to provide watertight sealing.

- E. Where not indicated on the Drawings, penetrations for conditions other than those specified under the preceding subparagraphs shall be one of the three types specified in such subparagraphs found by Engineer to be the most suitable for the particular conditions.

3.3 EXPOSED PIPING

- A. Install exposed piping in straight runs parallel to the axes of structures, unless indicated otherwise.
 - 1. Install piping runs plumb and level, unless otherwise indicated on the Drawings. Slope plumbing drain piping with 1/8 inch per foot downward in the direction of flow.
- B. Install exposed piping after installing equipment and after piping and fitting locations have been determined.
- C. Support piping as shown in the Drawings.
 - 1. Do not transfer pipe loads and strain to equipment.
- D. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
- E. Assemble piping without distortion or stresses caused by misalignment.
 - 1. Match and properly orient flanges, unions, flexible couplings, and other connections.
 - 2. Do not subject piping to bending or other undue stresses when fitting piping. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
 - 3. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
 - 4. Alter piping assembly to fit when proper fit is not obtained.
 - 3. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

3.4 BURIED PIPING

- A. Bury piping with minimum 54 inches cover without air traps, unless otherwise indicated on the Drawings.
- B. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.
- C. Laying Piping, as specified herein:
 - 1. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
 - 2. Place piping with top or bottom markings with markings in proper position.
 - 3. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
 - 4. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
 - 5. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.

3.5 PIPING ALTERNATES

- A. Provide piping in accordance with this Section, unless indicated on the Drawings or specified otherwise.
- B. Alternative Pipe Ratings: Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price. Piping of different material may not be substituted in lieu of specified piping.
- C. Valves in Piping Sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.
- D. For flanged joints, where one of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.

3.6 CLEANING

A. Piping Cleaning:

1. Upon completion of installation, clean piping interior of foreign matter and debris. Perform special cleaning when required by the Contract Documents.

3.7 PIPING SCHEDULE

A. Abbreviations

1. The following abbreviations used in the column of test method refer to the respective methods specified in Section 15992.

AM	Air method
GR	Gravity method
HH	High head method

2. Abbreviations to designate piping include the following:

CI	Cast iron
CI	Class, followed by the designation
DIP	Ductile iron piping
CHDPE	Corrugated High Density Polyethylene
RCP	Reinforced concrete piping
PE	Polyethylene
PVC	Polyvinyl Chloride
Sch.	Schedule, followed by the designation

PIPING SCHEDULE:

<u>Use</u>	<u>Piping</u>	<u>Joints/Fittings</u>	<u>Test Pressure</u>	<u>Test Method</u>
Shower/Chiller Supply Piping	Copper	as noted on plans	200 psig	HH
Chlorine Piping	as Recommended by Manufacturer	as Recommended by Manufacturer	200 psig	HH
Acid Piping	PVC, PP	Glued and as noted on plans	200 psig	HH

END OF SECTION

SECTION 33 11 13 - DUCTILE IRON PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Ductile iron piping, joints, fitting, cleanouts, and pipe lining and coating.
- B. Related Sections:
 - 1. Section 331112- Basic Piping Materials and Methods.

1.2 REFERENCES

- A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
 - 1. B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- B. American Society for Testing and Materials (ASTM):
 - 1. A 47 - Ferritic Malleable Iron Casting.
 - 2. A 536 - Ductile Iron Castings.
- C. American Water Works Association (AWWA):
 - 1. C 104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - 2. C 110 - Ductile-Iron and Gray-Iron Fittings, 3 Inches Through 48 Inches, for Water and Other Liquids.
 - 3. C 111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 4. C 150 - Thickness Design of Ductile-Iron Pipe.
 - 5. C 151 - Ductile-Iron Pipe, Centrifugally Cast for Water or other Liquids.
 - 6. C 153 - Ductile-Iron Compact Fittings, 3 Inches Through 24 Inches, and 54 Inches Through 64 Inches, for Water Service.
 - 7. C 600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - 8. C 606 - Joints Grooved and Shouldered Type.

1.3 SUBMITTALS

- A. Product Data: Prior to construction submit photographs, drawings, and descriptions of fittings, gaskets, couplings, grooving of pipe and fittings, and pipe lining.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Block piping material for shipment, prevent damage to castings and linings.
- B. Carefully handle piping material during loading, unloading, and installation. Do not drop piping material from cars or trucks. Lower piping material by mechanical means. Do not drop or pound pipe to fit grade.
- C. Repair damaged pipe lining to match quality, thickness, and bonding of original lining. When lining cannot be repaired or repairs are defective, replace defective piping with undamaged piping.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.
- B. Thrust Restraint Systems: Layouts and supporting calculations for restrained joint thrust restraint systems.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Ductile Iron Piping:
 - 1. Type, Typical: AWWA C 150 and AWWA C 151 latest revision with minimum Pressure Class 350 wall thickness.
 - 2. Type with Screw-On Flanges: AWWA C 115 with minimum Class 53 wall thickness.
- B. Joints:
 - 1. Flanged Joints:
 - a. Flanges: One of the following with diameter, thickness, drilling, and other characteristics in accordance with ANSI B 16.1:
 - 1) Cast integrally with the pipe.
 - 2) Screw-on: Comply with the following:
 - a) Ductile iron
 - b) Long hub, threaded, and specially designed for ductile iron pipe.
 - c) After attaching to pipe, machine flange face to make pipe end and flange even and perpendicular to the axis of the pipe.
 - b. Bolt Holes: Two-holed and aligned at both ends of pipe.
 - c. Cap Screw or Stud Bolt Holes: Tapped.
 - d. Bolts and Nuts: ANSI/ASME B 16.1 or when connecting flanges underwater, Type 304 or Type 316 stainless steel; otherwise use carbon steel bolts and studs machined heavy hex heads, Class 2 fit in accordance with ASTM A307, Grade B, threads in accordance with ASME/ANSI B1.1

- cut and finished to project a maximum of 1/4 inch beyond nut when joints are assembled. Grease and tape wrap steel materials for protection against corrosion after piping installation.
- e. Gaskets: As specified in accordance with Section 331112.
2. Mechanical Joints: AWWA C 111/ANSI A 21.11
3. Restrained Mechanical Joints: Shall be capable of restraining pipeline pressure. Manufacturers: One of the following or equal:
- EBAA Iron Sales Inc., Mega Lug.
 - American Cast Iron Pipe Company, LOK-Fast or Lugged Fastite.
 - Pacific States Cast Iron Pipe Company, Restrained Tyton or Lock Mechanical.
4. Push-On Rubber Gasket Joints: AWWA C 111/ANSI A 21.11.
5. Restrained Push-On Joints:
- Manufacturers: One of the following or equal:
 - United States Pipe and Foundry Company, TR Flex, comprised of ductile iron locking segments inserted through slots in the bell face, providing positive axial lock between the bell interior surface and a retainer weldment on the spigot end of the pipe, or a retainer weldment through a boltless system, providing a positive restraint against joint separation; with a safety factor of 2 under a pressure equal to the specified test pressure; capable of easy disassembly without cutting or burning of the gasket.
 - Manufacturers: One of the following or equal: Suitable for the following working pressures:
 - For 4 through 30 inch Pipe: 133 pounds per square inch gauge.
 - Restrained Joint Lengths

Size	Fitting	Length To Be Restrained (Ft)
16"	11.25	4
	22.5	8
	45	17
	90	39
24"	11.25	6
	22.5	12
	45	23
	90	56
30"	11.25	6
	22.5	12
	45	24
	90	57
	Dead End Cap	124

6. Grooved Joints: AWWA C 606, as complemented and modified below, radius-cut type, with following components:

- a. Couplings: Rigid type, cast from ductile iron in accordance with ASTM A 536, Grade 65-45-12 or malleable iron in accordance with ASTM A 47, Grade 32510.
- b. Bolts and nuts in accordance with ASTM A 183, Grade 2.
- c. Gaskets: Capable of being applied on surface of piping with cavities to provide for an improved seal with the internal piping pressure; material for following services:
 - 1) For Liquid Service: Halogenated butyl.
 - 2) For Air Service: Fluoroelastomer.
 - 3) For Hot Water Service: EPDM
- d. Fittings: AWWA C 606, rigid radius-cut groove.
 - 1) Center-to-Center Dimensions: AWWA C 110/ANSI A 21.10.
 - 2) Wall Thickness and Other Characteristics: AWWA C 153.
- e. Flanged Unit Connections: Flanged to grooved joint adapters or a long enough spool with 1 end flanged and the other grooved to prevent interference with the operation of adjacent valves, pumps, or other items.

2.02 ACCESSORIES

- A. Fittings: AWWA C 110/ANSI A 21.10 or AWWA C 153/ANSI A 21.53 with the same pressure rating and joint configuration as that of the associated piping.
- B. Flexible Couplings: AWWA C 219, Install as shown on the drawings.
 - 1. Flexible Couplings: galvanized when on galvanized pipe or pipe which are epoxy or cement lined or when underground.
 - 2. They shall have a minimum pressure rating of 200 psi.
 - 3. Where flexible couplings are installed underground, Type 316 stainless steel grade B-8M, Class 2 bolts shall be used. The entire couplings shall be given a 2" bitumastic coating.
 - 4. Insertion depth of the pipe in the coupling shall be controlled by a gauge mark or mechanical stop in the coupling which will allow for thermal expansion and contraction.
- C. Cleanouts: As shown on the Drawings.

2.3 PIPE LININGS

- A. Cement-Mortar Lining and Coating: AWWA C 104/ANSI A 21.4, applied on clean bare metal surfaces; extended to faces of flanges, ends of spigots, and shoulders of hubs; painted with bituminous material.
 - 1. Coating on Cement-Mortar Coating: Bituminous material, or none when specified to receive another coating.

2.4 MARKINGS

- A. Pipe markings shall include the following, marked continuously down the length:
 - 1. Weight

2. Class or nominal thickness
3. Casting period
4. Manufacturers mark and year in which pipe was produced
5. The letters "DI" or "Ductile" are cast or stamped on the pipe
6. All marks are on or near the bell

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 1. Install ductile iron piping in accordance with AWWA C 600, modified as specified in Section 331112.
 2. Lay mechanical joint or bell and spigot pipe with 1/8 inch space between the spigot and shoulder of the pockets.

3.2 JOINTS

- A. Install types of joints as specified in piping schedule in Section 331112.

3.3 GROOVED JOINTS

- A. Install piping with grooved joints where specified or indicated on the Drawings.
- B. Assemble grooved joints in accordance with manufacturer's published instructions.
- C. Support grooved-end pipe in accordance with manufacturer's published instructions. Install at least 1 support between consecutive couplings.
- D. Install flanged or grooved joints where flanged joints are scheduled, except under the following conditions:
 1. In underground and underwater installations.
 2. In piping subject to test pressure of 200 pounds per square inch gauge or more.
 3. When wall thickness of pipe is less than the minimum recommended in published instructions by the manufacturer of the grooved end coupling.
- E. Make connections to flanged valves, pumps and piping appurtenances by either:
 1. Flanged-to-grooved joint adapters.

2. Flanged-by-grooved end pipe spool of sufficient length to prevent interference with the operation of adjacent valves, pumps or other items.
3. Integrally cast flanged-by-grooved end pipe fittings.

3.4 FIELD QUALITY CONTROL

- A. Test ductile iron piping as specified in Section 331125.
- B. Do not test sections longer than 1/2 mile in total pipe length.

END OF SECTION

SECTION 331114 - HIGH DENSITY POLYETHYLENE PIPE

PART 1 - GENERAL

1.1 SUMMARY

- A. DESCRIPTION: The work in this section consists of providing High Density Polyethylene (HDPE) pipe and fittings.
- B. RELATED SECTIONS
 - 1. Excavation and Backfilling Operations – Section 312333.
 - 2. Valves – Section 331216
 - 3. Pipeline Testing – Section 331125
- C. QUALITY ASSURANCE: References, American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), Federal Specifications (FS), International Standards Organization (ISO), and manufacturer's printed recommendations.
- D. SUBMITTALS: Material list naming each product to be used identified by manufacturer and type number, in accordance with Section 013300.
- E. PRODUCT HANDLING: Handle pipe and fittings to insure delivery in a sound undamaged condition.
- F. JOB CONDITIONS: Do not lay pipe when trenches or weather conditions are not suitable for such work.

PART 2 PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

- A. The HDPE pipe shall be manufactured in a plant capable of providing continuous quality control through inspection. The facility shall have the necessary testing equipment to verify that the pipe meets the requirements of AWWA C901 or C906, NSF Standard #61 and ASTM standards.
- B. The facility shall have the necessary testing equipment to verify that the fittings meet the requirements of AWWA C901 for sizes ½" to 2" and AWWA C906 for sizes 3" through 54".
- C. Polyethylene pipe and fittings shall be made from resin meeting the requirements of the Plastic Pipe Institute as PE 4710. The resin shall meet the requirements of ASTM D3350 with a cell classification of 445474C or higher. The requirements of this cell classification are:

HDPE Resin Specifications

PROPERTY	SPECIFICATION	UNIT	TYPICAL VALUE
HIGH DENSITY POLYETHYLENE PIPE			33 11 14 - 1

Material Designation		PPI / ASTM			PE4710
Material Classification	(1)	ASTM D 1248			III C 5 P34
Cell Classification	(2)	ASTM D 3350			445474C or higher
Density	(3)	ASTM D 1505	g/cm3		0.947 to 0.955
Melt Index	(4)	ASTM D 1238		gm/ 10 min	<0.15
Flexural Modulus	(5)	ASTM D 790	psi		110,000 to 160,000
Tensile Strength	(6)	ASTM D 638	psi		3,500 to 4,000
Slow Crack Growth ESCR	(7)	ASTM D 1693	hours in 100% igepal		>5,000
PENT	(8)	ASTM F 1473	hours		>500
HDB @ 73 deg F	(9)	ASTM D 2837	psi		1,600
UV Stabilizer	(10)	ASTM D 1603	%C		2 to 2.5%

- D. High-density polyethylene pipe and fittings can be supplied by different manufacturers as long as they meet the above ASTM D3350 cell classification.
- E. Pipe shall have a manufacturing standard of ASTM F-714. Pipe O.D. sizes 4" to 24" shall be available in ductile iron pipe sizes (DIPS) or iron pipe size (IPS). Pipe O.D. sizes 26" to 54" shall be available in ductile iron pipe sizes (DIPS) or iron pipe size (IPS). Pipe shall be DR 11 (202 psi WPR) unless otherwise specified on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits per AWWA C906 Pressure Class (PC) 100 have a nominal burst value of three and one-half times the Working Pressure Rating (WPR) of the pipe.
- F. HDPE fittings shall be of the same material as the pipe. PE4710 HDPE, Cell Classification of 445474C as determined by ASTM D3350-02, and approved for AWWA use shall also be approved if the same pressure rating is maintained. Butt fusion fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the Quality Control records. All fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.
- G. The pipe manufacturer shall have an ongoing Quality Control program for incoming and outgoing materials. High-density polyethylene (HDPE) resins for manufacturing of pipe shall be checked for density, melt flow rate, and contamination. The manufacturer of the HDPE resin shall certify the Cell Classification as indicated in section 2.01 C. These incoming resins shall be approved by plant Quality Control before being converted to pipe.
- H. Pipe shall be checked for outside diameter, wall thickness, length, roundness, and surface finish on the inside and outside and end cut.
- I. The fitting manufacturer shall have an on-going quality control program for incoming and outgoing materials. The resin shall be checked as indicated in section 2.01 C. Pipe for fabricated fittings shall be checked as indicated in 2.01 H. Molded fittings shall be inspected for voids and knit lines. All fabricated fittings shall be inspected for joint quality and alignment. All fabricated fittings welds shall be made using a DataLogger. A record of the temperature, pressure and graph of the fusion cycle shall be maintained by the fitting manufacturer.

- J. The Manufacturer of the pipe and fittings shall maintain permanent QC and QA records. DataLogger records shall be maintained on fabricated fittings.
- K. If requested, the pipe or fittings manufacturer can be required to retest or verify certification data. All retesting shall be at the requestor's expense, and shall be performed as required in the specifications.

PART 3 EXECUTION

A. BUTT FUSION JOINING

- 1. The butt fusion procedures shall be in accordance with the manufacturer or the PPI. The fusion equipment operator shall receive training using the recommended procedure. The Contractor shall be responsible to verify that the fusion equipment is in good operating condition and that the operator has been trained within the past twelve months. The fusion equipment shall be equipped with a Datalogger. Records of the welds (heater temperature, fusion pressure, and a graph of the fusion cycle) shall be maintained for five (5) years. Fusion beads shall not be removed.
- 2. The supplier of the pipe and fittings shall provide a person certified by the pipe manufacturer and the fusion equipment manufacturer to train contractor fusion equipment operators and inspectors representing the Owner.

B. OTHER JOINING METHODS

- 1. Polyethylene pipe and fittings may be joined together using Flange Adapters. These fittings shall be made from PE 4710 HDPE, with a Cell Classification of 445474C as determined by ASTM D3350-02. Flanged adapters shall have a manufacturing standard of ASTM D3261. They shall have a pressure rating equal to the pipe unless otherwise specified on the plans.
- 2. Polyethylene pipe and fittings may be joined using approved electrofusion couplings. Fittings shall be PE 4710 HDPE, Cell Classification of 445474C as determined by ASTM D3350-02. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.

C. INSTALLATION

- 1. Pipe and fittings shall be installed using procedures recommended by the manufacturer.
- 2. Pipe and fittings shall be packaged in a manner suitable for shipment by a commercial carrier. Upon receipt at job site, a receiving inspection shall be prepared. The quantity shall be verified and any shipping damage shall be reported to the supplier within 7 days.

3. Trenches shall be excavated in accordance with the plans and specifications. OSHA standards or Owner safety policies regarding safety shall be followed regarding trench safety. If groundwater is encountered, it shall be removed by the Contractor.
4. Shoring of the trench, where required is the responsibility of the contractor.
5. Flange adapters shall be attached to pipe and fittings using butt fusion. The flange adapters shall be aligned and centered relative to the pipe. Flange adapters should be square with the valve or other flange before tightening of bolts. Bolts should not be used to draw flanges into alignment. Bolt threads shall be lubricated, and flat washers shall be used under flange nuts. Bolts shall be tightened using a "star tightening pattern". See manufacturer's recommendations. Twenty-four hours after first tightening the flange bolts, they must be re-tightened using the same "star tightening pattern used above. The final tightening torque shall be as indicated by the manufacturer.
5. Install pipe on grade and on a stable foundation. Unstable soil or muck shall be removed from the trench bottom. A 6" foundation or bedding of compacted Class 1 material shall in the bottom of the trench. This bedding material shall be installed on grade. Water shall be removed from the trench before bringing the bedding material and pipe to grade and backfilling. When a trench is cut through solid rock, it shall be excavated to 6" below the pipe bottom grade, and bedded with Class 1 bedding. All slabs of rock, boulders and large rocks shall be removed. ASTM D2321 is the reference specification for installation of HDPE pipe. Bedding shall be Class 1 per this specification.
6. A nylon fabric choker sling capable of safely handling the weight of the pipe or fitting, shall be used to lift, place and move pipe and fittings.
7. Class I and II backfill shall be used for pipe embedment backfill. This material shall be compacted to at least 95% Standard Proctor Density in 6" lifts to at least 6" above the crown of the pipe.
8. Final backfill shall be placed in the trench and compacted to finished grade. Native soils without roots, limbs, large rocks, boulders, clumps, or frozen clods or any object that could damage the pipe can be used subject to requirements in Section 312323.
9. Pressure testing shall be conducted in accordance with ASTM F2164, Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure. The HDPE pipe shall be filled with water, raised to test pressure and allowed to stabilize. The test pressure shall be 1.5 times the operating pressure at the lowest point in the system. In accordance with section 9.8, the pipe shall pass if the final pressure is with 5% of the test pressure for 1 hour. For safety reasons, hydrostatic testing only will be used.

END OF SECTION

SECTION 331115-PLASTIC PIPING AND TUBING (CULINARY WATER)

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Plastic pipe, tubing, and fittings.
- B. Related Sections:
 - 1. Section 331112 - Basic Piping Materials and Methods

1.02 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. B 16.12 - Cast Iron Screwed Drainage Fittings
- B. American Society for Testing and Materials (ASTM):
 - 1. D 638 - Test Method for Tensile Properties of Plastics
 - 2. D 648 - Test Method for Deflection Temperature of Plastics Under Flexural Load.
 - 3. D 1784 - Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride)(CPVC) Compounds.
 - 4. D 1785 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 - 5. D 1869 - Specification for Rubber Rings for Asbestos-Cement Pipe.
 - 6. D 2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
 - 7. D 2412 - Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
 - 8. D 2466 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings Schedule 40
 - 9. D 2467 - Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings Schedule 80.
 - 10. D 2564 - Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
 - 11. D 2665 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe Fittings.
 - 12. D 3212 - Specification for Polyvinyl Chloride (PVC) sewer pipe joints.

13. D 4101 - Specification for Propylene Plastic Injection and Extrusion Materials.
 14. F 439 - Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
 15. F 441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
 16. F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 17. F 483 - Method for Total Immersion Corrosion Test for Aircraft Chemicals Maintenance
 18. F 493 - Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
 19. F 645 - Guide for Selection, Design and Installation of Thermoplastic Water Pressure Piping Systems.
- C. American Water Works Association (AWWA):
1. C-900.
 2. C-905

1.03 ABBREVIATIONS

- A. ID: Inside diameter of piping or tubing.
- B. PVC: Polyvinyl Chloride.
- C. PVCO: Molecularly Oriented Polyvinyl Chloride.
- D. DR: Dimension ratio.
- E. SDR: Standard Dimension ratio.

1.04 SUBMITTALS

- A. Product Data: Describe materials and installation equipment including fusion machine.
- B. Manufacturer's Published Installation Instructions.
- C. Certificates:
1. Submit manufacturer's certificate attesting that plastic pipe, tubing, and fitting types meet specified requirements.
 2. Manufacturer's certification of date of manufacture of plastic pipe and tubing for each lot delivered.

1.05 QUALITY ASSURANCE

- A. Provide pipe and tubing bearing NSF seal, except for drainage piping.
- B. Mark plastic pipe with nominal size, type, class, schedule or pressure rating, and manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect piping materials from sunlight, scoring, and distortion.
- B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Extruding and Molding Material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.
- B. Fittings: Same material as the pipe and of equal or greater pressure rating.
- C. Unions 2-1/2 inches and smaller: Socket end screwed unions. Make unions 3 inches and larger of socket flanges with 1/8 inch full face soft rubber gasket.

2.02 PVC PIPING, CLASS TYPE

- A. Materials (culinary water service).
 - 1. PVC pipe of 4-inches through 12-inches shall meet the requirements of ASTM D2241 except that the pipe shall have outside diameters of ductile iron pipe sizes instead of iron pipe sizes and shall meet the requirements of AWWA C-900 with DR of 18 as indicated on the Drawings. PVC pipe shall withstand without failure the impact of a falling 12 pound missel with a 2-inch radius hose, when tested in accordance with ASTM D 2444 at an energy level of 120 ft-lbs at a temperature of 73 degrees Fahrenheit.

Provisions shall be made for contraction and expansion at each joint with a rubber ring and integral thickened bell as part of each joint. The rubber ring shall meet the requirements of ASTM D 1869. The bell section shall be at least as strong as the pipe barrel.

At least 85 percent of the total footage of pipe shall be furnished in standard lengths of 20 feet. The remaining footage of pipe may be in random lengths of not less than 10 feet long.
 - 2. PVC Pipe: Schedule 80 plastic pressure pipe with solvent welded joints will conform to the requirements of ASTM D 1785.
 - 3. Fittings: Cast or Ductile iron fittings as specified under Section 331113, sized for the dimensions of the pipe being used.
 - a. Fittings for joining pipe 4 inches in diameter and larger: Push-on rubber gasket or mechanical joint type.

- b. Restrained Gland Mechanical Joints shall be such that it can replace the standardized mechanical joint gland and can be used with the standardized mechanical joint bell conforming to ANSI/AWWA C111/A21.11 of latest revision. The restraining glands shall have pressure rating equal to that of the pipe on which it is used.
 - 1) EBAA Iron Sales 2000PV or approved equal.
- 4. Gaskets: Meeting the requirements of ASTM D 1869 or ASTM F 477.
- 5. Flexible Couplings: As shown on the Drawings (with the same pressure as the associated pipe)
 - c. Where flexible couplings are installed underground, they shall be galvanized and Type 316 stainless steel grade B-8M, Class 2 bolts shall be used. The entire couplings shall be given a 2" bitumastic coating.

2.03 SOURCE QUALITY CONTROL

- A. PVC Piping, Class Type:
 - 1. Test pipe to withstand, without failure, 600 pounds per square inch, gauge, hydrostatic pressure for a minimum of 5 seconds.
 - 2. Test integral bell with the pipe.

2.04 MARKINGS

- D. Pipe markings shall include the following, marked continuously down the length:
 - 1. Nominal Size.
 - 2. PVC.
 - 3. Dimension Ratio.
 - 4. AWWA pressure class.
 - 5. AWWA designation number.
 - 6. Manufactures name or trademark and production-record code.
 - 7. Seal (mark) of the testing agency verifying the suitability of the pipe material for potable service.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Where not otherwise specified, install piping in accordance with ASTM F 645, ASTM D2774, AWWA M23 or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.

2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.
 3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
 4. Provide serrated nipples for transition from plastic pipe to rubber hose.
- B. Installation of PVC Piping, Class Type:
1. Install piping in accordance with the Appendix of AWWA C 900 and AWWA C 909 complemented with manufacturer's published instructions.
 2. Provide for contraction and expansion at each joint with a rubber ring and integral thickened bell as part of each joint.
 3. 16 gage tracer wire and identification tape shall be installed with all water pipe and connected to all services and valves.

3.02 FIELD QUALITY CONTROL

- A. Leakage Test for PVC Piping, Class Type:
1. Polyvinyl-chloride (PVC) piping, Class type: Subject to visible leaks test and to pressure test with maximum leakage allowance, as specified in Section 331125.
 2. Do not test sections longer than 1/4 mile in total pipe length.

END OF SECTION

SECTION 33 11 25 - PIPELINE TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing requirements for potable water and sewer force main piping systems.

1.2 DEFINITIONS

- A. Leakage: The quantity of water required to maintain the specified hydrostatic test pressure after the pipeline has been filled with water and the air expelled.
- B. Non-rigid Pipe: Any pipe which required bedding and backfill material for structural support.

1.3 SUBMITTALS

- A. Pipeline Test Report: Include the following items:
 - 1. Type of test.
 - 2. Identification of pipe system.
 - 3. Size, type, location and length of pipe in test section.
 - 4. Test pressure and time.
 - 5. Amount of leakage versus allowable.
 - 6. Date of test approval.
 - 7. Signature of test supervisor.
 - 8. Signature of the Engineer or Inspector witnessing and approving the test.

1.4 PROJECT CONDITIONS

- A. Repair pipeline system at no additional cost to Owner until it passes subsequent retesting.
- B. Recording Equipment:
 - 1. Supply all necessary equipment to perform pressure testing.
 - 2. Secure Engineer's approval of pressure gages.

3. Locate all gages and recording equipment away from affect of sunshine or other weather conditions.
4. Place, vents, pressure taps and drains for the test. Repair pipeline at the completion of the test at no cost to the Owner.

PART 2 - PRODUCTS

2.1 TESTING MATERIALS

- A. Medium: Water as required by test.
- B. Equipment: Temporary motors, pumps, pumping apparatus, pressure gages, connections, power, etc. for making the tests.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Pipeline pressure and leakage testing shall be done in accordance with AWWA standards. AWWA C600-99 for ductile iron pipes and AWWA C605-94 for PVC pipes.
- B. Notify the Engineer 48 hours in advance of test.
- C. Carry out tests as pipeline construction progresses to ensure construction methods are producing satisfactory results.

3.2 PRESSURE TEST

- A. Test pressure may be limited by valves, or other lower pressure rated components. Such components may not withstand the required test pressure. They should be either removed, or isolated from the test section to avoid possible damage, or failure of these devices. Isolated equipment should be vented.
- B. Expel all air from the pipeline before applying the specified test pressure. Provide air release taps at points of highest elevations before testing. Insert permanent plugs after test has been completed.
- C. A minimum pressure 50% in excess of the maximum line operation pressure shall be maintained on the portion being tested for a minimum period of two hours, using hydraulic means to maintain the pressure. Test pressure to be 200 psi.
- D. Maximum leakage during the test shall not exceed 0.092 gallons per inch of diameter per 1000 feet of pipe per hour, for non-polyethylene pipe.

E. Polyethylene pipe testing:

1. For polyethylene pipe test pressure is 1.5 times the system operating design pressure, the total test time including initial expansion, and time at test pressure, must not exceed eight (8) hours. **If the test is not completed due to leakage, equipment failure, etc., depressurize the test section, then allow it to “relax” for at least eight (8) hours before bringing the test section up to test pressure again.**
2. The test procedure consists of initial expansion, and test phases. During the initial expansion phase, the test section is pressurized to the test pressure, and enough make-up liquid is added each hour for three (3) hours to return to test pressure.
3. The test phase follows immediately, and may be two (2), or three (3) hours. At the end of the test time, the test section is returned to test pressure by adding a measured amount of liquid. If the amount of make-up liquid added does not exceed the following values leakage is not indicated:

Phase Make Up Amount

Nominal Pipe Size (IPS) (in.)	Make-Up Water Allowance (U.S. Gallons/ 100 ft. Pipe)	
	2 hour test	3 hour test
1 1/4	0.10	0.16
1 1/2	0.10	0.17
2	0.11	0.19
4	0.25	0.40
6	0.6	0.9
8	1.0	1.5
10	1.3	2.1
12	2.3	3.4
14	2.8	4.2

4. An alternate leakage test consists of initial expansion, and test phases. For the initial expansion phase, make-up water is added as required to

maintain the test pressure for three (3) hours. For the test phase, the test pressure is reduced by 10 psi. If the pressure remains steady (within 5% of the target value) for an hour, no leakage is indicated.

- F. Suitable means shall be provided by the Contractor for determining water lost by leakage under the test pressure.
- G. Locate and repair the defective joints and retest until the leakage is within the specified allowance.
- H. Repair any noticeable leakage even if total leakage is less than allowable.
- I. Flushing:
 - 1. After pressure testing all pipelines shall be flushed.
 - 2. Flushing shall be accomplished through hydrants or, if a hydrant does not exist at the end of the line, the Contractor shall install a tap of sufficient size to provide for a 3.0 foot per second flushing velocity in the line.
 - 3. The following is the flow quantity required to provide a 2.5 foot per second flushing velocity:

Pipe Size (In.)	Flow (gpm)
2	30
4	120
6	270
8	475
10	750
12	1,050
16	1,900
20	2,446
24	3,525
30	5510

3.3 OBSTRUCTION TEST

- A. Visually examine pipe internally for obstructions.
- B. When required by the Engineer, a round incompressible madrel which is 1" less in diameter than the internal diameter of the pipeline and 2 times the diameter in length will be passed through the pipeline.

3.4 PIPE TESTING SCHEDULE

A. Potable Water System and sewer force main piping:

1. Obstruction test.
2. Pressure test.

END OF SECTION

SECTION 33 12 15 – DRINKING WATER AIR-RELEASE AND VACUUM-RELIEF VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section includes materials and installation of vacuum relief valves, air-release valves, combination air-release and vacuum relief valves for drinking water service.
- B. All drinking water valves shall be certified in accordance with NSF International standard 61 (NSF/ANSI 61).

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Pressure Testing of Piping: Section 33 11 25.

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with the General Provisions.
- B. Submit manufacturer's catalog data. Show dimensions, materials of construction by ASTM reference and grade, and coatings.

PART 2 - MATERIALS

2.1 VALVE IDENTIFICATION

- A. Valves are identified on the plans by size and type.

2.2 VALVE TAGGING AND IDENTIFICATION

- A. Provide identifying valve tags with Contract Documents

2.3 BOLTS AND NUTS FOR FLANGED VALVES

- A. See specification for the pipe to which the valve is attached.

2.4 GASKETS FOR FLANGED END VALVES

- A. Gaskets for flanged end valves shall be as described in the detail piping specifications.

2.5 VALVE DESIGN AND OPERATION

- A. Air-release valves for water service shall function to slowly release pockets of air which accumulate at high points in piping systems. Valves 3/4 inch and smaller shall be of the direct-acting type or lever type. Valves larger than 3/4 inch shall

have a float-actuated compound lever with linkage mechanism to release air. Float shall withstand an external pressure of 1,000 psig without collapsing.

Air-release valves of sizes 1 inch and 2 inches shall incorporate a body with flanged top cover and replaceable orifice and a synthetic rubber needle or disc actuated by the float and linkage mechanism. Top cover shall include a 1/2-inch threaded outlet with bronze plug. Body shall include a 1/2-inch threaded drain outlet near the bottom with a bronze plug.

- B. Combination air-release valve 4 inches and larger for water service shall consist of an air and vacuum valve with an air-release valve attached to it. The air and vacuum valve shall serve to release and admit large quantities of air when pipelines are filled and drained. The attached air-release valve shall serve to release small quantities of air that accumulate during pipeline operation. Connect the attached air-release valve to the air and vacuum valve with standard weight steel piping (ANSI B36.10) and an isolation gate valve.

2.6 MATERIALS OF CONSTRUCTION

- A. Materials of construction for air-release valves for water service shall be as follows:

<u>Item</u>	<u>Material</u>	<u>Specification</u>
Body and cover	Cast iron	ASTM A 48, Class 30; or ASTM A 126, Class B
Float	Stainless steel	AISI Type 316, ASTM A 240 or A 276
Linkage, orifice	Stainless steel	AISI Type 316, ASTM A 240 or A 276
air-release mechanism		
Needle	Buna-N	--

- B. Materials of construction for air and vacuum valves for water service shall be as follows:

<u>Item</u>	<u>Material</u>	<u>Specification</u>
Body and cover	Cast iron	ASTM A 48, Class 30; or ASTM A 126, Class B
Float, guide rod, guide bushings	Stainless steel	AISI Type 316, ASTM A 240 or A 276
Seat	Buna-N	--

- C. Bronze shall have the following chemical characteristics:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

- D. Rubber seats shall be made of a rubber compound that is resistant to free chlorine and monochloramine concentrations up to 10 mg/l in the fluid conveyed.
- E. Body and cover bolts, nuts, and cap screws shall be Type 304 stainless steel.

2.7 VALVE END CONNECTIONS

- A. Valves smaller than 3 inches shall have threaded ends. Valves 3 inches and larger shall have flanged ends.
- B. Flanges for Class 150 valves shall comply with ANSI B16.1, Class 125. Flanges for Class 300 valves shall comply with ANSI B16.1, Class 250.
- C. Threaded ends shall comply with ANSI B1.20.1.

2.8 VALVES

- A. Air-Release Valves, 1 inch and 2 inches, Class 300:

Valves shall have an operating pressure of 300 psi. Orifice size shall be 3/32 inch. Valves shall be APCO 200A, Val-Matic Model 38, or equal.

All valves covered by this section which are intended for use with potable water shall be fusion bonded epoxy lined and coated with an NSF61 approved epoxy coating product.

- B. Combination Air and Vacuum Relief Valves, 1 inch through 3 inches class 150.

1" Valves shall be APCO 143C or equal

2" Valves shall be APCO 145C or equal

3" Valves shall be APCO 147C or equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseal or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.
- B. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

3.2 VALVE PRESSURE TESTING

- A. Test valves at the same time that the connecting pipelines are pressure tested. See Section 33 11 25 for pressure testing requirements. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the test pressure.

END OF SECTION

SECTION 33 12 16 - VALVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The following valves and their installation: Gate, plug, ball, butterfly, pressure reducing, solenoid, air-release, and air-vacuum.
- B. This section address valves for drinking water and wastewater systems.
- C. This section includes materials, testing, and installation of drinking water service valves buried in soils with 2500 ppm chlorides groundwater.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this Section:
 - 1. American National Standards Institute (ANSI).
 - 2. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
 - b. B16.34, Steel Valves-Flanged and Butt Welding End
 - c. B16.5, Pipe Flanges and Flanged Fittings
 - d. B16.47, Large Diameter Steel Flanges
 - 3. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
 - 4. American Water Works Association (AWWA):
 - a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - b. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4-inch through 144-inch
 - c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
 - d. C504, Rubber-Seated Butterfly Valves.
 - e. C516, Large Diameter Butterfly Valves.

- f. C509, Resilient-Seated Gate Valves for Water Supply Service.
 - g. C540, Power-Actuating Devices for Valves and Sluice Gates
 - h. C550, Protective Epoxy Interior Coatings for Valves and Hydrants
 - i. C800, Underground Service Line Valves and Fittings.
5. ASTM International (ASTM):
- a. A182, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - c. A351/A351M, Standard Specification for Castings, Austenitic, Austenitic-Ferric (Duplex), for Pressure-Containing Parts.
 - d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - e. B61, Standard Specification for Steam or Valve Bronze Castings.
 - f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
 - h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
 - i. B139, Standard Specification for Phosphor Bronze Rod, Bar & Shapes.
 - j. B148, Standard Specification for Aluminum-Bronze Sand Castings
 - k. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
 - l. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
 - m. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.

- n. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
- o. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- 6. Manufacturers Standardization Society (MSS):
 - a. SP-80, Bronze Gate, Globe, Angle and Check Valves.
 - b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
 - c. SP-88, Diaphragm Type Valves.
- 7. NSF International (NSF): 61/372, Drinking Water System Components — Health Effects.
- 8. Underwriters Laboratories (UL).
- 9. USC Foundation for Cross-Connection Control and Hydraulic Research.
- 10. AWWA C111: American National Standard for Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
- 11. AWWA C504: AWWA Standard for Rubber-Seated Butterfly Valves
- 12. AWWA C508": AWWA Standard for Swing-Check Valves for Waterworks Service, 2 In. Through 24 In. NPS.
- 13. AWWA C509: AWWA Standard for Protective Interior Coatings for Valves and Hydrants.
- 14. AWWA C550: AWWA Standard for Protective Interior Coatings for Valves and Hydrants.
- 15. AWWA C600: AWWA Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.3 SUBMITTALS

- A. Manufacturer's affidavit certifying product was manufactured, tested and supplied in accordance with applicable references in this section together with a report of the test results and the date each test was completed.

- B. Provide detailed technical information as required by the Engineer for evaluating the quality of the valve. This shall include complete dimensions, weights, materials lists and operation charts, etc.
- C. Submittals shall be entirely in English and in English/US units. If metric information is provided, provide clear equivalent English information
- D. Shop Drawings for Drinking Water Valves
 - 1. Submit manufacturer facility where valves will be made and its ISO 9000 certification. Provide manufacturer lead contact name, address, and phone number.
 - 2. Detail the qualifications, name and phone number and office location of the qualified field maintenance representative in US to field certify installation, testing, field trouble shoot, and long term support for valves. Detail the qualifications, name and phone number and office location of who will handle this project order, production and delivery.
 - 3. Data for each make and model; valve type, number, tag number. Specify which detail sheets apply to each valve proposed.
 - 4. Complete information, descriptive literature, specifications, and materials of construction (in USA material specs i.e.: AISI, ANSI, ASTM, AWWA). Provide warranty for all valves.
 - 5. Submit valve preparation and coating written QA and QC procedures as approved and endorsed by an independent third party such as NACE, GSK or SSPC. QA/QC test procedures shall include photographic documentation to communicate quality acceptance levels. Coatings shall be applied in strict accordance of the coating manufacturer's recommendations for valve prep, temperature and humidity conditions.
 - 6. Certify linings and coatings are NSF 61 compliant. Certify valves are in compliance with NSF 61, or two other acceptable equal international drinking water standards.
 - 7. In transmittal letter listing valves proposed, certify each proposed valve is in full compliance with this specifications and note any exceptions to that certification.
 - 8. Manufacturer's Certificate of Compliance for butterfly valves and gate valves - indicating all proposed valves are in full compliance this specification and with manufacturer's quality control standards – with any exceptions noted.
 - 9. Tests and inspection data.

10. Operation and Maintenance Data.
11. Manufacturer's Representative Certificate of Proper Field Installation:
Certify the first of each valve size installed was installed per manufacturers' recommendations: the first 24-inch valve installed, the first 12-inch valve installed, and the first 8-inch valve installed.

1.4 WARRANTY

- A. Provide 2-year warranty.

PART 2 - PRODUCTS

2.1 VALVES - GENERAL

- A. Submerged or Above Water: Stainless steel nuts and bolts.
- B. Underground: Unless otherwise indicated, provide the following:
 1. 2.5" and larger: Flanged ends or designed for bolting to flanged pipe.
 2. Less than 2.5": Screwed ends.
 3. For valves exceeding 3" diameter, provide with non-rising stems and a 2" square operating nut. Provide low alloy steel bolts in accordance with AWWA C111.
- C. Below and Operating Deck: Provide shaft extension from the valve to deck level.
- D. Above Ground: Non-rising stems and equipped with a hand wheel unless indicated otherwise.
- E. Manually Operated Valves Over 6' Above Operating Level: Provide with chain operated handles.
- F. Install so that handles clear all obstruction when moved from open to closed.
- G. Rated Working Pressure: 250 psi unless indicated otherwise.
- H. Unless otherwise indicated coat non-plastic valves in accordance with AWWA C550.
- I. For drinking water valves:
 1. Certify valves are suitable for intended service:

- a. Valve Exterior Conditions: buried service within corrosive soils with 2500 ppm chlorides groundwater. Assume salt groundwater level is at elevation of the valve. Valve flanges and valves will be electrically bonded to cathodically protected well coated piping, and then flanges and bolts will be field wrapped in wax tape per AWWA 217.
- b. Valve Interior Conditions: potable water inside the valve.
- 2. Valves to be in full compliance with drinking water standards, NSF 61 or equal international standards. Compliance with WRAS (United Kingdom Water Regulation Advisory Standards) and DVGW (German drinking water certification agency) standards is considered equal to NSF 61 with approval from Utah Division of Drinking Water. Certify which drinking water standard each valve is compliant with. Provide valves for a pH range from 6 to 10 and temperature range from 33 to 100 degrees F.
- 3. Internal rubber parts exposed to water shall be made of a rubber compound that is resistant to free chlorine and monochloramine concentrations up to 10 mg/l (drinking water) in the fluid conveyed.
- 4. Valves shall be flanged, have AWWA Class E bolt pattern; shall mate to adjacent piping per Section 33 01 10, General Piping Requirements; and be of the same diameter as adjoining pipe.
- 5. All valves shall have zero leakage in both directions at valve rated design pressure. Certify valves have been shop tested above 200 psi pressure differential across seat in both directions with zero leakage across seat.
- 6. Valves and actuators shall both turn clockwise to close valves.
- J. Smaller drinking water valves in buildings and vaults shall be NSF 61 certified, 1000 psi rated, SST, ¼ turn, full port ball valves, unless otherwise noted. Connecting piping shall be SST Schedule 40.

2.2 GATE VALVES

- A. Acceptable Manufactures:
 - 1. For above ground installation:
 - a. Mueller
 - b. American Flow Control
 - c. AVK
 - d. Clow

- 2. For below ground (buried) installation
 - a. Erhard Multamed gate valve Premium, short pattern
 - b. VAG gate valve
 - c. AVK Series 66 (for HDPE pipe connections only)
 - d. Clow
- B. Valves 2 in.—66in. shall be resilient wedge type rated for 250 psig cold water working pressure.
- C. All ferrous components shall be ductile iron. The words "DI" or "Ductile Iron" shall be cast on the valve
- D. All NRS valves, in applicable configurations, 2-1/2in.—24in. in diameter shall be listed by Underwriters Laboratories, Inc.
- E. All OS&Y valves in applicable configurations, 3in.—24in. in diameter shall be listed by Underwriters Laboratories, Inc. Valves 3 in—54 in. shall be in full compliance with ANSI/AWWA C515.
- F. The wedge shall be ductile iron encapsulated with EPDM rubber and provided with male type guides and polymer guide covers.
- G. Bolting shall be Type 304 stainless steel and shall be provided with hexagonal heads with dimensions conforming to ANSI B18.2.1. Metric size, socket head cap screws therefore are not allowed.
- H. Operating nut shall be constructed of ductile iron and shall have four flats at stem connection to assure even input torque to the stem.
- I. All gaskets shall be pressure energized O-rings.
- J. Stem shall be sealed by three O-rings. The top two O-rings shall be replaceable with valve fully open and while subject to full rated working pressure. O-rings set in a cartridge shall not be allowed.
- K. Valve shall have thrust washers located with (1) above and (1) below the thrust collar to assure trouble-free operation of the valve.
- L. All internal and external surfaces of the valve body and bonnet shall have a fusion-bonded epoxy coating, complying with ANSI/AWWA C550, applied electrostatically prior to assembly.
- M. Valves shall be certified to NSF/ANSI Standard 61 and NSF/ANSI 372.
- N. Additional requirements for buried drinking water valves:

1. Buried Resilient Seated (RS) Gate Valves (GV) for Drinking Water Pipes in corrosive groundwater (4 to 12 inch Diameter):
 - a. Resilient, soft seated gate valve shall per AWWA C509, Class 150, for buried waterline service - but allow for British Standard EN 558, Series 14 option for face to face length.
 - b. Drill flanged ends to AWWA C207, E flange drilling pattern, flat face.
 - c. Ductile iron body and bonnet, non-rising stem, full port valve.
 - d. Fully encapsulated valve wedge of permanently bonded rubber.
 - e. Bottom of valve body channel to be smooth - with no recesses.
 - f. Protective cap at bonnet with triple lip seals to keep out groundwater.
 - g. Edge protection and sealing between body and bonnet shall be of single piece profile seal to ensure safety and impact protection.
 - h. Valve stem to incorporate Bayonet stem bearing design with multiple EPDM O-rings, medium free and maintenance-free (and vacuum safe).
 - i. Shaft/stem: super duplex SST per paragraph 2.03.
 - j. Shaft bearing/stem bushing: special bronze per paragraph 2.03.
 - k. Exterior Hardware/Bolts: countersunk and molded; made of super duplex SST per paragraph 2.03.
 - l. Linings/Coatings: FBE per paragraph 2.03.
 - m. Manufacturers and Products. Manufacturer shall have serviced their valves, under the valve manufacturer's name, in the US for at least 10 years (or in Canada for at least 20 years):
2. Fusion Bonded Epoxy (FBE) Lining and Coating:

- a. Heat-activated (fusion) material, "fusion" or "fusion bonded" epoxy (FBE). Provide a minimum of 14 mils dry film thickness on all surfaces.
 - b. Valve linings and coatings shall be blue.
 - c. Line and coat per AWWA C550 and manufacturer recommended quality control. Submit manufacturer written quality compliance requirements, preparation, work, documentation, and post application review based on professional coating and grading (i.e. NACE, SSPC, GSK, ISO or DIN) with both text and color photo-documentation. Document and implement quality control and quality assurance for all valves linings and coatings. At valve delivery, submit signed checklists indicating work was done per lining and coating quality control system.
 - d. Coating damaged in shipping or installation shall be noted and properly repaired to the satisfaction of the utility or its authorized agent.
 - 1) Buried Resilient Seated (RS) Gate Valves (GV) for Drinking Water Pipes in corrosive groundwater (4 to 12 inch Diameter):
3. Certify valves are suitable for intended service:
- a. Valve Exterior Conditions: buried service within corrosive soils with 2500 ppm chlorides groundwater. Assume salt groundwater level is at elevation of the valve. Valve flanges and valves will be electrically bonded to cathodically protected well coated piping, and then flanges and bolts will be field wrapped in wax tape per AWWA 217.
 - b. Valve Interior Conditions: potable water inside the valve.
 - c. Valves to be in full compliance with drinking water standards, NSF 61 or equal international standards. Compliance with WRAS (United Kingdom Water Regulation Advisory Standards) and DVGW (German drinking water certification agency) standards is considered equal to NSF 61 with approval from Utah Division of Drinking Water. Certify which drinking water standard each valve is compliant with. Provide valves for a pH range from 6 to 10 and temperature range from 33 to 100 degrees F.
 - d. Internal rubber parts exposed to water shall be made of a rubber compound that is resistant to free chlorine and monochloramine concentrations up to 10 mg/l (drinking water) in the fluid conveyed.

- e. Valves shall be flanged, have AWWA Class E bolt pattern; shall mate to adjacent piping per Section 33 01 10, General Piping Requirements; and be of the same diameter as adjoining pipe.
 - f. All valves shall have zero leakage in both directions at valve rated design pressure. Certify valves have been shop tested above 200 psi pressure differential across seat in both directions with zero leakage across seat.
 - g. Certify valves are suitable for intended service.
4. Special materials for buried valves in corrosive groundwater
- a. Buried valve external surfaces or parts will be exposed to up to 2500 ppm chlorides groundwater. The following valve components, which are not fusion epoxy coated, shall be made of materials that will not corrode in 2500 ppm chlorides groundwater which is commonly at the valve elevation.
 - b. Bolts on valve exterior: comply with Section 33 01 10, General Piping SST bolts. Use same bolts for flanges.
 - c. Stems, Shafts (for valves and gearboxes): manufacturer-recommended super duplex SST, PREN 37 or higher (S32520/S32550, or S32670 are acceptable), or Owner-approved equal.
 - d. 2-inch square nut and extension stem: manufacturer- recommended SST that won't corrode in 2500 ppm chlorides. Extension stem shall be 1.5- inch diameter pipe with 0.19-inch thick wall. Submit means to field-adjust stem length so nut in valve box is 4- to 8-inches from final grade.
 - e. Bushings around valve stems exposed to groundwater: manufacturer- recommended bronze that won't corrode in 2500 ppm chlorides water.
 - f. Internal bronze and brass valve components and accessories in contact with drinking water: shall have less than 16 percent zinc and 2 percent aluminum. Acceptable internal valve parts bronze alloys are ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127. Stainless steel Alloy 18-8 may be substituted for internal valve parts bronze.

2.3 CHECK VALVES

- A. Acceptable Manufactures:
 - 1. Apco/DeZurik
 - 2. Pratt
 - 3. Val-Matic
- B. Check valve shall be of the flanged, full body type.
- C. Valves shall be ANSI/AWWA C508 compliant.
- D. The flanged ends shall be manufactured in accordance with ANSI B16.1 Class 125.
- E. Valves shall be rated to 150 psi for all sizes.
- F. The valve body shall be constructed of ductile iron ASTM A-536 Grade 65-45-12 with flow area equal to the nominal pipe inside diameter throughout the valve.
- G. Valves shall be factory equipped with lever and weight assembly and air cushioned.
- H. The seat and internal body shall be fully coated with a two-part thermosetting epoxy suitable for use in both potable water and wastewater applications.
- I. The domed bonnet shall be manufactured of ductile iron ASTM A-536 Grade 65-45-12. The bonnet-to-body seal shall be provided by a gasket to allow easy removal and replacement of the access bonnet without removing the valve from the line. Bonnet bolting shall be SAE Grade 5.
- J. The resilient disc shall feature a fully encapsulated steel pressure plate with integral molded O-ring on the face of the elastomer. Seat shall have Buna-N resilient seat with drip tight shut off.
- K. The manufacturer shall furnish certified results of a proof of design test performed at an independent testing laboratory. Testing shall include a one (1) million-cycle continuous test to demonstrate the durability of the flexible connection.

2.4 PRESSURE RELIEF VALVE

- A. Acceptable Manufactures:
 - 1. Cla-Val (model 90-01 KO)
 - 2. Singer (model 106-AC)
- B. Valve shall open quickly at an adjustable pre-set overpressure to dissipate damaging surge, and close slowly at adjustable speed after restoration of normal line pressure.

- C. A needle valve shall be furnished to regulate valve closing speed.
- D. The valve shall have only one flanged cover at the valve top from which all internal parts shall be accessible. There shall be no stems, stem guides or spokes within the waterway. There shall be no springs to assist the valve operation. All controls and piping shall be of non-corrosive construction.
- E. Valve seat will be renewable without removing valve body from pipe installation.
- F. Valve interior trim shall be bronze B-62. The valve shall be supplied completely piped ready for installation.
- G. Valve shall be flanged suitable for 250 psi working pressure and for discharging 250 psi to atmosphere without damage to the valve or seat.
- H. Provide a 120 V electrical contact switch and extension rod to allow activation of alarm in the event the valve opens.

2.5 SEWAGE AIR VALVES

- A. Acceptable Manufactures:
 - a. DeZurik 440 SCAV
 - b. Or equal
- B. Sewage Combination Air Valve (single body, double orifice) allows large volumes of air to escape or enter the pipeline.
- C. When the pipeline is filled and pressurized the large air/vacuum orifice shall stay closed, but the smaller diameter air release orifice shall remain operative and open to allow small pockets of air accumulation to escape automatically and independently of the large orifice.
- D. The large air/vacuum orifice shall shut off when the free floating-center guided plug is raised into the orifice by the lifting force of the concave - bottom float.
- E. The large orifice shut-off shall be "without spilling."
- F. The Buna-N seat must be fastened to the valve cover, without distortion, for drop-tight shut-off.
- G. Body & Cover Ductile Iron ASTM A536 GR 65-45-12
- H. Needle and Seat Buna-N Nitrile Rubber
- I. Plug (1"-4")(25-102mm) Brass ASTM B124

- J. Exterior Paint Universal Metal Primer FDA Approved for Potable Water
- K. This discharge orifice area shall be larger or equal to the inlet of valve.
- L. The valve shall consist of a body, cover, baffle, float and seat. The baffle will be
- M. All materials of construction shall be certified in writing to conform to A.S.T.M. specifications as follows:

Body & Cover	Ductile Iron	ASTM A536 GR 65-45-12
Concave Float	Stainless Steel	ASTM A240 T304
Stem	Stainless Steel	Series T300
Needle and Seat	Buna-N Nitrile Rubber	
Exterior Paint	Universal Metal Primer FDA Approved for Potable Water	

2.6 DRINKING WATER AIR VALVES

See Section 33 12 15 Drinking Water Air Release and Air Vacuum Valves

2.7 PLUG VALVES

- A. Acceptable Manufactures:
 - a. Pratt
 - b. DeZurik
 - c. Valmatic
- B. Plug valves shall be of the non-lubricating, eccentric type and shall be designed for a working pressure of 175 psi for valves 12" and smaller, 150 psi for valves 14" and larger. Valves shall provide tight shut-off at rated pressure.
- C. Valves 12" and smaller shall have round port design. 14" and larger valves shall have rectangular port design.
- D. The plug valve body shall be cast iron ASTM A126 Class B with welded-in overlay of at least 95% nickel alloy content on all surfaces contacting the face of the plug. Sprayed, plated, nickel welded rings or seats screwed into the body are not acceptable.
- E. The valve plug shall be ductile iron ASTM A-536, Grade 65-45-12, in valve sizes up to 20", and ASTM A126 Class B cast iron in sizes 24" and larger, with Buna N resilient seating surface to mate with the body seat.
- F. Valve flanges shall be in strict accordance with ANSI B16.1, Class 125.
- G. Plug valve shall be furnished with permanently lubricated sleeve type bearings conforming to AWWA C517. Bearings shall be of sintered, oil impregnated type 316 stainless steel ASTM A-743 Grade CF-8M or bronze ASTM B-127.

- H. Valves shaft seals shall be of the "U" cup type, in accordance with AWWA C517. Seals shall be self-adjusting and re-packable without moving the bonnet from the valve.
- I. 6" and smaller exposed valves shall be provided with wrench actuators. 8" and larger exposed valves shall be provided with worm gear type manual actuators.
- J. All buried valves shall be provided with worm and gear actuators suited for the intended service.
- K. Valve actuators shall be fully grease packed and have stops in the open/close position. The actuator shall have a mechanical stop which will withstand an input torque of 450 lbs. against the stop.
- L. The actuator shall be able to provide 1.25 times the required operating torque under full rated line pressure combined with a flow velocity of 8 feet per second.

2.8 BALL VALVE

- A. Acceptable Manufactures:
 - 1. Pratt
 - 2. DeZurik
 - 3. Valmatic
- B. Each ball valve shall be rubber seated, round full port, and shall consist of these main elements:
 - 1. A pressure vessel (body), a rotatable closing element (ball), a torque unit, and an operator.
 - 2. Standard ball valves shall be furnished in cast iron ASTM A48 CL-35(150# class).
 - 3. Ball valve construction shall be in complete accordance with AWWA specifications C507 for ball valves 6" thru 48" with metal seats per specification section 3.2.3.2.
- C. The body shall have ANSI B16.1 CL. 125/150 flanges and shall house the ball.
- D. The body shall have integrally cast, bronze bushed trunnions. It shall provide rigid means for supporting the torque unit without the necessity of additional supports.
- E. There shall be two (2) pipe connections, one for an air vent and the other for drain. The body shall have rigidly attached corrosion resistant metal seat(s) made of 400 series Monel.

- F. Maximum seat bearing pressure shall not exceed 1,000 lbs/sq. inch.
- G. The ball shall have integrally cast, bronze bushed trunnions. An extension of one trunnion, called the operating shaft, shall pass through a sealing device (O-ring retainer) and connect to the torque unit.
- H. The operating shaft shall be 17-4PH high strength stainless steel. The sealing device shall be capable of being removed and having its seals replaced without removing the valve from the line.
- I. The ball shall have corrosion resistant metal seat(s) of 300 series stainless steel rigidly attached and fully adjustable to provide drop-tight sealing (1 oz. per inch per hour exceeding AWWA C507 standards).
- J. The ball shaft shall be so designed that the factor of safety for all combined stresses shall be at least five to one. Maximum torsional deflection shall not exceed 1/6 degree per foot of unsupported length using a seat coefficient of friction of 0.5 and a bearing coefficient of friction of 0.3.
- K. The torque unit shall employ a traveling crosshead to impart positive rotary movement to the ball by means of a link and lever connected to the ball shaft.
- L. A ball shaft support bearing shall be connected to the ball shaft. The torque unit shall be designed so that during the first 50 percent of stroke in closing, the flow area is reduced by approximately 81 percent. The remaining flow area shall be gradually reduced to a complete shutoff throughout the last 50 percent of closing stroke.
- M. The torque unit shall also be designed so that the O-ring seals on the main shaft can be replaced without removing the torque unit housing and while the valve is in the line.

2.9 ACCESSORIES FOR BURIED VALVES

- A. Cast Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 6-inch ID shaft.
 - 1. Box: Cast iron with minimum depth of 9 inches.
 - 2. Lid: Cast iron, minimum depth 3 inches, marked WATER.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Flush all pipelines with valves in fully open positions.
- B. Install per manufacturer recommendations and requirements.

- C. In ductile iron water mains install valves in accordance with AWWA C600.

END OF SECTION

SECTION 33 12 19 - FIRE HYDRANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Barrel type fire hydrants.

1.2 REFERENCES

- A. American Water Works Association (AWWA):
 - 1. C 502 - Hydrants, Dry Barrel Fire.
- B. Draper City Standards

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Waterous "Pacer"; Clow Medallion; or equal.

2.2 MATERIALS

- A. Fire Hydrants:
 - 1. Dry barrel in accordance with type AWWA C 502, as complemented and modified herein.
 - 2. Provide hydrants with ground level break-off feature and manufacture such that the valve stem will not be bent when the hydrant is damaged or broken at or near the ground level.
 - 3. When shut, provide valves that remain reasonably tight when the upper portion of the barrel is broken off.
 - 4. Diameter of the main valve opening: Not less than 4 inches.
 - 5. Inlet connection: 6 inch diameter mechanical joint for ductile iron pipe.
 - 6. Provide two, 2½ inch hose nozzles and one, 4½ inch pumper nozzle facing the street.
 - a. Provide nozzles with hose caps chained to the hydrant barrel.
 - b. Nozzle threads: National standard hose thread.
 - 7. Hydrants: Furnish with drain valve.

8. Color of hydrant above ground shall be red.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install hydrants with proper extension so that branch pipe to hydrant and supply main are at the same elevation.
- B. Attach auxiliary 6 inch gate valves by mechanical joint at 18 inches from the hydrant joint, and attach piping ductile-iron to the supply.
- C. Firmly set hydrants on a bed of coarse gravel.

END OF SECTION

SECTION 33 13 00 - DISINFECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Disinfection of potable water system.
- B. Test and report results.

1.2 REFERENCES

- A. AWWA A100: AWWA Standard for Water Wells.
- B. AWWA B300: AWWA Standard for Hypochlorites.
- C. AWWA B301: AWWA Standard for Liquid Chlorine.
- D. AWWA C651: AWWA Standard for Disinfecting Water Mains.
- E. AWWA C652: AWWA Standard for Disinfection of Water-Storage Facilities.
- F. State of Utah: Public Drinking Water Regulations, R309-545-20.

1.3 DEFINITIONS

- A. Disinfectant Residual: The quantity of disinfectant in treated water.
- B. ppm: Parts per million.

1.4 SUBMITTALS

- A. Contractors evidence of experience in disinfection.
- B. Bacteriological laboratory's evidence of certification.
- C. Contractor's disinfection plan
 - 1. Contractor's disinfection plan shall be submitted for approval by the Engineer 30 days prior to the anticipated date of the beginning of disinfection activities.
- D. Operation of valves
 - 1. Contractor shall only operate valves which were installed as a part of this work. Valves existing prior to this work shall be operated by the Owner's representatives.

- E. Disinfection Report: 3 copies including:
1. Date issued.
 2. Project name and location.
 3. Treatment contractors name, address and phone number.
 4. Type and form of disinfectant used.
 5. Time and date of disinfectant injection started.
 6. Time and date of disinfectant injection completed.
 7. Test locations.
 8. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
 9. Time and date of flushing start.
 10. Time and date of flushing completion.
 11. Disinfectant residual after flushing in ppm for each outlet tested.
- F. Bacteriological Report: 3 copies including:
1. Date issued.
 2. Project name and location.
 3. Laboratory's name, certification number, address, and phone number.
 4. Time and date of water sample collection.
 5. Name of person collecting samples.
 6. Test locations.
 7. Time and date of laboratory test start.
 8. Coliform bacteria test results for each outlet tested.
 9. Certification that water conforms or fails to conform to bacterial standards of State of Utah public drinking water regulations.
 10. Bacteriologist's signature.

1.5 QUALITY ASSURANCE

- A. Affidavit by manufacturer that disinfectant conforms to AWWA standards.
- B. Bacteriological Laboratory: Certified by State of Utah.

1.6 PRODUCT HANDLING

- A. Store and protect disinfectant in accordance with manufacturer=s recommendations to protect against damage or contamination. Do not use unsuitable disinfectant.
- B. Follow all instruction labeling for safe handling and storage of disinfectant materials.

1.7 REGULATORY REQUIREMENTS

- A. Conform to State of Utah public drinking water regulations.

PART 2 - PRODUCTS

2.1 DISINFECTANT

- A. Liquid Chlorine: AWWA B301 with chlorine 99.5 percent pure by volume.
- B. Sodium Hypochlorite: AWWA B300 with not less than 100 grams per liter available chlorine.
- C. Calcium Hypochlorite: AWWA B300 with 65 to 70 percent available chlorine by weight in granular form.
- D. Powder, tablet, or gas according to manufacturer's specification.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prior to starting the disinfection procedure ensure the potable water system is completed, cleaned, tested in accordance with Section 33 11 25 and ready for disinfection.
- B. Ensure that the pipeline to be disinfected is not connected to the existing system.

3.2 DISINFECTION OF WATER LINES

- A. Use on of the approved methods in AWWA C651.
- B. Disinfecting solutions containing chlorine should not exceed 12% active chlorine,

because greater concentration can chemically attack and degrade polyethylene.

- C. Chlorination shall provide a minimum of 25 ppm residual after 24-hours contact in the pipeline. In general, this residual may be expected with an application of 50 ppm although some conditions may require more.
- D. Chlorine, in the form of a 1% slurry of high test calcium hypochlorite (HTH, Perchloron, Pittchlor, etc.) shall be fed into the pipeline in such a manner as to mix with the water flowing in the pipeline. (A 1% slurry results from mixing 1 pound of the calcium hypochlorite with 7.50 gallons of water.)
- E. The following table provides information as to the required quantity of slurry to be used per 100 feet of pipe to provide a chlorine concentration of 50 ppm:

Pipe Size (In.)	Vol. Of 100 Ft. Length (gal.)	Required Amount of Slurry (gal.)
4	65	0.33
6	147	0.74
8	261	1.3
10	408	2.0
12	588	3.0
16	1044	5.2
24	2350	11.5

- F. During the process of chlorinating the pipeline all valves and other pipeline appurtenances shall be operated several times to provide sufficient contact with the chlorinating agent.

3.3 DISINFECTION OF WATER STORAGE RESERVOIRS

- A. Use one method defined under AWWA C652, as approved by the Engineer.
- B. Do not start disinfection until water storage tank is thoroughly cleaned.
- C. Provide and use necessary safety equipment for workers in contact with disinfectant or gasses they may produce.

3.4 QUALITY CONTROL - BACTERIOLOGICAL TEST

- A. No samples for testing shall be taken sooner than 24 hours after system flushing.

- B. Sample water at each of the following locations, as applicable:
 - 1. Where water enters system.
 - 2. Ends of piping runs.
 - 3. Remote outlets.
- C. A minimum of two samples taken at least 24 hours apart shall be taken at each location.
- D. Analyze water samples in accordance with State of Utah requirements.
- E. If bacteriological tests proves water quality to be unacceptable, repeat system treatment.
- F. Water systems shall not be accepted or placed into service until two negative bacteriological tests are made on water taken. Repeat dosing as necessary until negative tests are obtained. Provide a copy of the negative bacteriological tests to the Engineer.
- G. It shall be the contractor's responsibility to submit and pay for the bacteriological tests.

3.5 FLUSHING AND DISPOSAL OF DISINFECTANT

- A. Before disinfection and flushing contractor shall submit a flushing plan to the Engineer to be approved by the City. Flushing water will not be available during high usage periods.
- B. After the 24 hour retention period, flush the chlorinated water from the main until chlorine measurements show the concentration in the water leaving the main is no higher than that generally prevailing in the system or is acceptable for domestic use.
- C. Legally dispose of disinfecting water and ensure no chlorine buildup or damage to the environment.
- D. Failing to flush the line may require Contractor to replace all gaskets and valves within the system at Contractor's expense.

END OF SECTION

SECTION 333913 - MANHOLES AND COVERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Modular precast concrete manhole sections with tongue-and-groove joints covers, anchorage, and accessories.

1.2 RELATED SECTIONS

- A. 03 11 00 Concrete Formwork
- B. 03 20 00 Concrete Reinforcement
- C. 03 30 00 Concrete Work
- D. 03 30 40 Portland Cement
- E. 03 35 00 Concrete Finishing
- F. 03 39 00 Concrete Curing

1.3 REFERENCES

- A. AASHTO M-105: Gray Iron Castings.
- B. AASHTO M-199: Precast Reinforced Concrete Manhole Sections.
- C. ASTM C-923: Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes.

1.4 SUBMITTALS FOR REVIEW

- A. Shop Drawings: Indicate manhole locations, elevations, piping, and sizes and elevations of penetrations.
- B. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 GENERAL REQUIREMENTS

- A. The Contractor shall furnish and install watertight cast-in-place or precast concrete manholes at the locations shown on the Drawings approved by the Engineer.
- B. Manholes shall be furnished complete with cast iron rings and covers.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Manufacturers:
 - 1. Amcor Model
 - 2. Geneva Pipe Model
 - 3. W.R. White Model
 - 4. Materials and Equipment: Product options and substitutions. Substitutions: Permitted.
- B. Manhole Sections: Reinforced precast concrete in accordance with AASHTO M-199 with gaskets in accordance with ASTM C-923.
- C. Mortar and Grout: Type S.
- D. Reinforcement: All reinforcement for precast manholes, sections and risers shall be FBE (fusion bonded epoxy) coated.

2.2 COMPONENTS

- A. Wall and Cone Sections
 - 1. Manhole walls shall be constructed of 48" I.D. precast sectional, reinforced concrete pipe.
 - 2. For pipelines of 18" diameter or larger, the manholes shall be 60" minimum I.D. Both cylindrical and taper sections shall conform to all requirements of AASHTO Designation M-170 for Reinforced Concrete Culvert Pipe with the following exceptions:
 - a. The throat section of the manhole shall be adjustable by use of pipe sections up to 18 inches in height.
 - b. The 48-inch inside diameter pipe used in the base section shall be furnished in section lengths of 1, 2, 3 and 4 feet as required.

- c. Reinforcing steel shall consist of a circular cage with a minimum cross sectional area of three-tenths (0.3) of a square inch of steel per foot in both directions.
 - 3. All joint surfaces of precast sections and the face of the manhole base shall be thoroughly cleaned and wet prior to setting precast sections.
 - 4. All joints including grade rings shall be set in mortar consisting of 1 part cement and 1 ½ parts sand with sufficient water added to bring the mixture to workable consistency, or the joints shall be sealed with butyl rubber gasket that is permanently flexible and non-shrinking, similar to Brandt No. 95 Cold Weather Vault Sealant.
- B. Manhole Steps
- 1. 12" Copolymer Polypropylene Plastic Steps
 - 2. Reinforcement: ½" grade 60 steel reinforcement.
 - 3. Steps must meet requirements outlined in ASTM 2146-68 under Type II, Grade 16906 and AASHTO M-31.
 - 4. Steps are not required unless specifically called out on drawings.
- C. Concrete Base Pad
- 1. Except as noted below, manhole bases shall be pre-cast concrete conforming to the requirements of Section 03 30 00 of these Specifications.
 - 2. For high ground water areas, precast manholes and bases shall be required.
 - 3. The Precast manhole supplier shall design manholes using buoyancy countermeasures for the existing ground water conditions. A safety factor of 1.25 shall be used.
- D. Lid and Frame
- 1. All iron castings shall conform to the requirements of AASHTO M-105 for grey iron castings.
 - 2. Rings and covers shall have machined bearing surfaces and a minimum cover weight of 150 pounds and minimum ring weight of 233 pounds.
 - 3. The manhole cover shall be a smooth surface "cross-hatch" pattern class 35 lid with the words "SEWER".

4. All manhole rings shall be carefully set to the grade shown on the approved drawings or as directed by the Engineer.
5. The manhole covers shall be so installed to be within 1/4" from the asphalt surface.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location and ready for roughing into Work.
- C. Verify excavation for manholes is correct.

3.2 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.3 PLACING MANHOLE SECTIONS

- A. Place base pad, with top surface level.
- B. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.
- C. Cut and fit for pipe as required.
- D. Grout vase of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.
- E. Set cover frames and covers level without tipping, to correct elevations.

END OF SECTION

SECTION 33 41 00 – STORM DRAINAGE UTILITY PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and fittings
- B. Channel drainage systems
- C. Manholes
- D. Cleanouts
- E. Non-pressure transition couplings
- F. Expansion joints
- G. Catch basins
- H. Stormwater inlets
- I. Pipe outlets

1.2 RELATED SECTIONS

- A. Section 01 33 00: Submittal Procedures
- B. Section 01 45 13: Materials Quality Requirements
- C. Section 01 50 00: Temporary Facilities and Controls
- D. Section 01 70 00: Execution and Closeout Requirements
- E. 2017 APWA Standard specifications

1.3 REFERENCES Not Used

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Manholes: Include plans, elevations, sections, details, frames, and covers.
 - 2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Polypropylene (PP) Storm Drain Pipe

1. Use polypropylene (PP) storm drain pipe and fittings (ADS HP Storm or equivalent) per ASTM F2881 and AASHTO M330, Type S for respective diameters. Minimum stiffness at 5% deflection (at diameter) shall be:
 - a. 60 at 15"
 - b. 56 at 18"
 - c. 50 at 24"
 - d. 46 at 30"
 - e. 40 at 36"
 - f. 35 at 42" and 48"
 - g. 30 at 60"

B. Spirolite HDPE Storm Drain Pipe of Equal Stiffness

1. If there is no alternate to HDPE HP Storm PP an equal material is Spirolite HDPE Storm drain pipe per ASTM F-894 and ASTM D-3350, having equal or greater stiffness as HP Storm pipe listed in 2.1.A.1.

2.2 NONPRESSURE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.3 MANHOLES

- A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478 precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 60 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990 bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923 cast or fitted into manhole walls, for each pipe connection.
9. Steps: Deformed, 1/2-inch reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Retain one of two subparagraphs below if required to raise top of manhole to grade.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.
3. Manholes should be avoided in inmate accessible areas. If such installations cannot be avoided, structure cover frames should be of steel construction set in concrete. The covers should be secured by spot welding the lids to the frames to restrict access.

2.4 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 2. Benches: Concrete, sloped to drain into channel.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

2.5 CATCH BASINS

- A. Standard Precast Concrete Catch Basins:
1. Description: ASTM C 478 precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
 4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 5. Joint Sealant: ASTM C 990 bitumen or butyl rubber.
 6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
 8. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.
1. Size: 24 by 36 inches minimum unless otherwise indicated.
 2. Grate Free Area: Approximately 50 percent unless otherwise indicated.
 3. All shall be Bicycle Safe type grates.
 4. Catch basins should be avoided in inmate accessible areas. If such installations cannot be avoided, structure cover frames should be of steel construction set in concrete. The grates should be secured by spot welding the lids to the frames to restrict access.

2.6 STORMWATER INLETS

- A. Curb Inlets: Made with vertical curb opening.
- B. Gutter Inlets: Made with horizontal gutter opening. Include heavy-duty frames and grates.
- C. Combination Inlets: Made with vertical curb and horizontal gutter openings. Include heavy-duty frames and grates.
- D. Frames and Grates: Heavy duty.
- E. See Division 05 53 00 Gratings, Cover Plates, Handrails, and Roof Access Hatch for fabricated-steel grating.
- F. Stormwater inlets should be avoided in inmate accessible areas. If such installations cannot be avoided, structure cover frames should be of steel construction set in concrete. The grates should be secured by spot welding the lids to the frames to restrict access.

2.7 PIPE OUTLETS

- A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
- B. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
1. Average Size: NSSGA No. R-3, screen opening 2 inches.
 2. Average Size: NSSGA No. R-4, screen opening 3 inches.

3. Average Size: NSSGA No. R-5, screen opening 5 inches.
 4. Retain both paragraphs below to require specific stone sizes.
- C. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.
- D. Stainless steel security bars shall be installed on all outlet pipes 10 inches in diameter or larger to prevent passage of a human.

2.8 REINFORCEMENT

- A. Reinforced concrete storm drain manholes, grade rings, catch basins, inlets, outlets, etc shall use only fusion bonded epoxy coated rebar and other reinforcing components.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Division 31 Section "Utility Trenching."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, non-pressure drainage piping according to the following:
1. Install piping pitched down in direction of flow.
 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting

- manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
- 3. Install piping with 24 inches minimum cover.
- 4. Install PE corrugated sewer piping according to ASTM D 2321.
- 5. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- F. Install drainage pipe to tolerances recommended by manufacturer. Unless otherwise shown, install drainage pipe true and level using precision gauges and levels.
- G. Refer variances between manufacturer's installation instructions and Contract Documents to Owner's Representative.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, non-pressure drainage piping according to the following:
 - 1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
 - 2. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
 - 3. Join dissimilar pipe materials with non-pressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
 - 2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
 - 3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
 - 4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

- A. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.9 CONNECTIONS

- A. Connect non-pressure, gravity-flow drainage piping in building's storm building drains to drain piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- B. Connect sanitary sewer sediment interceptors sewer to drain piping and underground manholes.
- C. Pipe couplings and expansion joints with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use non-pressure-type flexible couplings where required to join gravity-flow, non-pressure sewer piping unless otherwise indicated.

3.10 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earthwork." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
1. Use detectable warning tape over ferrous piping.
 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
1. Submit separate reports for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.

- b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B.** Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soil-tight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.
 - c. Option: Test concrete piping according to ASTM C 924.
- C.** Leaks and loss in test pressure constitute defects that must be repaired.
- D.** Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Corrugated Polyethylene Double-Wall Drainage Pipe	Installation & Leakage	Visual inspection of finished installation	1 inspection	Owner	Owner
	Field Performance	ASTM F2487 Demonstrate compliance to Contract Documents and Manufacturers' printed Literature	1 test	Contractor	Contractor
	11 month Warranty Inspection	Demonstrate compliance to Contract Documents	1 test	Owner	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
		and Manufacturers printed Literature			

END OF SECTION